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NOVEMBER 1986

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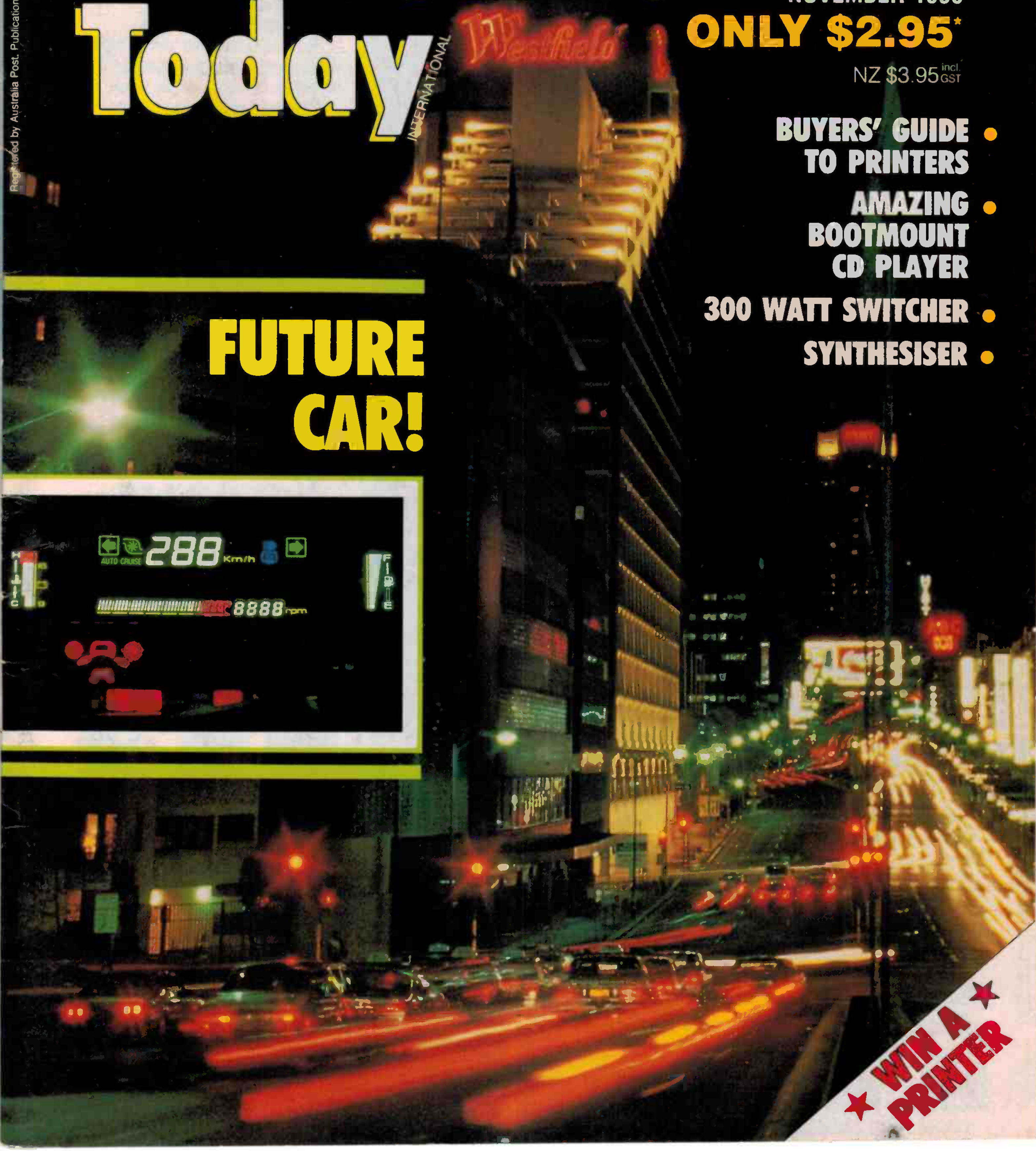

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COVER: Photography by Jon Fairall.

Government stimulating science

Public perception as expressed in the mainstream media seems to be that Science Minister, Barry Jones, and Industry, Technology and Commerce Minister, John Button, are relative lightweights in the Hawke ministry. Yet both have been suprisingly successful in selling Canberra on the idea of a technology-led answer to our current economic woes.

In the Budget, science and technology were one of the few areas where government spending actually increased in real terms. What's more, the move seemed to have bipartisan support in the house. It's one of the few areas where the opposition didn't attack the government.

Specific details of some of the allocations of the budget: Dept of Science appropriation was almost $591 million, including $364 million for the CSIRO. Other beneficiaries included the Research Grants Scheme ($32m); meteorology ($82m); Ionospheric prediction ($1.8m); National Research Fellowships ($4m); Antarctic division ($46m); analytic laboratories ($9m); and the Institute of Marine Science ($8.2m). Some special grants were also made to the Anglo-Australian Telescope ($2m), and space projects ($100,000).

Total allocation to the Department of Industry, Technology and Commerce, (DITAC) was $380m. Specific allocations were made for $30m for the steel industry; $25m for the car industry; $90m in heavy industry; and $0.4m for communications. Space projects get $5.25m.

At the same time, Telecom, with an embarrassingly large operating profit was talking about investing $2200m this year. $1450m has been allocated to technical equipment and material, $131m on buildings and $70m on R&D. Almost all the R&D and building money will be spent here, and more than half the $1450m will be given to local manufacturers.

In after-budget statements DITAC's John Button called the budget a responsible balance between restraint and revitalization. Science's Jones said "we have come a long way from the *annus horribilis* of 1984/85," when the science budget was horribly cut up.

After the budget dust had settled, it became apparent that various schemes to encourage development of new technologies were still well in place. The 150% tax deductability of R&D expenditure is still a feature of the tax package, and numerous departments now have schemes in place to funnel money to innovators.

Telecom's new antenna test range at Caldermeade, Vic.

Button announced a new scheme immediately after the budget called the National Teaching Company scheme to encourage academics and companies to come together to develop products. The scheme pays half the salary of a researcher and has been allocated $0.75m in the current year.

OTC's new player

A new force has entered Australian electronics, attracted by the smell of wealth in the Tasman 2 cable project unveiled recently by OTC (see "News" August '86 ETI). It's the result of the merger of two of the world's biggest communication companies, AGC/Alcatel of France and ITT of the US.

ITT, of course, owns STC, one of the current big players in the Australian market.

The new company has agreed to build a $53 million factory to supply fibre for the Tasman 2. It will be capable of manufacturing 75 km of unbroken cable.

The company results from the merger of CIG, Alcatel and Thomson CSF of France in January 1986. Now comes the merger with ITT, making it the second biggest communications company in the world, smaller only than the US giant ATT.

Between them the parent companies have considerable expertise and market penetration in a number of areas which flows on to the new group. For instance, Alcatel was the first to introduce digital time domain switching in the public communications network and now claims about 14% of the world market.

Other parts of the group rank second in the world for microwave switching technology, hold 25% of the world market for submarine coax, are number 2 in the supply of satellite downstations, number 1 in the supply of road and rail toll stations and command a major share of the market for automatic mail sorting machines.

This giant's interest in Australia stems from Tasman 2, OTC's plan to link Australia to NZ by 1990 with optic fibre. This will be the first part of a Pacific fibre ring that will run from Australia to SE Asia and Japan, and then to Los Angeles, before returning via Hawaii and New Zealand. The total projected cost for this is $2 billion.

OTC and the NZPO have made it a top priority to use Tasman 2 as a means of creating and sustaining employment and expertise in the communications area, by letting contracts only in the two countries.

A space policy for Australia

The Federal Government has released details of a national space policy to support Australia's involvement in space-related technology research and development. The objective of the policy will be to encourage greater involvement by Australian industry in space research and development activities and to promote development of commercially viable industries based on space technologies.

The Minister for Industry, Technology and Commerce, Senator John Button, and the Minister for Science, Mr Barry Jones, announced this recently when releasing the Government's response to the Australian Academy of Technological Science's Working Party Report entitled 'A Space Policy for Australia'.

"Australia's geographic position, size and natural resources – both on and offshore – guarantee we will be a major user of space technology," they said.

"This provides us with an opportunity to develop a local industry with potential for sales in the world market.

"The leading-edge technologies used in such a space program will have an important leavening effect on Australian industry."

The Government's decision was complementary to other initiatives designed to foster greater private sector participation in research and development – such as the 150 per cent tax concession and the Grants for Industrial Research and Development Scheme. These were all important elements in the Federal Government's strategy to revitalise Australian industry so it could operate more efficiently and compete more effectively on overseas markets.

The Ministers said the Federal Government had accepted the thrust of the Madigan Report's recommendations, particularly the need to formulate a national space policy and that the Federal Government should play a leading role in facilitating the development of space science and technological capabilities. It also accepted the identification of ground sector activities and remote sensing technology as areas of immediate potential, and the important role of international collaboration.

The only recommendation not accepted by the government was the setting up of a statutory authority to pull together all of the country's space efforts. The government has gone for an Australian Space Board instead, which will report directly to the Minister of Industry, Technology and Commerce.

There will be a review of the arrangements before the end of 1989-90 to see if they are still an adequate response to Australia's industrial and scientific objectives.

Scitec's infrared laserhead and the laserlynx base unit combine to make the interlaser system the very latest in state-of-the-art laser technology.

Light moves

The electro optical industry is rapidly growing in size and importance in Australia. Financial dealings are resulting in small firms becoming parts of larger ones with more resources for R&D.

Quentron Optics, for instance, the Adelaide-based manufacturer of medical lasers, was recently absorbed by Laserex to make it one of the larger industrial groupings in the country. More recently Laser Systems has been taken over by BWD systems, itself a subsidiary of BWD Industries, best known for its line of CROs.

BWD Precision Instruments will manufacture lasers and carry out R&D on behalf of Laser Systems, a move expected to enable a major expansion into Australian and export markets.

Meanwhile, other companies are already at it. Vision Systems recently announced a successful tender in the US for its optical recognition security systems, and Scitec Communications has just sold the first of its laser open air communications systems to AAP.

The Scitec system, called Interlaser involves a laser, with appropriate lenses, that can project a detectable beam over about 2 km at speeds up to 2.048 Mb in full duplex mode. AAP will use the system for networking data streams between buildings in the city.

Ericsson puts on line giant PABX system

The Swedish Ericsson group has completed one of the world's largest corporate PABX installations, linking all its sites in the Stockholm area.

With 25,000 extensions covering 22 different sites, it has more 'subscribers' than some of the area codes in the Swedish public network.

Known as the 'LMCOM' network, it is a fully digital, distributed telephone system, built up around the Ericsson MD110 digital PABX, which is used by many of Australia's major business houses.

There are a total of nine PABX exchanges with 104 distributed line interface modules (LIMs) on different sites, working together as a single integrated network.

The largest single MD110 – with 50 LIMs – is at the company's Telefonplan headquarter, south of Stockholm. This supports 8500 extensions and will be expanded to 11,700 extensions.

The LMCOM acts just like a single telephone exchange, and has the capacity for 2500 trunk lines into the public network.

Incoming calls can be transferred from one part of the network to any other part – a facility that eliminates the frustration of callers dialling one number, and then being told that they should dial a different number for the division or person they want to contact. Internal traffic needs only a five-digit number.

As well as developing the LMCOM network as a solution to its own communications needs, Ericsson has treated the project as a test bed for the assessment and trial of new corporate network techniques.

Research began in the late '70s, as the group tried to predict what sort of communications networks the big companies around the world would need for the mid to late '80s and beyond.

The MD110 PABX at the heart of the LMCOM network – a major product also marketed by Ericsson Australia – is a fully digital exchange capable of handling integrated voice and data. At the moment, about 20% of the telephone extensions in the network are digital instruments, but this figure is increasing.

The network can be used for point-to-point data communications for the desktop PCs that are proliferating within the company. PCs and data terminals are able to be connected to the PABX via an ordinary twisted pair telephone cable – a facility that is seen as cutting the cost of providing data networking facilities.

COMING EVENTS

NOVEMBER

Infotex 86, a computer and electronics exhibition presented by the NSW Chamber of Manufacturers and the Australian Computer Society will be held 4-6 November in Canberra. For further details contact Atek Promotions, 131 City Walk, Canberra, ACT 2601. (062)49-7799.

Aussat will hold a conference for satellite users — **Aussat '86: New Horizons** on 5 and 6 November at the Hyatt Kingsgate Hotel in Sydney. Contact Aussat Public Affairs Dept. on (02) 238-7800.

Computer Expo '86 will be held 5 to 8 November at the Mayfair Crest Hotel, Brisbane. Contact Robert Woodland on (07) 372-3233.

Seminars on understanding **data communications** will be held 10 to 11 November at the Ansett International, Perth; 17 to 18 November at the Grosvenor Hotel, Adelaide; 20 to 21 November, Sheraton Hotel, Melbourne; 27 to 28 November, Sheraton Hotel, Brisbane; 1 to 2 December, Gazebo Hotel, Sydney. Contact Management Technology Education on (02) 290-3555 or (03) 67-7117.

The 1st Australian Artificial Intelligence Congress and Exhibition will be held 18 to 20 November, Hyatt on Collins. Contact (02) 439-5133.

Pronic '86 an international exhibition of products for electronics will be held in Paris 18 to 21 November. Contact French Chamber of Commerce and Industry on (02) 29-3320.

Munich will be host to **Electronica '86**, the 12th international trade fair for electronic components and assemblies. Set aside 11-15 November. More details are available from the German Australian Chamber of Industry and Commerce on (02)29-3999.

DECEMBER

Hong Kong CommuniTech & Computer '86 is on 3 to 6 December. Contact Australian Exhibition Services on (03) 267-4500.

The third **'mathematics-in-industry' study group** will be held at Monash University, Melbourne, from 1 to 5 December, 1986. Further information is available from Dr F.R. de Hoog, CSIRO Division of Mathematics and Statistics, GPO Box 1965, Canberra, ACT 2601. (062) 82-2011.

The 11th Optical Fibre Technology Conference will be held 1 to 4 December. Contact the Institute of Radio & Electronics Engineers on (03) 606-6581 for more information.

A seminar on **integrating voice and data** is on 3 to 5 December at the Gazebo, Sydney. Contact Management Technology Education on (02) 290-3555 or (03) 67-7117.

The **Pacific Region Conference on Electrical Engineering Education** is on 15 to 17 December at Vue Grand, Queenscliffe, Vic. Contact John Hulskame at RMIT on (03) 660-2453 for more information.

The Intelligent Autonomous Systems Conference is on 8 to 11 December in Amsterdam. Contact Secretariat, Conference IAS, C/- Congressbureau "Van Neutegen", PO Box 27783, 3003 MB Rotterdam. (010) 433-3179.

JANUARY

Information Online '87 will be held 27 to 29 January at the Hilton, Sydney. Contact Kay Paterson on (02) 332-4622.

FEBRUARY

Finance '87 Melbourne, an exhibition of money-handling technology, will be held at the World Trade Centre, Melbourne, 10 to 13 February. For further information contact BPI Exhibitions on (02) 266-9799.

MARCH

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

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

The dates and venues for the two PC87s are as follows: **Eighth Australian Personal Computer Show**, Centrepoint, Sydney, 18-21 March, 1987; and **Ninth Australian PC Show** 'Communications 87', 'Office Technology 87', Royal Exhibition Building, Melbourne, 1-4 June, 1987.

Labex '87, International Lab and Equipment and Products exhibition is in Brisbane at the Science Pavilion, RNA Exhibition Grounds, 31 March to 2 April. Contact BPI on (02) 266-9799.

APRIL

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

MAY

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

JUNE

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

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

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

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

AUGUST

Nelcon '87, National Electronics Conference will be held 24 to 28 August at Auckland University, New Zealand. Contact B.S. Furby on (02) 957-3017.

SEPTEMBER

Labex '87, International Laboratory Equipment and Products Exhibition is on 21 to 24 September at the Royal Exhibition Building, Melbourne. Contact BPI Exhibitions on (02) 266-9799 or (03) 699-9151.

NEWS DIGEST

OTC chooses GTE

OTC recently awarded the Telecommunications division of GTE Australia contracts worth SA3.4m for two of its major projects. The first is to supply a wide range of earth station equipment for OTC's new earth stations in Sydney, Perth and Melbourne. Sydney will be a major gateway for international FDM telephone and TV traffic via the Intelsat V Indian and Pacific Ocean Satellites. Perth will also work the Indian and Pacific Satellites, and Healesville (near Melbourne) will be used for uplinking TV to the Pacific Satellite.

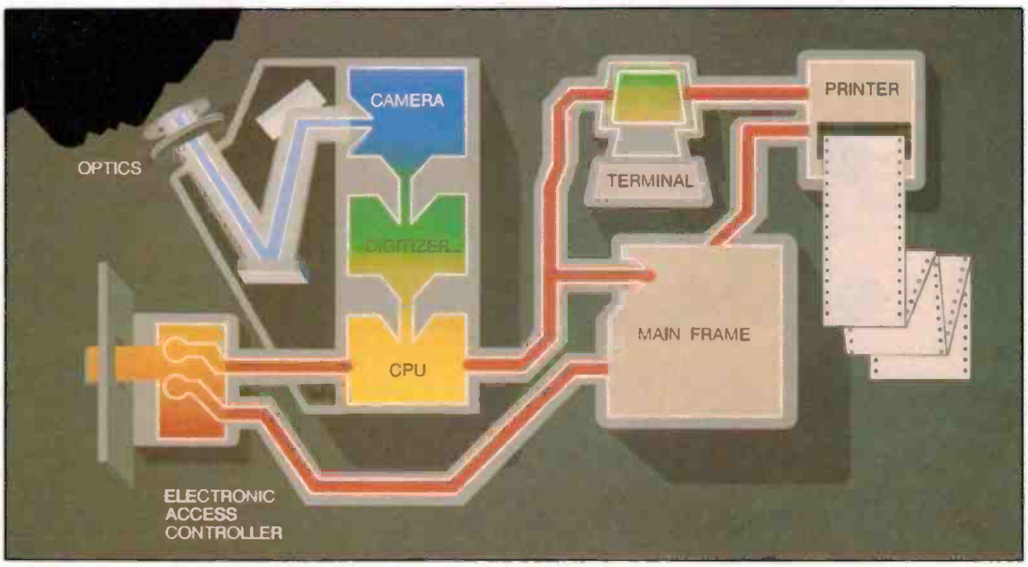
Further contracts have also been received for equipment at these down stations and for the existing Ceduna earth station in South Australia, for the forthcoming transition to digital telephone and data traffic on the Intelsat satellites. The earth station equipment to be supplied comprises up- and down-converters and mode-modulators for TV and telephony, some in redundant configuration.

Intelsat communications satellites (courtesy COSSA).

The second project is an 11 GHz terrestrial microwave and optical fibre system to carry two 140 Mb/s and two TV traffic signals from the new earth station near Sydney to the OTC gateway exchange in the city. The system is novel in so far as the link is implemented by microwave radio between the city and a repeater site, and thence by optical fibre down an escarpment to the earth station. At the repeater the TV signals are through-connected to the optical fibre at IF. The 140 Mb/s signals are transferred at the radio's aggregate bit rate of 143 Mb/s, thus avoiding demodulation to baseband. The optical fibre and the IF transmission system is to be supplied to OTC by Integral Fibre Systems.

The transmission equipment to be supplied on both these projects is being manufactued by GTE Telecomunicazioni SpA of Milan, Italy. The first earth station equipment for Perth has already been delivered ahead of the other stations, in order to be available for the transmission of the TV pictures to the USA and Europe for the forthcoming America's Cup yacht race.

Ultimate ID system



Most people relate personal identification to finger printing, but now new technology has developed a foolproof method of identification by scanning people's eyes.

Developed in the US, the new system is being used to screen personnel in defence bases and other high security areas.

The equipment is called the EyeDentification System. It is being marketed in Australia by Access Control Systems.

The unit uses precision optics and sophisticated computer technology to 'read' the retinal eye patterns of people's eyes. It works on the principle that every person, even an identical twin, has a totally distinct, stable retinal pattern that is impossible to change. Research has shown that the probability of two people having the same pattern in either eye is one in a million and that the pattern, or signature, is remarkably stable, varying only under conditions of severe eye disease.

The system is claimed to have capabilities which give it an accuracy unmatched by other personal identification systems such as lock and key devices, written signatures and fingerprints, plastic card systems and digital locks, and security guards.

The unit is compact, either wall-mounted or free-standing and uses advanced technology and a low-intensity infrared light source to perform a circular scan and 320 readings of the intricate pattern at the back of the eye.

With the EyeDentify's maximum of 1200 stored eye signatures, the unit averages less than seven seconds to scan and then release security mechanisms.

It can operate as a stand-alone system, as a network of units linked to a central computer, or as a value-added component to an existing security control system.

For further information contact **Access Control Systems (Aust) Pty Ltd, 20 Powells Rd, Brookvale, NSW 2100. (02) 938-2122.**

Making the Gordon River safe

A Department of Communications report should lead to greater safety for tourists on Tasmania's Gordon River, an area attracting up to 1000 visitors a day. Following radiocommunications tests, the report and advises marine authorities how to ensure the speedy transmission of radio messages to rescue organizations in any emergency.

Fears have been held for the safety of tourists travelling along the four hour, 160 km return trip from Strahan across Macquarie Harbour, and up the Gordon River. It is a scenic trip, but could present hazards for visitors.

The Marine Board of Hobart wanted to make by-laws for passenger craft in the area, but lacked expertise on radio propagation matters. It sought advice from the Department of Communications which suggested that a properly planned survey of radio propagation in the area would be the best approach to the problem.

The tests were conducted in March 1986. The ever-changing nature of high frequency radio propagation was taken into account, as well as the practical aspects of operating radios whilst piloting vessels in confined waters.

In many cases, radio-equipped vessels operating at a lower standard than that recommended could communicate from much of the river. However, no safety margin existed for poorer conditions.

High frequency propagation revealed good performance on 4125 kHz, whatever the hour. Late in the day 2182 kHz was useful, and 6215.5 kHz provided excellent long-range communication. This situation could vary throughout the year, which boat operators should be aware of.

Because high frequency band performance may at times be poorer than on the test day, maximum antenna and overall efficiency are essential. Also, suppression of all on-board noise is necessary (very often operators are unaware that their calls have been answered, due to on-board interference).

Ship-to-ship communications were found to be best performed on the international VHF band. This band frequency is best for ship-to-aircraft communications and a boon for any search-and-rescue operation in the area.

Following the extensive tests carried out by DOC, the Marine Board of Hobart has adopted a set of procedures in the interests of passenger safety and safe navigation. These procedures apply to all commercial passenger-carrying vessels and seaplanes.

All commercial vessels are required to maintain a continuous listening watch on VHF channel 16 for the duration of the trip, making position reports at designated places. They must ensure their high frequency radios are capable of communicating with any OTC station for the whole trip.

Seaplanes need to be equipped with a marine VHF radio with channel 16 as a minimum. They have to be fitted with an International VHF marine transceiver of 25 watts minimum power, in addition to compulsory aviation equipment.

Also, all marine board craft are required to maintain a continuous listening watch on VHF radio channel 16.

Electronic funds agreement

EFTech, in a move designed to consolidate its position in the expanding EFTPOS (electronic funds transfer at point of sale) industry, has announced distributor/dealer agreements with three major EFTPOS equipment suppliers.

The companies which have signed agreements to date with EFTech are Burroughs, Fortronics Technology, and STC.

These international organisations are already firmly established in the Electronic and telecommunications industries and EFTPOS equipment is forming an integral part of their product ranges. Terminals and other hardware available from them will be offered by EFTech to retailers seeking specific solutions to their particular needs.

Retailers will therefore have a choice of equipment from EFTech that will be approved for connection to the ANZ-EFTPOS network (ENS) which in turn is linked to other financial institutions through the national Telecom communications distribution switch.

EFTech's wholly-owned subsidiary, EFTech Technical Services, is currently providing project management, site preparation and installation of EFTPOS equipment for Sportsgirl and Bristol Decorator Centres; two national retailer groups which are being connected to the ANZ/ENS network.

NEWS DIGEST

Radio Moscow covers the world

A wall full of Radio Moscow cards.

Operating in an area that covers one seventh of the world's land surface, some 11 time zones, and with a population of 250 million people, the Union of Soviet Socialist Republics has the most extensive shortwave service in the world.

The major broadcasting organization in the USSR is Radio Moscow which broadcasts to every corner of the globe. The Radio Moscow World Service which presumably takes its title from the successful BBC World Service, operates around the clock in English. It is identified by the Kremlin Bells and news broadcast on the hour every hour. The balance of the program is made up of commentaries, music and special interest programs.

Radio Moscow operates four other services. One, identified by the Kremlin Bells and a nine pip time signal is intended for home reception but can be heard on many SW frequencies. The "Mayak" program has a music service and identifies itself with the "Midnight in Moscow" theme. The third service broadcasts mainly literature and music, but it is seldom heard on SW. The other service is the Youth Radio Station but with a format far removed from the top 40. While all the programs are intended for domestic use, the vastness of the Soviet Union demands the use of SW.

Listeners in other parts of the world besides the USSR can hear the Voice of the Soviet Homeland as well as several political groups on the Radio Peace and Progress transmission. Seamen the world over can be reminded of home by Radio Leningrad or, in the Pacific Ocean, from Radio Vladivostok.

In the afternoons many broadcasts in Spanish to Cuba are heard, as well as a special transmssion to Chile known as Radio Magallenes.

Radio Moscow also supplies transmitters to many other countries in the Eastern bloc. Most of the various Soviet republics have SW transmissions with a foreign service. The one best heard in Australia originates from Radio Tashkent in Uzbekistan. These transmissions in English are 1200-1230 and 1330-1400 UTC on 7325, 9620, 9715, 11785 and 15460 kHz.

Radio Moscow transmission schedules to Australia are as follows:

- 000-0500 UTC on 15510, 17730 and 17850 kHz;
- 0500-0800 UTC on 15220 and 17730 kHz;
- 1000-1300 UTC on 15140, 15220, 15490, 15510, 17640, 17750 and 21580 kHz;
- 2000-2200 UTC on 9790 and 15360 kHz;
- 2200-2400 UTC on 15360 and 17850.

— Arthur Cushen

Voice of Germany from Africa

The Voice of Germany, Deutsche Welle, this year celebrates 20 years of broadcasting from its relay post in Kigali.

Germany was the first European broadcasting organization to build a relay post in southern Africa, a move followed by the Voice of America with stations in Morocco, Liberia and Botswana, the BBC with a relay post in Lesotho and Radio Nederland with relay facilities on Madagascar.

Deutsche Welle has nine 500 kW transmitters at its transmitting site in the South of Germany and realising that it is not possible to serve the world from this one point has established relay facilities on Antigua and Monserrat in the Caribbean, at Trincomalee in Sri Lanka and Kigali in Central Africa. The current service from the VOG operates 13½ hours daily with broadcasts of the African Service — in English, French, Portuguese, Swahili, Hausa and Amharic, as well as the German Language Service, going out to a satellite to be bounced back to the African continent.

To ensure optimum reception for listeners in Africa, the shortwave bridge comes to rest on a second point — the Kigali Relay Station. Under a licensing agreement arrived at in the spirit of friendship and co-operation with the Rwandan government, a receiving station and two 250 kW transmitters were built on the outskirts of the capital of Rwanda. After boosting to ensure trouble-free reception, the Voice of Germany's broadcasts are transmitted to listeners in north-east, eastern, southern, central and western Africa.

Night and day, technicians in Germany and Rwanda are hard at it maintaining and fine-tuning these installations. At the Voice of Germany head office in Cologne there is a special section which is kept fully occupied with evaluating listeners' letters and technical monitor reports in order to keep reception up to scratch. Of course, not all listeners on the African continent can be satisfied at all times. The quality of reception is subject to a day and night rhythm and to the cyclical ups and downs of the seasons. To this day there is no alternative to the boosting of overseas broadcasts by relay stations.

Rwanda is a country which enjoys political stability and maintains good relations with neighbouring countries, thanks to the farsighted policies of President Jovenal Habyarimana. Rwanda is the most densely populated country in Africa, as well as being landlocked and having few mineral resources. Nonetheless, it has succeeded in the purposeful pursuit of development.

Kigali uses several frequencies, and those which carry English are 7225 kHz, 0430-0500 UTC; 9735 kHz, 1000-1030 UTC; 1500-1530 UTC, on 17800 kHz, 0900-0950 UTC; and 21560 kHz, 0900-0950 UTC.

— Arthur Cushen

VOA relay in Israel

After months of speculation at a ceremony in Jerusalem the US Vice President George Bush has signed an agreement for a huge relay station to be built in Israel to carry both the Voice of America and Radio Free Europe. The complex will contain 16 500 kW transmitters and an antenna system to be located in the desert.

The $200m project has come under criticism from various protection societies which claim it will upset the migration patterns of the millions of birds which fly over the area annually. There were also fears that any birds flying into the antenna system would suffer radio frequency burns.

Research in Europe, however, has found the main cause for concern should be the taking of energy from transmitters to antennae when birds land on the live feeder lines.

— Arthur Cushen

Swedish satellite system

The Swedish Telecommunications Administration and Swedish companies are planning a joint venture to launch a new satellite system which will send and receive messages throughout the world with a maximum delay of three hours.

Sweden has the world's largest number of multinational corporations per capita. One purpose of the satellites will be to enable Swedish companies to communicate with subsidiary companies and branch offices, primarily in developing countries, independent of local infrastructures and telecommunications.

A Swedish company, Mailstar AB, is being formed to send up a series of small satellites. The majority owner of the company is the state Swedish Telecommunications Administration's holding company, Teleinvest, which accounts for 60 per cent. Other joint-owners are Ericsson Radio Systems, Saab Space and Rymdbolaget. At later stages other owners from Swedish industry can be offered shares.

The satellite system Mailstar will, as opposed to usual geostationary satellites, circle in a low orbit over the poles. This means that the satellite passes all places on the Earth several times a day, resulting in a short communications time.

It will be possible to send both text and pictures with the satellite and via some of the telecommunication administration's network services.

The first launching is planned for 1990. A Chinese rocket has been suggested as the transport rocket. Mailstar is placed, according to plans, as a piggyback to a larger satellite which is sent up at the same time.

The Chinese Long March 3.

KILOHERTZ COMMENT

AUSTRIA: Broadcasts from Vienna to Australia in English 0630-0700 UTC are on 6000, 6155, 11920 and 15410 kHz. The transmission at 0830 UTC is on 11840 kHz to this area, while additional frequencies are 6000, 6155, 11915, and 15410 kHz

CANADA: The world's lowest powered shortwave station, CKFX Vancouver on 6080 kHz continues to operate with 10 watts. The station relays the mediumwave CKWX on 1130 kHz, but is on the air mainly for the benefit of shortwave listeners, as the original coverage to the inlets north of Vancouver is now reached by AM radio. The aerial system was changed from a quarter wave in 1979 to an omnidirectional. The transmitter dates back to the 1940s, according to Jack Wiebe, Chief Engineer of CKWX-CKFX. The station operates 24 hours a day and is heard from time to time in the South Pacific around 0800 UTC.

Radio Canada International has retimed its "Shortwave Listeners Digest", now to be heard on Sunday at 0305 UTC on 5960 and 9755 kHz. A transmission broadcast on Saturday at 2030 UTC is also heard in the South Pacific on 11945, 15150 and 15325 kHz.

DUBAI: The Voice of UAE, Dubai, now uses four frequencies in its transmission in English 0330-0400 UTC. Broadcasts are on 9640, 11940, 15435 and 17890 kHz; the first two frequencies give the best reception.

MEXICO: Radio Universidad has been noted in New Zealand on 9602 kHz at around 0400 UTC. The station generally closes at 0650 UTC but on an irregular basis. It is reported to be using the power of only 250 watts.

SWEDEN: Radio Sweden continues to use 15390 kHz for its English broadcast to Australia 0930-1000 UTC. The broadcast 1000-1030 UTC is in Swedish, while on Wednesday at 0945 UTC "Sweden Calling DXers" is carried on the frequency. Signals at 0230 UTC in English are noted on 9695, and at 0330 on 11750 kHz.

USA: The frequency of 9455 kHz is used by the Voice of America in English up to 0400 UTC and after that time test transmission from WMLK Bethel PA, a new gospel station, has been heard. At 1100 UTC the channel is used by KNLS, Anchor Point, Alaska for broadcasts in Chinese.

This item was contributed by Arthur Cushen, 212 Earn St, Invercargill, New Zealand who would be pleased to supply additional information on medium and shortwave listening. All times quoted are UTC (GMT), which is 10 hours behind Australian Eastern Standard Time. Areas observing daylight time should add a further hour.

Computer Manufacture and service linked

What is claimed to be the world's fastest IBM compatible microcomputer is now supported by Australia's largest supplier of independent third party maintenance.

Two Australian companies, Earth Computer Systems and Computer Maintenance of Australia, have reached an agreement for the service of all ECS equipment throughout Australia.

The contract will involve warranty support, services and repairs for any ECS user in Australia.

ECS, wholly-owned and operated in Australia, was established in 1985 to manufacture and market the world's fastest IBM compatible (at 10 MHz). Claims are that the ECS 286-30 has a performance ratio of 10:1 against an IBM-XT and is three times faster than an IBM-AT.

Design and manufacture of components is carried out completely in Australia. Demand for the product, especially at the top end of the CAD and engineering markets, is escalating and inquiries from around the world, including America, have been received.

ECS offers a 12-month warranty, now to be serviced by Computer Maintenance of Australia, also a wholly-owned and operated Australian company. Since its rise to prominence in 1982, when it won an agreement with Australian Airlines (formerly TAA) to service the airline's reservation network, CMA has grown to more than 3000 installations, supported by 26 maintenance response centres throughout the country.

CMA provides services to companies such as Prime, Utah, BHP and Telecom.

THE TECHNOLOGY OF SOUND SYNTHESIS

Neale Hancock

Through the psychedelic haze of the 1960s there emerged a new generation of musical instrument: an instrument not limited to one typical sound, but able to copy or synthesise existing sounds and generate sounds never heard before.

OVER THE 21 years since synthesisers have been with us their appearance has changed noticeably. The bulky boxes covered in masses of knobs have given way to slim featureless units with only one or two sliders and display. But in many cases the method used to generate sound is very similar to that which Dr Robert Moog used in his first synthesiser in 1965. The main differences lie in changes made to how the instrument is controlled, its ability to store sounds and how the information is displayed. The result is quite often a box full of old technology behind a high tech front panel which is impossible to program. But synthesis techniques have been developed that do away with the tried and true building blocks and bring better sound at a lower cost.

Traditional synthesis techniques

The method of sound generation created by the good Dr Moog was based around the use of voltage controlled oscillators (VCOs), low frequency oscillators (LFOs), voltage controlled filters (VCFs), voltage controlled amplifiers (VCAs), a mixer, and envelope generators. Whilst oscillators, filters, amplifiers and envelope generators have been around for a long time, it was the ability to control them via a control voltage (CV) which made them useful in the synthesis of sound.

Each of these building blocks needs to have at least two of its parameters variable, for instance, a filter can have its breakpoint and sharpness (resonance) changed, thus it requires at least two control voltages. Since a knob or slider is used to change each parameter, it is no wonder that many synthesisers appear as a multiplicity of sliders and knobs!

Figure 1 shows a block diagram of a synthesiser which uses voltage controlled oscillators, filters and amplifiers. The control voltages for these building blocks come from the front panel knobs, the low frequency oscillator, the envelope generator, the musical keyboard and controllers. The technique which utilizes these building blocks is called subtractive synthesis.

The VCO takes control voltages from many different sources, namely, the musical keyboard, the envelope generator and the low frequency oscillator. When the VCO is controlled by the keyboard, its pitch is shifted to match the musical scale. Controlling the VCO with an LFO results in a tremlo effect whilst controlling it with the envelope generator results in a pitch sweep. All three control voltages are mixed via a summing amplifier to allow them all to control the VCO at the same time.

The VCO can generate triangular, saw tooth, square and pulse waves, all of which have a different harmonic content (see Figure 2). Each of these waveforms has a characteristic sound, and should be viewed as the raw material for making new sounds. For instance, a triangular wave is useful when generating flute-like sounds, a sawtooth wave is useful for brass sounds, square waves are useful for wood-wind or bass sounds and pulse waves are good for harpsichord or piano sounds. The waveshapes correspond to these typical sounds because their harmonic content is similar to that of the corresponding sounds.

The pulse wave is different from the other

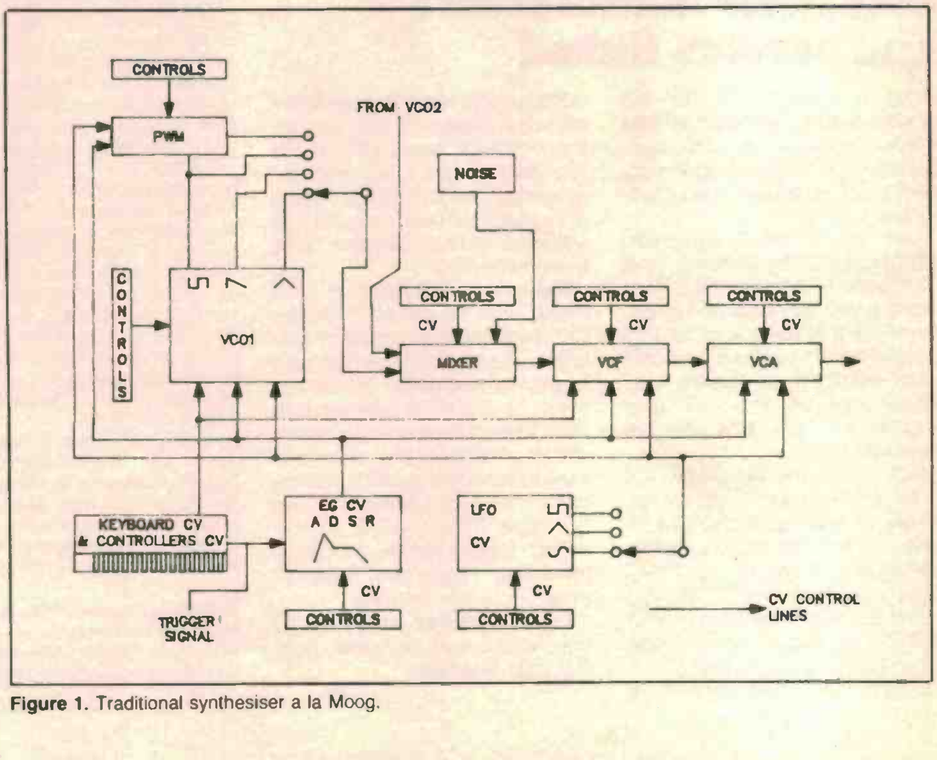


Figure 1. Traditional synthesiser a la Moog.

Jupiter 8, a classic programmable voltage controlled synthesiser.

VCO waveshapes because it can have its pulse width controlled by the LFO and the envelope generator (pulse width modulation). Modulating the pulse width creates a rich and variable harmonic content.

The VCF is used to modify the basic sound of the waveshapes generated by the VCO by reducing or increasing the harmonic content. This control over harmonic content is achieved by changing the resonance or the breakpoint of the VCF. The VCF's breakpoint (in some cases the resonance as well) can be changed via control voltages from the keyboard, the LFO and the envelope generator. Since a summing amplifier is used, all three control voltages can be used to control the VCF at the same time. Controlling the breakpoint of the VCF with a control voltage from the envelope generator changes the harmonic content while the note is being played. Controlling the breakpoint of the VCF via the keyboard control voltage enables the VCF to track the VCO.

The envelope generator (EG) typically has an attack time, a decay time, a sustain level and a release time. The envelope generator is sometimes referred to as an ADSR (attack, decay, sustain, release). The duration of the note can be set by using the EG to control the voltage controlled amplifier (VCA). The EG can be set up differently for different instrument types, for instance, plucked instruments would have a short attack time, short decay, no sustain and a long release. Vibrato is obtained by controlling the VCA with the LFO.

Later models of synthesiser (see Figure 5) have their oscillators, filters and amplifiers controlled by digital signals instead of control voltages. As these synthesisers are velocity sensitive, a digital control signal corresponding to playing velocity (how hard a key is pressed) results. When the keyboard velocity controls the amplifier (DCA), the note is louder when a key is pressed hard and quieter when the key is pressed softly. Harmonic content can also be changed by controlling the filter (DCF) with the keyboard velocity.

History

The early synthesisers had VCOs, VCFs, VCAs, envelope generators, etc, all in independent modules. Each module could be patched to the next with leads and the level of each control voltage was set by a slider or a knob. This design concept was the most flexible since patching allowed the output from any module to be fed into the input of any other module. Whilst this inherent flexibility permitted a vast array of sounds to be created, the trade off was that it was only done with difficulty. Most serious musicians want to spend their time playing music, not creating sounds, although there are those amongst us who derive as much pleasure from creating an excellent sound, as we do from using it!

In the next generation of synthesiser, the patch leads were replaced by rotary switches. Whilst this made the synthesiser easier to use, it also meant that inputs and outputs were hard wired thus limiting the flexibility of the synthesiser. One other disadvantage of hard wired synthesisers is that they do not allow external signals (eg, from a microphone or guitar) to modulate the signal or be inserted into signal path at any point.

After synthesisers had been made easier to program, the keyboard players of the world wanted to store and recall sounds and play them polyphonically. The alternative was to use a synthesiser with selectable preset sounds. This, however, limited the variety of sounds. ▶

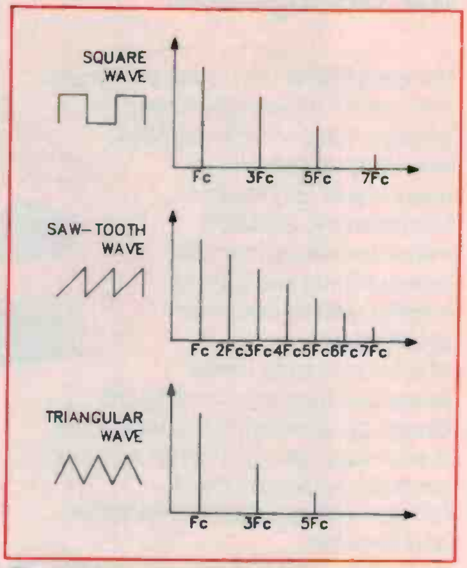


Figure 2. Harmonic content of various VCO outputs.

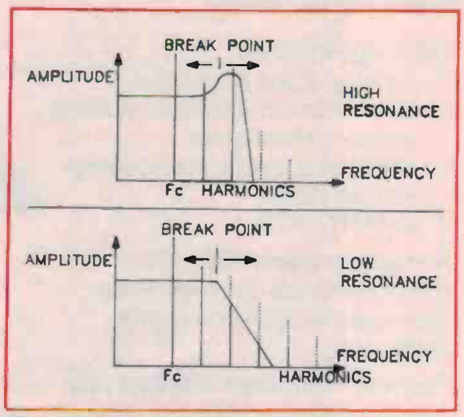


Figure 3. Filter parameters.

String and brass ensembles were polyphonic versions of these preset synthesisers minus the facility to create and store new sounds. The first polyphonic synthesisers were programmable, which meant that they *could* store and recall sounds. A block diagram of such a synthesiser appears in Figure 4.

For a sound to be stored, the settings of the oscillators, mixer, filter and amplifier were stored in random access memory (RAM). Thus the corresponding control voltage of each knob and slider was digitized by an anologue-to-digital converter (ADC) and stored in memory. A previously generated sound could be recalled by reading the RAM and the digital signal sent to a corresponding digital-to-analogue converter to set the control voltage. The control voltage connected to the VCOs, VCFs, VCAs, etc, to re-generate the sound.

The next evolutionary step led to the present generation of synthesiser by making the oscillators, filters, amplifiers, etc, digitally controlled (see Figure 5). Thus VCOs became DCOs, VCFs became DCFs, VCAs became DCAs and EGs became DEGs. Direct digital control over parameters removes the need for converting control voltages into digital signals thus simplifying the internal workings of the synthesiser and reducing cost. Digital control has the added advantage of being more precise and stable than voltage control and in the case of digitally controlled oscillators (DCOs) their inherent stability enables synthesisers to say in tune for longer periods of time.

Synthesisers that are digitally controlled are often referred to as digital synthesisers but don't be fooled into thinking that you are getting some new form of sound generating instrument. In most cases (with some notable exceptions that I will mention later), digital synthesisers use the same old synthesiser building blocks but control them with digital signals instead of control voltages. Some so-called digital synthesisers are just voltage controlled synthesisers with a DCO instead of a VCO (and only one DCO in some cases). Don't get me wrong, digitally controlled synths can sound fantastic (just listen to the latest Oberheims). This is the case when manufacturers implement more than one DCO, DCF, DCA, and envelope generator. Also the quality of the DCF can make a huge difference.

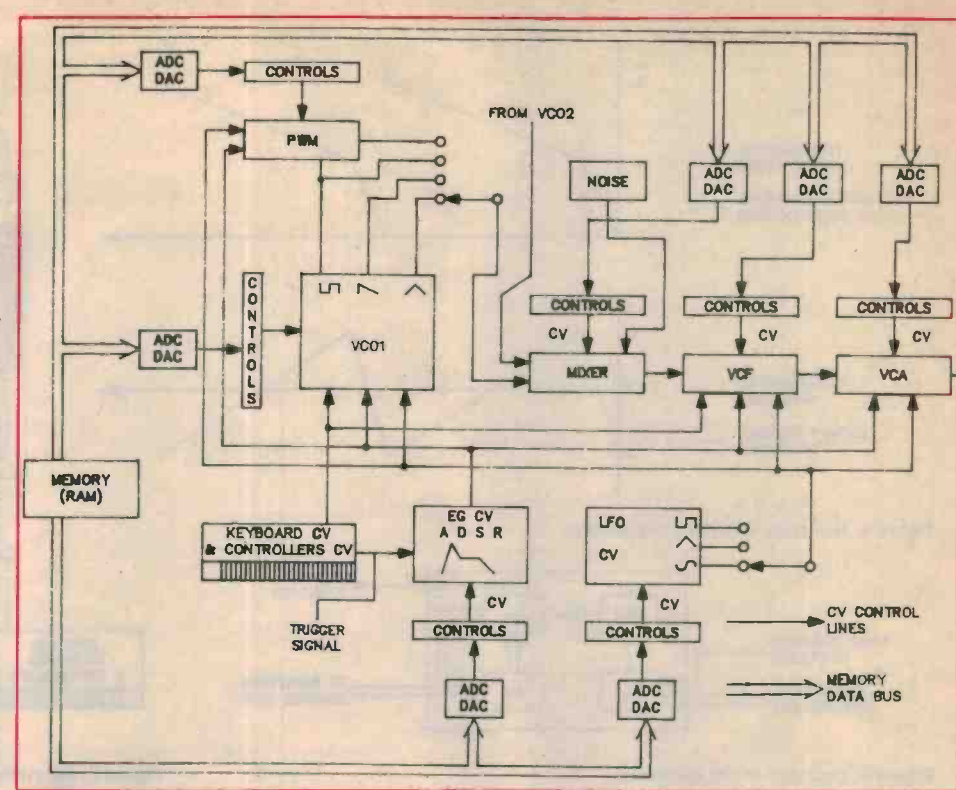


Figure 4. A polyphonic synthesiser.

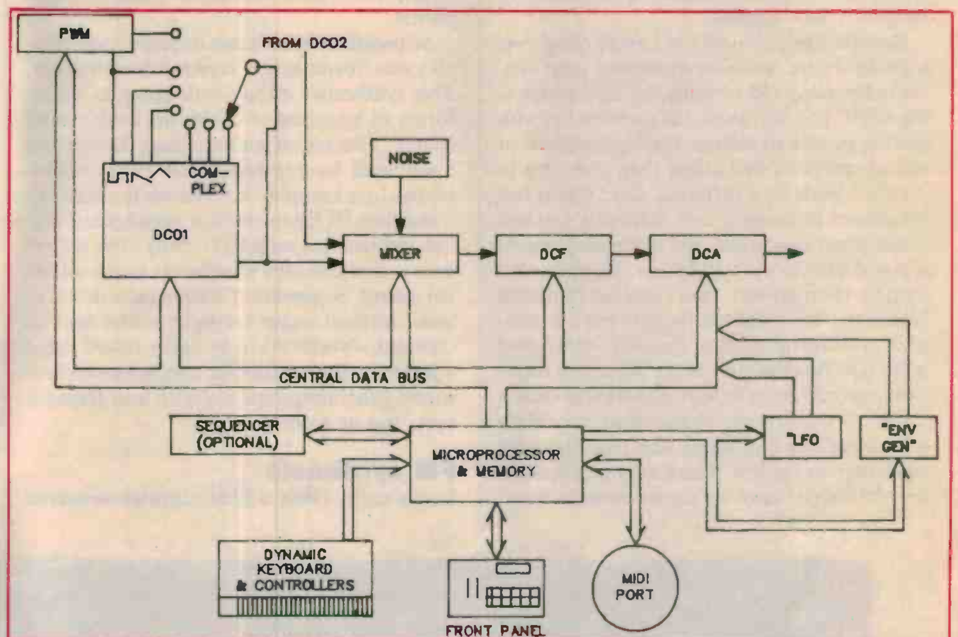


Figure 5. A typical modern synthesiser.

Digitally controlled synthesisers use one control and an array of buttons to modify all the parameters. Instead of a separate control to change each parameter, a particular button selects each parameter and one slider knob controls the value of the lot. The values of these settings are then stored in memory. This way of changing parameters enables synthesisers to be much lower in price largely due to the lower component and manufacturing costs involved. However, the saving in cost is lost in user friendliness, since a panel controlled this way requires each parameter to be called up individually before it can be viewed or controlled.

The ability to control a synthesiser with digital signals also permits it to be controlled remotely, provided there is a way to transfer the digital signals. Remote control allows one synthesiser to be played from the keyboard of another synthesiser or from a computer. To allow the playing information (represented by digital signals) to be transferred, a digital communications bus was developed, this digital communications bus was called the Musical Instrument Digital Interface or MIDI, (see our October issue for all the ins and outs of MIDI). To allow instruments made by different manufacturers to control each other (to communicate), the playing data transferred by the bus was made standard.

Some manufacturers of digital synthesisers have broken away from the four traditional oscillator waveshapes (pulse, square, ramp and triangular) and use new waveshapes (called complex waveforms) to generate sounds. Some manufacturers have even been daring enough to get rid of the traditional synthesiser building blocks and have invented ▶

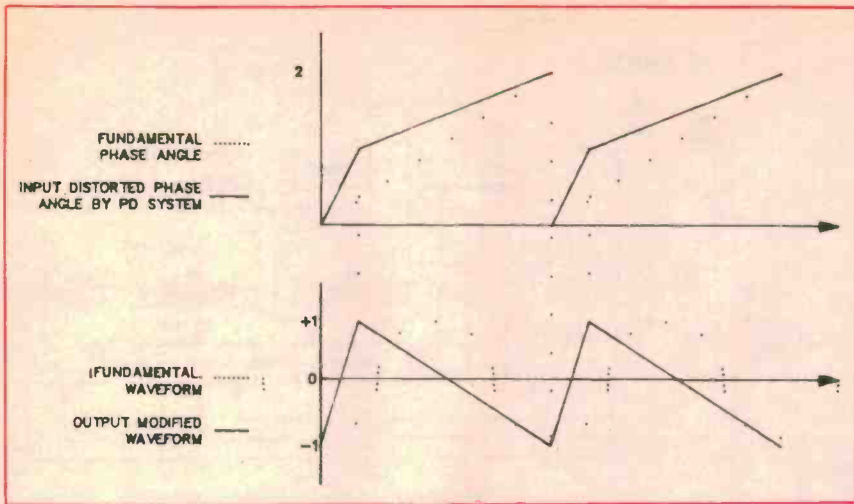


Figure 6. Non-linear waveform modification.

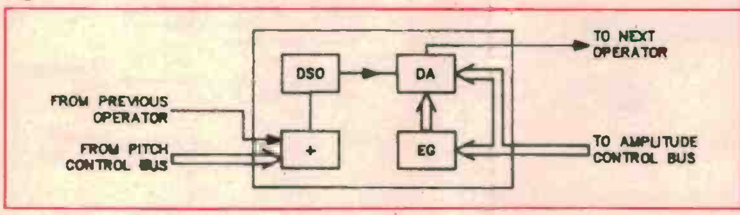


Figure 7. Operators in FM synthesis.

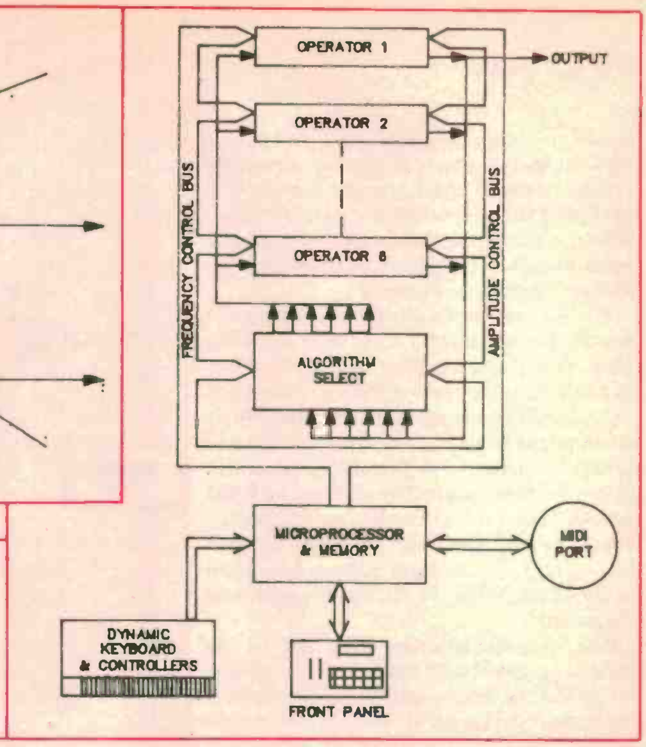


Figure 8. FM synthesis block diagram.

totally new ways of synthesising sound as well as totally new sounds.

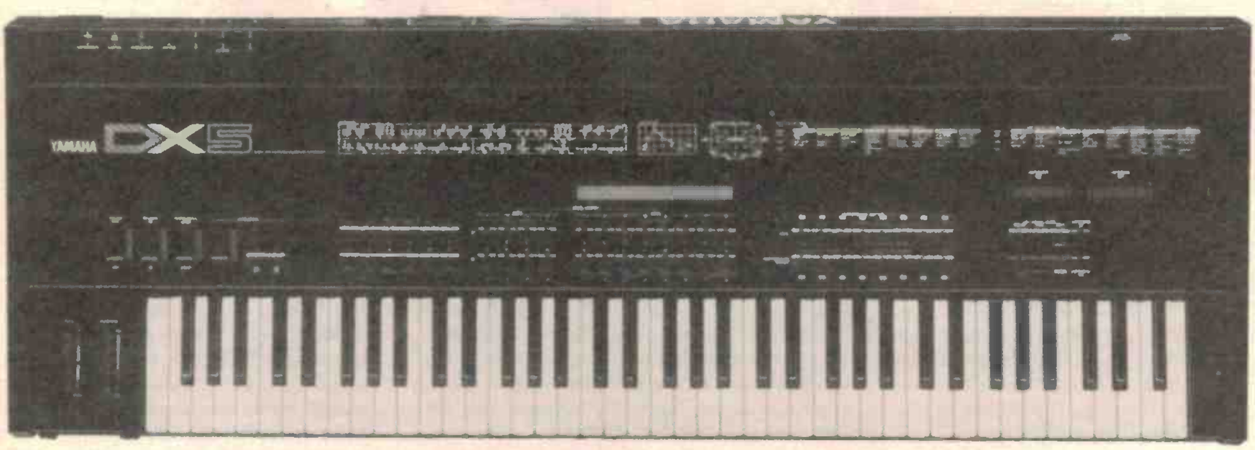
Surprisingly, synthesisers employing new techniques are no more expensive than synthesisers using old techniques. So "where is the rub?" you ask. Well, the problem lies with getting people to change their perception of sound synthesis and adapt their thinking to create sounds in a different way. Casio has succeeded in using a new synthesis method called phase distortion, and made an economical and easy to use synthesiser. Its phase distortion synthesisers use similar building blocks to traditional synthesisers but use complex waveforms and a digitally controlled wave (DCW) converter in the place of a filter. This method of synthesis apparently uses a DCW to modify the phase of an incoming waveform in a non-linear way (see Figure 6) to change its timbre. The Casio synthesisers are extremely easy to create sounds with, largely due to their conveniently laid out front panels.

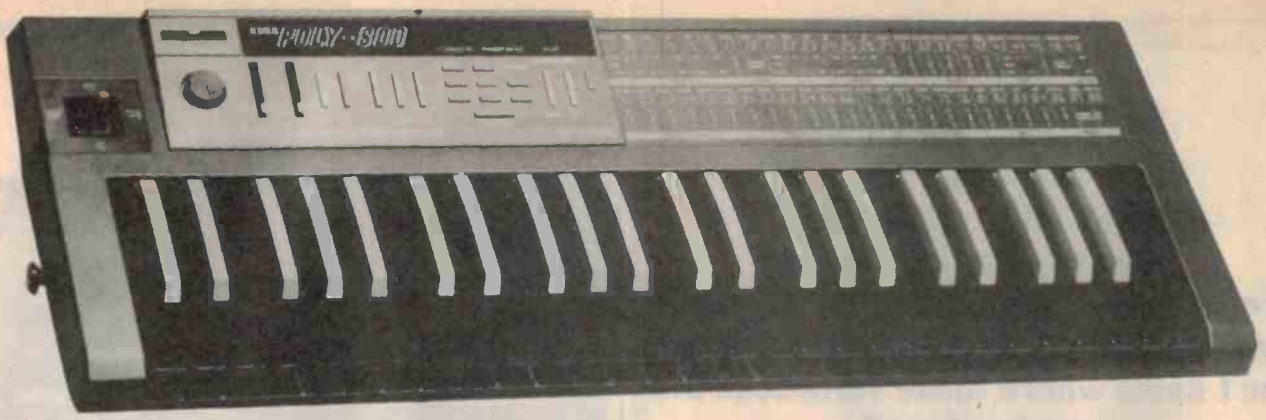
Sequential Circuits has implemented complex waveforms in its Prophet VS synthesiser. This synthesiser allows four complex waveforms to be mixed to create the basic sound source. This sound source is then filtered and modulated by envelopes and LFOs. Combining four complex waveforms is similar to using four DCOs to create a sound (most digital synthesisers only have two). The difference is that complex waveforms give a different sound. Sequential Circuits calls this synthesis method vector synthesis, and it enables complex waveforms to be easily mixed using a joystick. The synthesiser combines excellent sound generating capacity with user friendliness, but at a cost.

FM synthesis

In the early 1980s a breakthrough occurred in the synthesis of sound that was as innovative as Moog's use of voltage controlled oscillators, filters and amplifiers was in the 1960s. The breakthrough was FM (frequency modulation) synthesis. This form of synthesis was a total departure from traditional methods and since it was implemented on VLSI circuits, the FM synthesisers were not only low in price, but were also very reliable.

When the first of Yamaha's FM synthesisers (the DX7 and DX9) hit the market, they were generally capable of making sounds far superior to any synthesiser in the same price range. But since these synthesisers used a different method to generate sound, they were criticized as being difficult to use. In practice, one only had to be slightly open minded and spend a few hours getting familiar with it, and the FM synthesiser was no more difficult to use than any other digital synthesiser. It is not surprising that within





a year the DX7 became the industry standard in synthesisers.

A feature of FM synthesisers which makes them unique is that they do not contain filters. This means that the sounds can be synthesised with software.

FM synthesisers create sounds using four to six operators (see Figure 7), which can be arranged to create different algorithms. Each operator consists of a digital sine oscillator (DSO) and a digital amplifier (DA), both of which are implemented in software. The envelope generator used to control each operator is implemented in software too, therefore the diagram is purely representative. Sounds are generated by digitally controlling the frequency and amplitude of the operators via the DSOs and the DAs. Figure 8 shows a block diagram of an FM synthesiser.

The individual operators are arranged so that the output from one operator (operator 1) can frequency modulate the next (operator 2). Harmonics are generated when the sine wave from operator 1 modulates operator 2. As the output from operator 1 increases in amplitude more harmonics are generated; Figure 9 illustrates this effect. Since the output level from an operator controls the amount of harmonics generated, a filter is not required to control these harmonics.

A group of operators can be arranged in many different combinations to form different algorithms by switching the outputs from some operators to the inputs of others. The amplitude of each of the operators (and thus the harmonic content of the sound) can be controlled by the envelope generators, the playing velocity, and the front panel. Controlling the harmonic content with playing velocity allows the FM synthesiser to copy the dynamics of an instrument with remarkable realism.

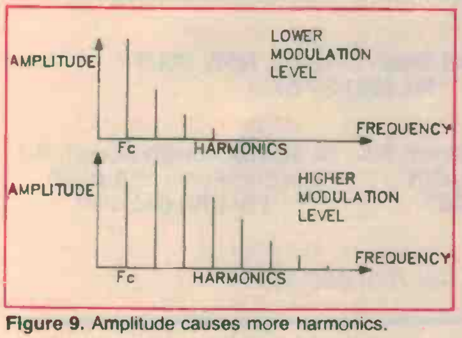


Figure 9. Amplitude causes more harmonics.

Sampling v structured adaptive synthesis

With the advent of sampling (a method where sounds are digitally recorded and musically scaled) any sound, musical or not, can be played from a musical keyboard. This method of sound generation is not actually synthesis. It uses existing sounds and modifies them, whereas synthesisers use oscillators, filters or software, to create sounds.

Sampling has some major drawbacks due to the massive amounts of memory required. For instance, one second of high quality sound (compact disc quality) sampled at a 44.1 kHz rate using 16-bit analogue-to-digital conversion would require 88.2 Kbytes of memory. To perfectly sample a grand piano (88 sample points, 2 second sample time and 50 levels of dynamics, at least) one would require a staggering 755 megabytes of memory!! (Separate samples are required for each level of dynamics because the harmonic content of a sound changes with dynamics.) However, there is an alternative to sampling when recreating real sounds. This alternative is Roland's latest contribution to the world of music technology and is called SAS, structured adaptive synthesis.

The Roland RD 1000 keyboard and MKS-20 rack module both use the SAS technique to create extremely real piano-type sounds. This method of synthesis also allows better dynamic control of harmonics than FM. Structured adaptive synthesis method implements an algorithm to generate the sound instead of using masses of memory. To get this algorithm, the 88 keys of a grand piano are sampled at many different levels of dynamics. All these samples are then fed into a powerful computer, and using some heavy duty signal processing software the relationship between the harmonic content of each of the samples is then worked out. This relationship is transformed into an algorithm, which is then implemented on an integrated circuit.

The SAS method allows 128 levels of dynamics, (some form of interpolation is probably used to get this many levels) whilst even the most expensive sampler can only give a few. About 2 gigabytes (2000 megabytes) of memory would be required to get the equivalent sound quality with 16-bit PCM sampling. All the sonic characteristics of a piano are stored in the SAS algorithm, so when note and velocity information is sent to it from a velocity sensitive keyboard the corresponding audio signal (sound) is output by the algorithm.

Unfortunately SAS requires an algorithm to be worked out for each sound, thus sounds are dependent on what Roland creates. The other drawback is that Roland cannot at present synthesise sustained sounds (such as strings and brass) using SAS. An SAS synthesiser with a full range of sounds would pose a threat to samplers but would not be of any use to people who want to sample their own sounds.

The future

Ideally, a combination of SAS with sampling would be an excellent way to use sounds, as it would give excellent dynamics and user sampling and not require half a ton of memory. To implement this technique a sampled waveform could be fed into a signal processor and have its harmonics modified by an algorithm. Different typical algorithms could be used for typical types of sound, for instance string sounds could have a typical algorithm, as could brass and wind instruments. One could sample a trumpet, then dynamically control its harmonics via a trumpet algorithm, or for more bizzare combinations, sample a hand clap and dynamically control its harmonic content via a piano algorithm. At present it is not feasible to use real time signal processing to control sound in this manner, however, this is probably due to economic and ergonomic reasons.

As to the future I consider that complex waveforms, FM and other new methods of synthesis have the best potential for creating new and realistic sounds. However, a better means of displaying and editing parameters needs to be developed.

The traditional waveforms and filters have been with us for over 20 years, and even though they are now digitally controlled it seems unlikely that many more new sounds can be squeezed from synthesisers designed this way. I suspect that these traditional methods are still with us largely due to people's familiarity with them. As people become accustomed to the new methods of sound synthesis the traditional VCO . . . sorry, DCO, DCF and DCA type synthesisers will be finally out-evolved. ●

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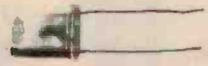

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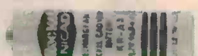

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R15794	22uF 50V	$0.17	$0.15	$0.13
R15812	25uF 25V	$0.13	$0.12	$0.11
R15815	25uF 63V	$0.17	$0.15	$0.13
R15831	47uF 16V	$0.16	$0.13	$0.12
R15832	47uF 25V	$0.16	$0.13	$0.12
R15835	47uF 63V	$0.22	$0.19	$0.17
R15841	100uF 16V	$0.18	$0.16	$0.15
R15842	100uF 25V	$0.18	$0.16	$0.15
R15845	100uF 63V	$0.27	$0.24	$0.22
R15851	220uF 16V	$0.17	$0.15	$0.14
R15852	220uF 25V	$0.21	$0.18	$0.17
R15855	220uF 63V	$0.50	$0.46	$0.40
R15871	470uF 16V	$0.27	$0.24	$0.22
R15872	470uF 25V	$0.29	$0.27	$0.25
R15873	470uF 35V	$0.75	$0.70	$0.60
R15875	470uF 63V	$0.75	$0.70	$0.65
R15885	1000uF 63V	$0.60	$0.58	$0.55
R15891	1000uF 16V	$0.39	$0.35	$0.30
R15892	1000uF 25V	$0.45	$0.40	$0.38
R15893	1000uF 35V	$0.70	$0.65	$0.55
R15894	1000uF 50V	$0.00	$0.00	$0.00
R15903	2200uF 35V	$1.20	$1.10	$0.90
R15904	2500uF 50V	$1.30	$1.20	$1.00
R15911	2500uF 16V	$0.59	$0.50	$0.40
R15912	2500uF 25V	$0.95	$0.90	$0.80
R15913	2500uF 35V	$1.10	$1.00	$0.90
R15914	2500uF 50V	$1.30	$1.20	$1.00
R15932	4700uF 25V	$1.90	$1.80	$1.60
R15933	4700uF 35V	$2.40	$2.15	$1.90

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P10960	Pin Line Male	2.00	1.85
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4164-15P	$ 2.00	$ 1.70	$ 1.65	$ 1.60
41256	$ 4.50	$ 4.00	$ 3.60	$ 3.30
6116P-3	$ 3.00	$ 2.90	$ 2.20	$ 2.00
2716	$ 7.50	$ 7.00	$ 6.50	$ 6.00
27128	$ 5.00	$ 4.50	$ 4.00	$ 3.50
2532	$ 7.50	$ 6.50	$ 6.40	$ 6.30
2732	$ 6.50	$ 6.10	$ 5.90	$ 5.50
27256	$ 9.00	$ 8.00	$ 7.00	6.50
6264	$ 5.50	$ 5.00	$ 4.50	$ 4.00
2764	$ 6.00	$ 5.00	$ 4.50	$ 4.00

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1.2 AH	S15029	$12.50	$11.75
2.6 AH	S15031	$17.70	$16.50
4.5 AH	S15033	$23.40	$22.00

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ALL PRICES PER 100 METRE ROLL

Cat. No. Description Colour
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W11252 13/.12 TLD BROWN
W11253 13/.12 TLD ORANGE
W11254 13/.12 TLD YELLOW
W11255 13/.12 TLD GREEN
W11256 13/.12 TLD BLUE
W11257 13/.12 TLD WHITE

PRICES PER 100 METRE ROLL

1-9	10+
$3.50	$3.00

Plus 20% tax where applicable

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

PRICES PER 100 METRE ROLL

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$9.00	$7.00

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

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1-9	10+
$11.00	$10.00

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W11280 32/.2 BROWN
W11282 32/.2 BLUE

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Desc.	10+	100+	Desc.	10+	100+
2SJ49	5.50	4.95	2SK134	5.50	4.95
PN2222A	.10	.08	PN2907A	.10	.08
PN3463	.15	.13	PN3565	.12	.11
PN3566	.15	.13	PN3567	.10	.08
PN3569	.18	.16	PN3639	.18	.16
PN3640	.18	.18	PN3641	.10	.08
PN3642	.10	.08	PN3643	.10	.08
PN3644	.15	.13	PN3645	.15	.13
PN4250A	.15	.13	PN4355	.16	.14
PN4356	.16	.14	MPSA42	.23	.20
MPSA43	.23	.20	MPSA55	.15	.14
MPSA56	.15	.14	MPSA92	.22	.20
MPSA93	.22	.20	SC1410	.85	.75
BU126	1.50	1.25	BUX80	2.75	2.55
BU208	2.50	2.20	2SD350	2.75	2.40
BU326	1.75	1.60	BC547	.07	.06
BC548	.07	.06	BC549	.07	.06
BC557	.07	.06	BC558	.07	.06
BC559	.07	.06			

Plus 30% tax where applicable

TELEPHONE CABLE (200 METRE ROLLS)

Cat.No.	Description	1-9	10+
W11302	2 Pair	$34.00	$28.00
W11303	3 Pair	$42.00	$39.00
W11310	10 Pair	$120.00	$115.00

Per 200m Roll
20% Sales tax where applicable

75 OHM COAX CABLE IN 100M ROLLS

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

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

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Cat.No.	Description	10+	100+
R16124	4.7uF 16V	$0.24	$0.18
R16125	10uF 16V	$0.25	$0.23
R16126	15uF 16V	$0.38	$0.36
R16128	22uF 16V	$0.42	$0.40
R16132	47uF 16V	$1.55	$1.20
R16134	68uF 16V	$1.80	$1.50
R16220	4.7uF 16V	$0.35	$0.33
R16224	10uF 16V	$0.38	$0.37
R16228	22uF 16V	$1.20	$1.00
R16300	0.1uF 35V	$0.13	$0.12
R16302	0.15uF 35V	$0.13	$0.12
R16304	0.22uF 35V	$0.15	$0.12
R16306	0.33uF 35V	$0.15	$0.14
R16308	0.47uF 35V	$0.15	$0.14
R16310	0.68uF 35V	$0.16	$0.15
R16311	0.82uF 35V	$0.18	$0.15
R16312	1uF 35V	$0.15	$0.12
R16314	1.5uF 35V	$0.24	$0.20
R16316	2.2uF 35V	$0.24	$0.23
R16318	3.3uF 35V	$0.29	$0.27
R16320	4.7uF 35V	$0.35	$0.33

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Green	$0.15	$0.10	$0.09
Yellow	$0.15	$0.10	$0.09

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Q10500	MU45 0-1mA	7.50	6.95	6.75
Q10502	MU45 50-0-50uA	7.50	6.95	6.75
Q10504	MU45 0-100uA	7.50	6.95	6.75
Q10505	MU45 0-50uA	7.50	6.95	6.75
Q10510	MU45 0-5A	7.50	6.95	6.75
Q10518	MU45 0-1A	7.50	6.95	6.75
Q10520	MU45 0-20V	7.50	6.95	6.75
Q10535	MU45 VU	8.50	7.75	7.50
Q10530	MU52E 0-1mA	9.95	8.35	
Q10533	MU52E 0-5mA	9.95	8.35	
Q10538	MU65 0-50uA	10.50	9.35	8.95
Q10540	MU65 0-1mA	10.50	9.35	8.95
Q10550	MU65 0-100uA	10.50	9.35	8.95
Q10560	MU650 0-20v	10.50	9.35	8.95

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NEW PERSPECTIVES ON HOLOGRAPHY

Holography has been with us for some 38 years. But in spite of the striking three-dimensional images that it produces on screens or even floating in the air, it is still far from achieving its full potential. There are numerous limitations that affect quality, size of image, effective viewing angles and so forth, and the biggest of all is its cost. Yet recent strides in the technology point to its becoming more readily adaptable as a tool for the scientist, the industrialist and the artist.

R.A.J. Arthur

HOLOGRAPHY is both science and art. It affects activities as widely different as aviation technology and advertising. Yet it has been slow to win support of the kind that gives a secure foundation to commercial enterprise.

Professor Dennis Gabor first outlined the basic theory in 1984 at the Thomson-Houston Laboratories at Rugby in the English Midlands. Practitioners of the art of holography insist that the long-predicted, long-delayed revolution in 3D imaging really will come and this I find impossible to doubt after interviewing one pioneer of holography, Nick Phillips, who is Reader in Physics at the University of Loughborough, not far from Rugby. In 1981 the Institute of Physics recognized his work with the award of the Thomas Young Medal, commemorating the 19th-century English doctor who established that light travels in a wave motion with crests and troughs at right angles to the line of travel.

Phillips indicated a dozen points where important contributions are being made. Holography has a many-sided influence on industry, but its aesthetic impact could be greater still. It has to do with light, and light is as much the artist's concern as the physicist's.

Three into two

Pictorial art since the Renaissance has mimicked a third dimension with rules based on a knowledge of perspective. The eye co-operates because it has been schooled to accept art conventions, but there are plenty of examples to show how this trained eye can be fooled into swallowing the absurd.

Holography dispenses with the need for an art convention to pack three dimensions into two. It operates with total conviction by an ingenious manipulation of light to project a third dimension to the senses where none exists. The holographic image may appear either in front of or behind the holographic plate, or it may protrude from it, partly behind, partly in front. A reflection hologram is illuminated from the front, a transmission hologram from behind, by a point source of white light such as a good spotlamp. Holographic images created by coherent light from a laser may hover in space as if by some magic.

The final touch of authenticity is the effect of parallax — foreground objects moving realistically against the background as the eye shifts, revealing parts of the scene previously concealed behind them.

Already the achievements of holography are stunning to the eye. They spur the imagination to build palaces of light. But just at this point reality steps in with a sharp reminder that the techniques have hard-edged limitations, affecting quality, size of image, ability to project, effective viewing angles. And the whole thing still is formidably expensive. Yet it is possible to imagine that many flat surfaces in our towns and cities, or inside buildings could become three-dimensional to the eye; be turned into urban space on vistas of dream-like subtlety and complexity. Somewhere between this dream of a three-dimensional art world created by light and the holographer's contest with reality it is necessary to search for the true outlines of holography in the future.

Commercial factors are important, even though the technology continues to make rapid strides, for rate of investment depends on public acceptance. Advertisers, the most likely buyers, will take the plunge when they see the public strongly welcoming holography. This in turn depends on still more persuasive demonstration. One important aim in holography is to develop the art of display until people demand holograms as now they demand computer games and home video.

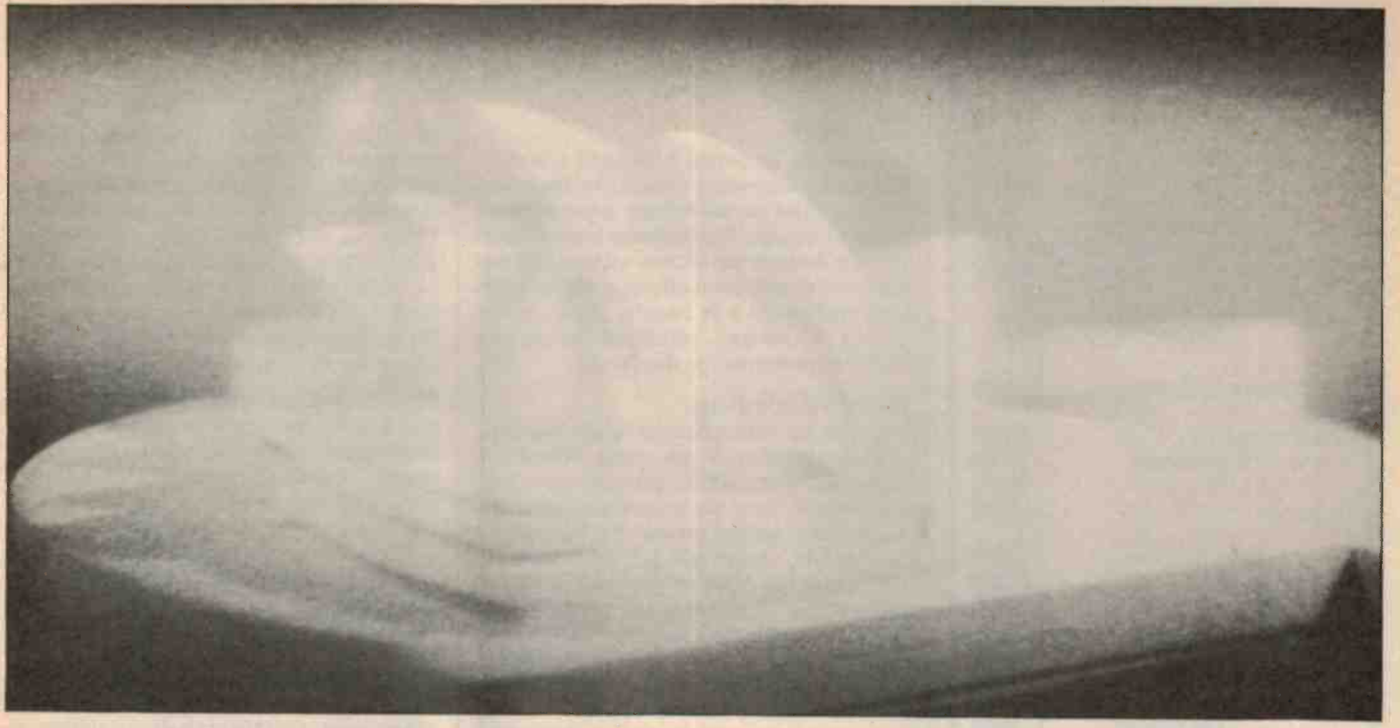
Holography as a true art form has been effectively demonstrated in Coventry Cathedral, where Malcolm Woodward created a series of sculptures on a religious theme "Stations of the Cross" which were then recorded as holograms for permanent display. The company concerned, Advanced Holographics, is an acknowledged leader in the quality of its work. It makes display items that are viewable under white light, and its clients include many leading companies in Britain, France, Germany, Japan and the USA.

With a studio on the fashionable King's Road in London's Chelsea district, Advanced Holographics has played a notable part in making the medium acceptable. In the words of Nick Phillips, "they have produced really quite startling improvements in the displays that we created in the very early days. They have achieved very bright displays which overcome some of the difficulties of holography by making the images easily viewable."

Mass production

So far as cost limitations are concerned, there has been significant progress by another firm, Applied Holographics, of Witham, Essex, in the south east England, with its invention of a fast, high-quality mass-production machine for silver halide reproduction, the Holocopier. The object, or master hologram to be copied, goes into a chamber in an exposure unit and a pulse of light from a ruby laser makes the exposure. The operation can be repeated at rates varying from one per second to one every six seconds, depending on energy level, while a roll of light-sensitive film is fed through the machine under precise microprocessor control. Runs of many thousands are possible.

Because the pulse of laser light lasts less than a millionth of a second, movement and vibration which are so often the holographer's



HOW HOLOGRAMS ARE CONSTRUCTED

There are a number of different types of holograms. However, the simplest to understand is still the classic method, called double beam holograms.

A laser is used to shine a beam of light at an object. The laser beam is interrupted by a partially reflecting mirror, or beam splitter. The two beams are then passed through diverging lenses, which spread the beam out.

One of the beams is directed onto the object. The light is reflected off it in the normal fashion and falls onto a photographic plate. The other beam is bounced off a series of mirrors and also directed onto the plate. This latter beam is called the reference beam.

The result of this second beam is that a normal image doesn't form on the plate. Instead, the two beams, both composed of monochromatic laser light, interfere with each other to produce interference fringes. The pattern of these fringes depends on the phase relationship of the light coming off the object and the reference beam. The photograph so produced is actually a record of these interference patterns.

To view the hologram, the reference laser, or indeed, any laser is shone at the picture and its interference patterns. The reverse process now occurs. The coherent laser light interferes with the pattern, and reflects back from the object an identical pattern to the one that was produced during the original exposure. The object is reproduced in space in exactly the same position as it was originally. So, what we see is an image, exact in all its details, floating in space.

bugbear become irrelevant. The Holocopier can be used both for originating master holograms and for making copies. Various adjustments of setting give it flexibility in the type of hologram produced.

The work of Applied Holographics to develop the Holocopier was carried out in association with photographic firm Ilford. Ilford concentrated on improving the chemistry of the recording media: the Holocopier uses a silver halide based film, and Ilford's research resulted in a much improved emulsion coated on to an appropriate base to provide a film 240 mm wide and 120 m long. The copy film is mounted on spools for use with a transport mechanism which advances it frame by frame and synchronizes it with successive laser pulses.

Though the emulsion for the Holocopier is only red-sensitive, it is being made available separately in a form sensitised for the blue-green part of the spectrum. It has minimal scatter, high sensitivity, and is optimised for very short exposures. Scatter is cut down by making sure that all particles present in a coated layer are significantly smaller than the wavelength of light.

Scatter has the effect of reducing the contrast of the interference fringes which are the whole basis of holography. The three-dimensional image is made possible by splitting a beam of coherent light from a laser into an object beam reflected from the object on to the recording plate, and a reference beam. When the two beams meet, the light waves overlap in such a way that either crests and troughs coincide and the light is amplified, or the crest of one coincides with the trough of another and they subtract. The complex pattern caused by the interference of the two beams and recorded by the photographic emulsion is the diffraction grating of the hologram, and white light shone through (after a suitable development process) will be diffracted in such a way as to create the three-dimensional image of the object.

Storage of holograms

The emulsion for the Holocopier is only one of Ilford's recent advances. Phillips points to several significant inventions that should be of benefit to everyone involved in making holograms. We may now expect chemical products which will completely stabilize the silver image of a hologram against degradation by light. One problem in storing holograms has been a possible change of state in the silver, which might make them unusable. Archival permanence of holograms is now much easier to achieve through this research.

Phillips adds: "They have also come up with a neat trick for changing the colour of reflection holograms in a permanent and simple way, which will mean that even if your laser colours are rather restricted to, say, green or red, you can make reflection holograms which are in various forms of intermediate colour".

The company's achievement, he said, was considerable over such a short period. They had also improved the structure of the silver halide recording media. "What they have managed to do is to make superfine grain emulsions which, while being noticeably freer from grain scatter, are rather higher in photographic speed — so this is very advantageous considering the high cost of laser light."

Embossed holograms

To make holography more acceptable by reducing costs, industry today finds a variety of uses for the cheapest and best-known example of the technique: the embossed hologram. Most widely used in America, it has made a big market impact, notably with images on credit cards and, in publishing, front covers of the *National Geographical Magazine*.

Embossed holograms, mechanically produced by minute indentations on a prepared surface, can give a genuine three-dimensional effect, though with only one plane of parallax, whereas photographic holograms may have both vertical and horizon- ▶

tal parallax.

However, embossed holograms are dazzling in their superiority to ordinary decoration when applied to advertising paperwork or fancy wrappings. They enhance whatever pattern the designer has chosen with an interesting three-dimensional effect. A major practical application is in security paper: by encoding a design, embossed holograms multiply problems for the forger.

Data recording

One firm has achieved exceptionally high densities of information storage for computers with a disc system which, although not strictly holographic, does use a surface relief effect and a laser recording process. PA Technology of Royston, south east England, have introduced a new type of disc with a surface thinly coated in a continuous, homogeneous film of platinum and patterned like the eye of a moth; the effect is achieved by laser interference techniques. The disc becomes, like the moth's eye, black and non-reflective. A low-power laser, working as part of the computer set-up, then carries out thermal erasing to produce light-reflecting shiny spots on the disc, so giving a differential means of data recoding. Each disc stores 600 megabytes.

British Telecom has made extensive use of holographic security in its phonecard system for calls on a public telephone. Each card allows the user 20 calls. The holograms inside are thermally erased at the time of use, and are not susceptible to re-recording by dishonest people.

Among others developing advanced holographic security is the firm Cambridge Consultants, which has a system going beyond the usual credit card type. On such cards the company can encode specific data about the cardholder in a way that is exceptionally difficult for a thief to decode, let alone tamper with. The same principle works with high-value bank drafts and other security paper. The firm is also investigating the application of diffractive optical elements to document security.

Photography

Embossed holograms are produced mechanically, not by a photographic emulsion. The further extension of embossing, however, holds possibilities which could affect the future of photography. The Polaroid Corporation in the USA has developed a technique for forming lenslet surfaces on photographic emulsion. By pressing cups into the surface of a photographic layer, it is possible to organise the grains into a spatially periodic array. This reduces the granularity of the recording medium, and with it the grain 'noise'. The lenslet array has improved the quality of colour photographs.

Nick Phillips points out a further and exciting potential of such lenslets on the recording medium. If they could be made to act as lenslets in the way that the imaging medium of a fly's eye can work, it might be possible to foresee a three-dimensional snapshot camera. Another possible outcome of present American research — in this case by Emmett Leith, one of the two scientists who first applied the laser to holography in 1960 — might be edge-lit holograms, dispensing with the need for a spotlight at the front or back. Either development would have a big impact on public acceptance of holography.

Microcircuit lithography

Exciting for the future of electronics is the possibility of making microcircuit lithography cheaper. Printing today's microcircuits with sub-micrometre resolution limits is done by very high resolution optics and UV lamp sources. To use a hologram for printing the image of a microcircuit would offer big advantages.

At the Rutherford Appleton Laboratory, near Oxford, Dr Malcolm Gower and colleagues have experimented with a sophisticated technique known as dynamic phase conjugation. Certain crystals are subject to what is known as the photo-refractive effect. When they are exposed to spatially non-uniform light fields, light-induced changes occur in the refractive index owing to the migration and retrapping of electrical charges. These crystals used as volume holograms (three-dimensional media for holographic recording) can contain information at densities up to 10^{12} bits cm^{-3}, yet have exposure sensitivities comparable with the best photographic emulsions. In dynamic, or real-time holography using such crystals, the 'writing' and 'reading' processes are virtually continuous and simultaneous.

Nick Phillips gave me this explanation: "In simple terms it means that certain recording materials for holography are in fact self-developing, as the interference patterns form without any subsequent processing. Light coming into the medium then images itself and it can, under the right conditions, be literally retro-reflective; so even if a wave arrives on a surface of a complex shape it will in all parts of the wavefront be retro-reflected. Therefore a point-source of light irradiating such a surface will generate from the surface of the recording medium a backward-travelling wave which is going right back to that point again.

"By being a bit clever about it and putting a beam-splitter in the path between the source of light and the reflective material, one can produce a printed page in the direction of right angles, and it avoids therefore the use of the hideously expensive imaging lens that is employed in these sorts of arrangements."

This method has the disadvantage that the mask used is in a one-to-one ratio with the printed image, whereas the lens used in the imaging process can be used to reduce the image by up to ten-to-one; so the mask, produced by electron-beam technology, is rather expensive. But the lens itself, which

might cost from 40,000 to 50,000 pounds, could be eliminated — a major step forward in imaging technique.

Though work at the Rutherford Appleton has not yet produced a highly-defined sub-micrometre line good enough to convince the micro-electronics specialist, the experiments are being repeated to give a conclusive demonstration; so far, results look promising.

Microcircuit lithography in no way exhausts the possibilities of dynamic holograms. Dr Gower noted in a *Nature* paper last year (1985) that the capacity of the technique for rapid parallel-bit processing of information might give the photo-refractive effect applications in real-time optical data-processing, from optical image amplifiers, enhancers and pattern recognizers to optical switches and memories. He concluded with the suggestion that photo-refractive media might well produce a revolution no less dramatic than that caused by the discovery of photographic materials over a century ago.

Head-up displays

Further important applications of holography are likely to flow from the use of dichromated gelatin (DCG), a silverless medium able to produce bright and clear holographic displays. Pilkington Brothers, of St Helen's in the north of England and Marconi Avionics at Rochester in the south east, have been developing DCG for airborne head-up displays enabling pilots to view the instrument console and the outside world simultaneously.

Looking both at and through the display, they can see with remarkable clarity an image reflected off the DCG over a narrow band of wavelengths in the yellow-green part of the spectrum. At the same time they can steadily view the outside world, which appears with a hint of pink owing to some removal of the green part of the spectrum.

Notoriously, the speed of modern military aircraft is such that a two-second recovery period from a glance downward at the console can easily mean flying into a mountain. The new displays allow an eye-related view to where the holographic image appears as if at infinity through the viewing screen.

Reactors

Other important industrial applications of holography are in the inspection of inaccessible or dangerous domains. At Aberdeen University, Scotland, the technique is being developed for underwater use in inspecting the surfaces of oil-rig supports. Vital sightings to determine whether the support has been buckled or corroded are obtainable in this way.

At the University of Kent, at Canterbury, experiments with optical fibres are assisting another form of inspection. In spite of a tendency of optical fibres to produce awkward phase errors in the light, it is possible to pass the image of a hologram down an optical fibre and then recreate it elsewhere. One practical application is in medicine, to look into inaccessible places such as the ear.

In their research laboratories at Marchwood nearh Southampton, the Central Electricity Generating Board (CEGB) has devised a holographic technique for inspecting nuclear fuel elements. The element is raised to an observation port, but kept safely behind a radiation shield throughout the inspection. The technique depends on forming a hologram of the fuel element within the reactor (which is possible without any fogging from the radiation). Backward illumination with a reference beam allows the image to be projected out of the hologram.

It is a real image, and it can be more than a metre in depth. It can be examined out in the air, but is back-to-front. A television camera passes through the image to inspect it. The research is now well advanced, and undoubtedly a workable inspection method has been devised. ●

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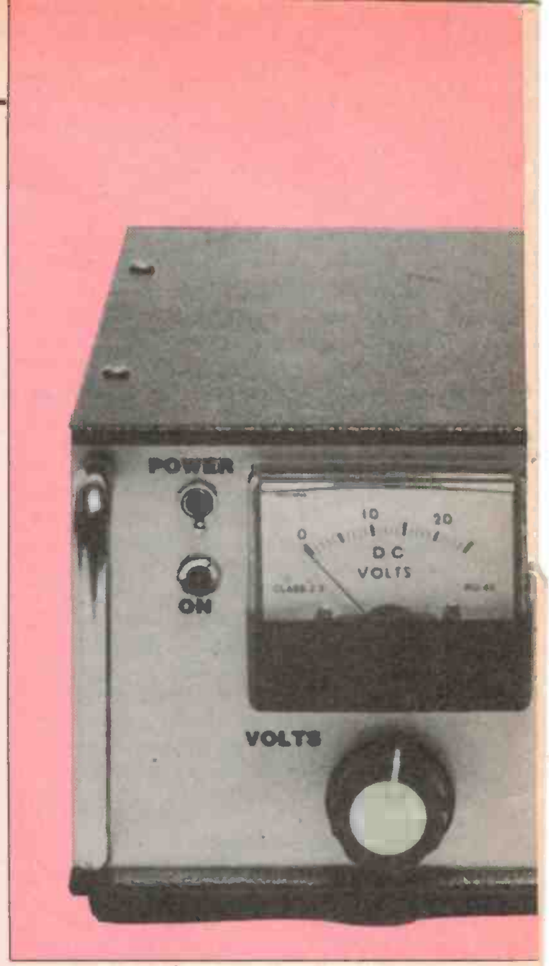
HEAVY DUTY SWITCHING REGULATOR



320 watts of brute power!! Another ETI maxi project that describes the construction of a 16 volt, 20 amp supply. This month the design, next month the construction.

Part 1

FOR MANY MONTHS NOW I have been annoyed by the lack of a power supply with enough grunt to deal with automotive accessories that draw a fair bit of power. Even the ETI-342 Pulse Shaped CDI Electronic Ignition drew too much power for my bog standard 2.5 amp power supply and had to be tested using a car battery. Car stereo power boosters can drawn 10 to 15 amps which is far out of the reach of laboratory power supplies. It became pretty obvious that an 'electronic car battery' would be a most useful thing to have.

I discussed the possible specifications with a few engineering friends over a beer or three. They drew my attention to the fact that a good power supply with an output capability similar to a car battery would make a perfect battery charger. No arguments and the specification became clear, an output voltage up to 16 volts and proper current limiting from 0.1 amp up to 20 amps. It could be used as a conventional power supply or, alternatively, it could be used as a battery charger and the current limit set at the maximum allowable charging rate. As soon as the battery voltage rose to 16 volts the charger would drop back to a trickle charge rate. Wonderful both ways!

A power supply capable of delivering 20 amps at 16 volts is a pretty high powered device (320 watts to be precise!) and a certain amount of care is needed when working with such power (otherwise *kablam*). The most obvious way, given current technology, is to use an off-line switching regulator. The problem with this is that you, dear reader, would have to wind your own transformer. Experience has shown that you really prefer not to and even if you did there would be a tiny chance of a mistake. Mistakes with mains voltages and powers are at best spectacular and at worst lethal so I chickened out! Given these probabilities I decided to use a commercial mains transformer to bring the input mains voltage down to a more manageable 16 Vac then rectify it to produce a 22 volt dc supply. A simple switching down-converter could then produce the regulated output.

As luck would have it Ferguson Transformers makes a battery charger transformer rated at 16 + 16 Vac out at 300 VA rating. The transformer's a bit low in output and I figured it was near enough and an awful lot cheaper than getting a special wound. The main effect of the slightly small rating would be for the supply to fade away (drop out of regulation) if the full 20 amps and 16 volts were set simultaneously. It's about the size of a brick and twice as heavy but it does fit in a readily available Horwood instrument case.

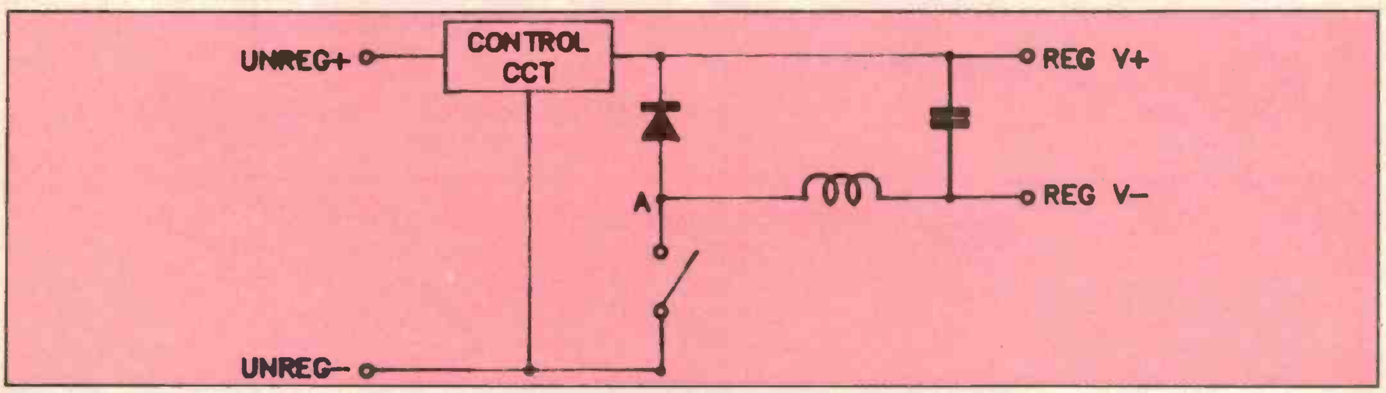


Figure 1. Block diagram of switching regulator.

Ian Thomas

Principles of operation

A switching down-converter is the simplest of all switching regulators to understand and is shown in block diagram form in Figure 1. The 16 volts ac is rectified by the bridge rectifier and filtered by the input smoothing capacitor to give an unregulated 22 volts dc supply. A series arrangement of a power FET and Schottky barrier diode are connected across the 22 volts. A series inductor is connected from the drain of the FET (and the anode of the diode) to an output filter capacitor which is connected back to the input positive supply.

The regulator uses a positive earth system as the FET is an n channel device and is easiest to operate in the negative rail. When the control circuitry turns the FET on, current is drawn from the negative output and the output filter capacitor through the inductor. Because the filter capacitors are large, the voltage across the inductor is more or less constant. This means that the current through the inductor rises linearly with time while the FET is on. When the current has risen sufficiently the FET is turned off. There is a lot of energy stored in the inductor which has to go somewhere and this shows up as the voltage on the drain of the FET going positive fast (very) and far.

When the FET drain voltage rises above the positive rail the Schottky barrier diode turns on and the inductor current is able to flow through it. During this time no power is drawn from the input supply and energy is recovered from the inductor. The current then runs down until the FET is turned on again to repeat the cycle. Control over the output voltage is achieved by varying the FET on time to off time ratio. This cycle is shown in Figure 2.

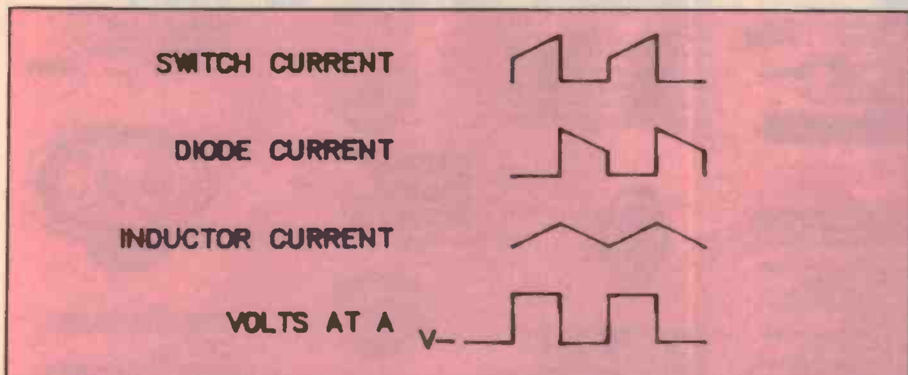


Figure 2. Current cycle of switching regulator.

The reason for all this complicated switching, inductors and exotic control circuitry is in the sacred name of *efficiency*. In a conventional regulator the input diode bridge and filter capacitor are the same but the regulator that follows is not. Your average bog standard regulator is what is known as a linear regulator and in effect is an electronically controlled variable resistor between the unregulated supply and the output. The control circuitry varies the value of this resistor to ensure that the output voltage remains correct.

A quick example will illustrate what happens with a linear regulator and why it really isn't suitable. If the output was set at 10 volts and the unregulated input was 22 volts the linear regulator would have to drop 12 volts. If the regulator were supplying 20 amps then the power dissipated in it would be 12 x 20 amps or *240 watts*. This needs a heatsink as big as all outdoors and twice as bulky!

However, in the switching regulator case you will notice that the two main electronic devices that pass all the current are operated in either the 'off' state where no current is flowing or in the 'on' state where the device has almost no voltage drop across it (or as close to no volts as we are able to arrange). This results in no power dissipation (or once again as close as possible) in the devices and hence the whole regulator.

Design details

One of the first parameters that must be decided on in the design of switchers like this is the operating frequency of the whole thing. In the bad old days a 20 amp switcher would be a rather large device because the diodes and transistors that could handle the current regrettably couldn't switch from on to off or off to on very fast. In very round figures switching speed was in the order of microseconds. Today's high current power FETs and Schottky barrier diodes make things much more reasonable because they switch *fast*. Switching speeds in the order of tens of nanoseconds are not hard to achieve for FETs and speeds are almost unmeasurable for Schottky barrier diodes.

Switching speeds are very important because when a transistor switches there is a period of time during the transition from on ▶

SERIES 5000

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WHY YOU SHOULD BUY A "ROD IRVING ELEC...
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SPECIAL, ONLY $329
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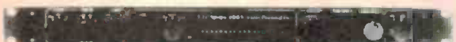
...and developed by ...IRVING ELECTRONICS and is being supplied to other kit suppliers.

SPECIFICATIONS: 150 W RMS into 4 ohms
POWER AMPLIFIER: 100W RMS into 8 ohms (+−55V Supply)
FREQUENCY RESPONSE: 8Hz to 20Hz +0=.0.4 dB 2.8Hz to 65KHz, +0=3 dB. NOTE: These figures are determined solely by passive filters
INPUT SENSITIVITY: 1 V RMS for 100W ouput.
HUM: 100 dB below full output (flat).
NOISE: 116 dB below full output (flat, 20KHz bandwidth).
2nd HARMONIC DISTORTION: ‹0.001% at 1 KHz (0.0007% on Prototypes) at 100W ouput using a +=56V SUPPLY rated at 4A continues ‹0.0003% for all frequencies less than 10KHz and all powers below clipping.
TOTAL HARMONIC DISTORTION: Determined by 2nd Harmonic Distortion (see above)
INTERMODULATION DISTORTION: 0.003% at 100W. (50Hz and 7KHz mixed 4:1).
STABILITY: Unconditional.

Cat. K44771 .... **$359**
Assembled and tested $549
packing and post $10



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THE ADVANTAGES OF BUYING A "ROD IRVING ELECTRO...

SPECIAL, ONLY $299
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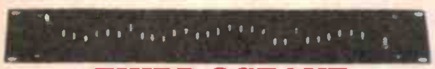
...knobs ... (We believe that dollar for ... a commercial unit available that sounds as good!)

SPECIFICATIONS:
FREQUENCY RESPONSE: High-level input: 15Hz =130KHz, +0.=1dB
Low-Level input-conforms to RIAA equalisation +=0.2dB
DISTORTION: 1KHz ‹0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation).
S/N NOISE: High-Level input, master full, with respect to 300mV input signal at full output (1.2V)›92dB flat ›100dB A-weighted, MM input, master full, with respect to full output (1.2V) at 5 mV input 50ohms source resistance connected: ›86dB flat/92dB A-weighted MC input, master full, with respect to full output (1.2V) and 200uV input signal: ›71dB flat ›75dB A-weighted.

Cat. K44791 .... **$319**
Assembled and tested $599
packing and postage $10

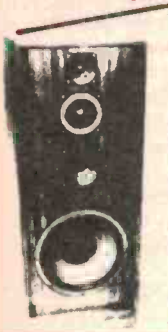


THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS:
BANDS: 28 Bands from 31.5Hz to 16KHz.
NOISE: ‹0.008mV, sliders at 0, gain at 0...
20KHz BANDWIDTH DISTO...
sliders at 0, gain...
FREQ...

SPECIAL, ONLY $209
SAVE $10

...unit **$219**
$429
packing and postage $10



SERIES 4000 SPEAKERS

8 Speakers .... only $549
8 Speakers with Crossovers $795
Speaker Cabinet Kit (complete) $395
(Please specify cabinet to suit 7" or 8" mid range woofer)
Crossover Kits $295
Complete kit of parts (speakers, crossovers, screws, innerband boxes.) $1,095
Assembled, tested and ready to hook up to your system ... $1,295
(Approximately 4 weeks delivery)

Errors and Ommissions Excepted

VIFA/AEM 2 WAY SPEAKER KIT!

This exciting new speaker kit, designed by David Tillbrook (a name synonymous with brilliant design and performance) uses VIFA's high perfomance drivers from Denmark. You will save around $800 when you hear what you get from this system when compared to something you buy off the shelf with similar characteristics. Call in personally and compare for yourself!

The system comprises...
2 x P21 Polycone 8" woofers
2 x D25T Ferrofluid cooled dome tweeters with Polymer diaphrams
2 pre-built quality crossovers

The cabinet kit consists of 2 knock-down boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.

D25T SPEAKER SPECIFICATIONS
Nominal Impedance: 6 ohms
Frequency Range: 2 - 24kHz
Free Air Resonance: 1500Hz
Operating Power: 3.2 watts
Sensitivity (1W at 1m): 90dB
Nominal Power: 90 Watts
Voice Coil Diameter: 25mm
Air Gap Height: 2mm
Voice Coil Resistance: 4.7ohms
Moving Mass: 0.3 grams
Weight: 0.53kg

P21 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 26 - 4,000Hz
Free Air Resonance: 33Hz
Operating Power: 2.5 watts
Sensitivity (1W at 1m): 92dB
Nominal Power: 60 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5.8ohms
Moving Mass: 20 grams
Thiele/Small Parameters: Qm: 2.4
Qe: 0.41
Qt: 0.35
Vas: 80:1
Weight: 1.65kg

Complete Kit Cat.K16020 .... **$699**
Speaker Kit Cat.K16021 ... **$549**
Cabinet Kit Cat K16022 ... **$209**

ARLEC "DISCO LITE" CONTROLLER

Give your parties a professional touch with the arlec "Disco Lite" Simply plug your light(s) into the "Disco Lite" and you've instant party lite!
3 DIFFERENT MODES!
Music Mode: Place the "Disco Lite" in range of the speakers and it flashes the lights to the beat of the music!
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Dim Mode: Allows you to dim the lights to create moods, effects etc.
Cat. M22003 .... **$49.50**

CRYSTAL LOCKED WIRELESS MICROPHONE AND RECIEVER

MICROPHONE SPECIFICATIONS:
Transmitting Frequency: 37.1MHz
Transmitting System: crystal oscillation
Microphone: Electret condenser
Power Supply: 9V battery
Range: 300 feet in open field
Dimensions: 185 x 27 x 38mm
Weight: 160 grams
RECIEVER SPECIFICATIONS:
Recieving Freq: 37.1MHz
Output Level: 30mV (maximum)
Recieving System: Super heterodyne crystal oscillation.
Power Supply: 9V Battery or 9V DC power adapter.
Volume control
Tuning LED
Dimensions: 115 x 32 x 44mm
Weight: 220 grams
Cat. A10452 .... **$89**

VIFA/AEM 3 WAY SPEAKER KIT!

This superb 3 way speaker kit competes with systems that cost 2 - 3 times the cost of these units! (which may even be using VIFA drivers etc.) Never before has it been possible to get such exceptional value in kit speakers! Call in personally and compare for yourself!

The system comprises...
2 x D19 dome tweeters
2 x D75 dome midrange
2 x P25 woofers
2 x pre-built quality crossovers

The cabinet kit consists of 2 knock-down boxes in beautiful black grain look with silver baffles, speaker cloth, innerbond, grill clips, speaker terminals, screws and ports.

D19 DOME TWEETER SPEAKER SPECIFICATIONS
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20kHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts
(fo: 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2ohms
Moving Mass: 0.2 grams
Weight: 0.28kg

D75 DOME MIDRANGE SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 350 - 5,000Hz
Free Air Resonance: 300Hz
Sensitivity (1W at 1m): 91dB
Nominal Power: 80 Watts
(fo: 500Hz, 12dB/oct)
Voice Coil Diameter: 75mm
Voice Coil Resistance: 7.2ohms
Moving Mass (incl. air): 3.6 grams
Weight: 0.65kg

P25 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 25 - 3,000Hz
Free Air Resonance: 25Hz
Operating Power: 5 watts
Sensitivity (1W at 1m): 89dB
Nominal Power: 60 Watts
Music Power: 100 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5.7ohms
Moving Mass (incl. air): 44 grams
Thiele/Small Parameters:
Qm: 3.15
Qe: 0.46
Qt: 0.40
Vas: 180:1
Weight: 1.95kg

Complete Kit Cat.K16030 **$1,095**
Speaker Kit Cat.K16031 ... **$879**
Cabinet Kit Cat.K16032 ... **$349**

PHILIPS SPEAKERS

"Unfortunately we cannot always guarantee Philips speakers to be in stock due to availability problems, nor can we guarantee the exact models listed. However, Philips equivalent or better will be supplied." -Rod.

Description	Cat.No.	Price
AD01610T8	(C12030)	$24.95
AD02160SQ8	(C12040)	$69.95
AD80652W8	(C12042)	$69.95
AD070620M8	(C12045)	$69.95
AD12250W8	(C12050)	$129.00

MIDRANGE & TWEETER LEVEL CONTROLS

Designed for midrange or tweeter controls on multiway speaker systems, these are suitable for systems up to 80 watts power handling capacity. They present a constant 8 ohms impedance to the load, and so do not disturb the crossover points. Both types come with fully air sealed mounting plates and are labelled 'MID' and 'HIGH'.
Midrange Cat.A16007 .... **$7.95**
Tweeter Cat.A16008 .... **$7.95**

SUPERB NEW VIFA/EA 60+60 SPEAKER KIT!

The new Vifa/EA 60+60 loudspeaker kit has been designed to completely out perform any similarly priced speakers. This is a 2-way design incorporating drivers which give a deeper, more natural bass response and 19mm soft-dome ferro fluid cooled tweeters which provide clear, uncoloured sound reproduction.

These Vifa drivers are identical to the ones used in such fine speakers as Mission, Rogers, Bang & Olufsen, Monitor Audio and Haybrook just to name a few. Some of which cost well over $1,000 a pair!

The dividing network is of the highest quality and produce no inherent sound characteristics of their own, they simply act as passive devices which accurately distribute the frequency range between both drivers in each speaker.

The fully enclosed acoustic suspension cabinets are easily assembled. All you need are normal household tools and a couple of hours and you've built yourself the finest pair of speakers in their class!

D19 TWEETER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 2.5 - 20KHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts
(fo: 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6.2 ohms
Moving Mass: 0.2 grams
Weight: 0.28kg
Cat. C10301 .... **$38**

C20 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 35 - 6,000Hz
Resonance Frequency: 39Hz
Sensitivity 1W at 1m: 90dB
Nominal Power: 50 Watts
(12dB/oct)
Voice Coil Diameter: 25mm
Voice Coil Resistance: 5.5 ohms
Moving Mass: 15 grams
Cat. C10322 .... **$89**
Cat. K86091 .... R.R.P. $449
Special introductory offer...$399

HI FI SPEAKERS

A comprehensive range of matched appearance speakers, all with square silver grey frames and black cones - ideal for building up low cost speaker systems that will look and sound superb.

1½" TWEETER

SPECIFICATIONS:
Sensitivity: 90dB
Freq. Response: 1.2 - 20 kHz
Impedance: 8 ohms
Power RMS: 10 watts
Magnet Weight: 2 oz
Cat. C10200 .... **$5.95**

2½" TWEETER

SPECIFICATIONS:
Sensitivity: 94dB
Freq. Response: 1.1 - 17 kHz
Impedance: 8 ohms
Power RMS: 10 watts
Magnet Weight: 2 oz
Cat. C10202 .... **$6.95**

4" MIDRANGE WITH SEALED BACK

SPECIFICATIONS:
Sensitivity: 96dB
Freq. Response: 650 - 15 kHz
Impedance: 8 ohms
Power RMS: 15 watts
Magnet Weight: 3.6 oz
Cat. C10204 .... **$11.95**

4½" MIDRANGE WITH SEALED BACK

Clothed edge surrounds.
SPECIFICATIONS:
Sensitivity: 97dB
Freq. Response: 600 - 8 kHz
Impedance: 8 ohms
Power RMS: 20 watts
Magnet Weight: 5.4 oz
Cat. C10206 .... **$14.95**

6½" WOOFER

Cloth edge roll surround.
SPECIFICATIONS:
Sensitivity: 96dB
Freq. Response: 55 - 7 kHz
Impedance: 8 ohms
Power RMS: 15 watts
Magnet Weight: 5.4 oz
Cat. C10208 .... **$17.95**

8" WOOFER RIBBED CONE

Cloth edge roll surround.
SPECIFICATIONS:
Sensitivity: 94dB
Freq. Response: 55 - 8 kHz
Impedance: 8 ohms
Power RMS: 20 watts
Magnet Weight: 5.4 oz
Cat. C10210 .... **$20.95**

10" WOOFER RIBBED CONE

Cloth edge roll surround.
SPECIFICATIONS:
Sensitivity: 95dB
Freq. Response: 37 - 6 kHz
Impedance: 8 ohms
Power RMS: 25 watts
Magnet Weight: 10 oz
Cat. C10212 .... **$35.95**

12" WOOFER RIBBED CONE

Cloth edge roll surround.
SPECIFICATIONS:
Sensitivity: 92dB
Freq. Response: 32 - 4 kHz
Impedance: 8 ohms
Power RMS: 30 watts
Magnet Weight: 13.3oz
Cat. C10214 .... **$49.95**

12" HIGH POWER MUSICAL SPEAKER

- Aluminium die cast chassis
- Carbon fibre impregnated cone paper
- Foam edge
- Light grey cone, silver dust cap
- High temperature "NOMEX" voice coil

SPECIFICATIONS:
Sensitivity: 97dB
Frequency Response: 50-4kHZ
Impedance: 8 ohms
Power RMS: 60 watt
Magnet Weight: 30 oz.
Cat. C10216 .... **$82.50**

to off (or the other way around) where the device has both a high voltage across it *and* high current through it. During this time the device dissipates power so the switching time must be made a small part of the total switching cycle. A similar type of phenomenon occurs with ordinary pn junction diodes and is known as reverse or forward recovery time. Long recovery times result in high power dissipation too.

If slower bipolar transistors are used in a regulator such as I have just described, the operating frequency is limited to 20 to 50 kHz. In the really old days when I was a spotty faced kid and transistors had just been invented, switchers used to run at audible frequencies and drive you crazy with their whistle, but I digress. This means that the inductors and filter capacitors must be *big* to deal with the lower frequencies which makes the power supply much bulkier.

Given power, FET performance switching regulators can be operated easily at 100 kHz (as this project is) and people are working with exotica at over 2 MHz. Certainly at 100 kHz everything will fit in the box very nicely.

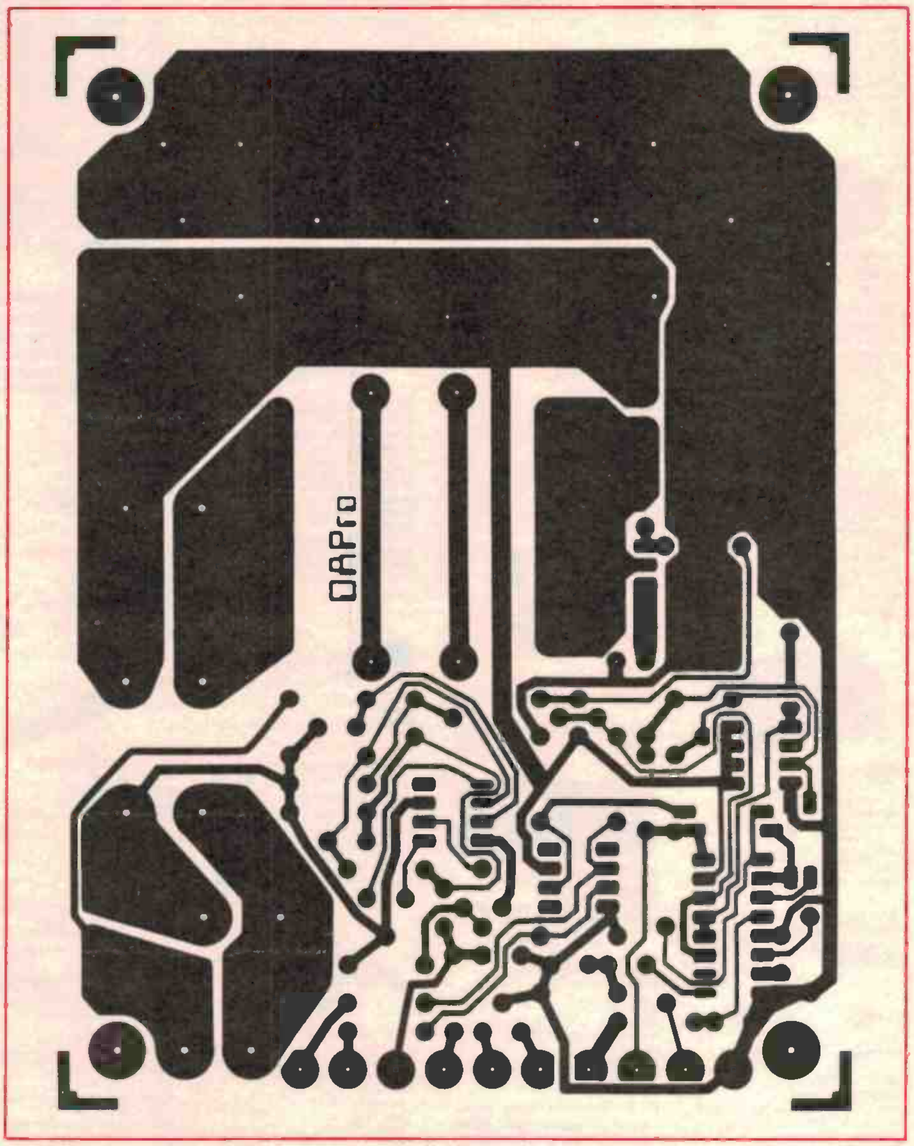
The next problem that showed up in the sums was that 20 amps is an embarrasingly large current. I could afford to put *no* resistance anywhere for any reason without the whole thing getting very hot. To illustrate this consider an ordinary printed circuit track. The ordinary one ounce copper foil on your bog standard board has a sheet resistance of approximately 0.5 milliohms/square. That is, a square of any size with perfect connections down two opposite sides will have a resistance of about 0.5 milliohms. To translate this to more understandable numbers, take a track 50 thou wide (common enough) and 1 inch long. It has effectively 20 squares of copper 50 thou on a side connected end to end. Therefore its total resistance is 20 x 0.5 or 10 milliohms. A quick bit of arithmetic shows that when the track carries 20 amps its total power dissipation is 20 x 20 x 0.01 or *4 watts*. This means the track stays in existence for a second or two at the most (poof!). The point in this is *big and short tracks* for all high current paths.

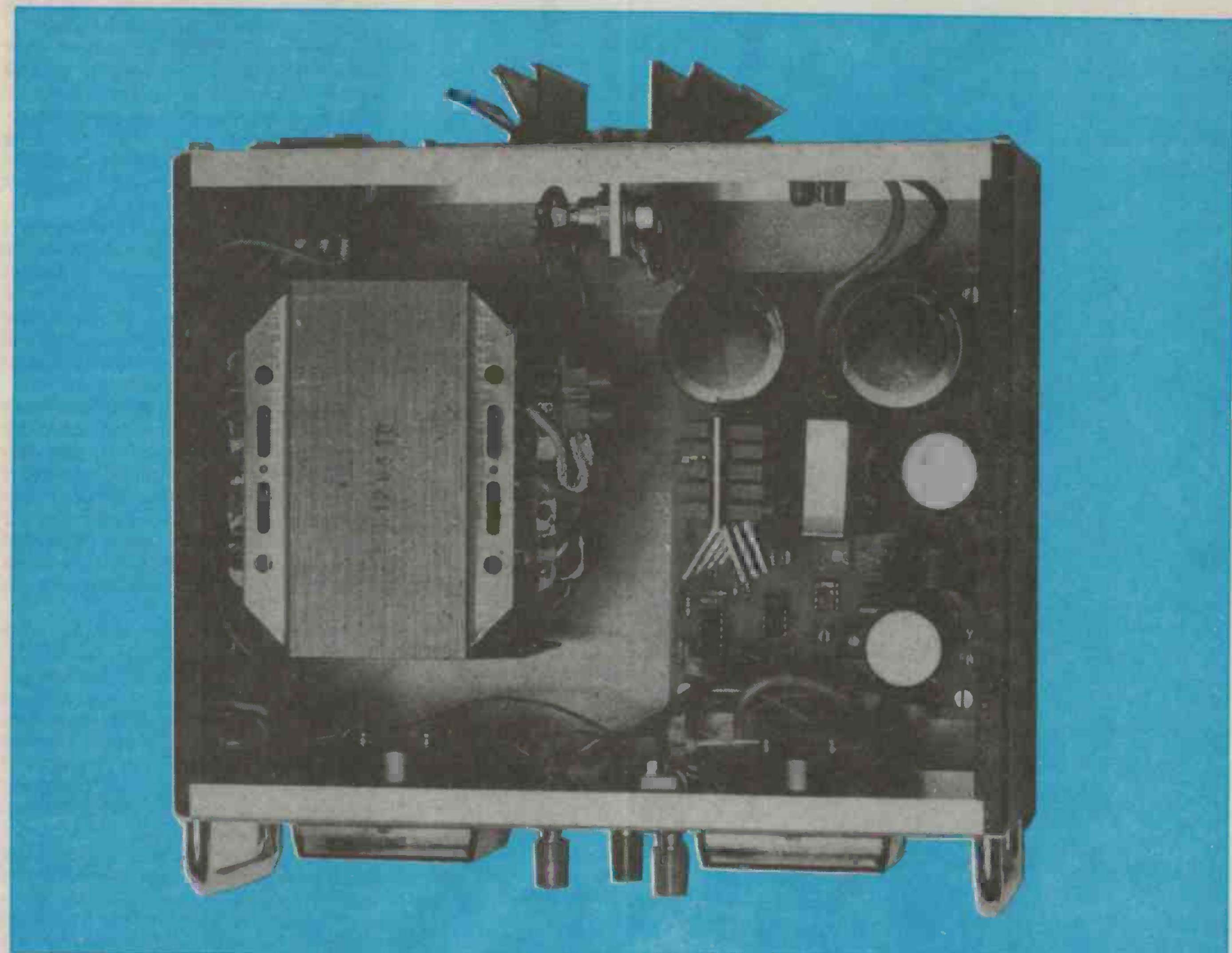
There are other problems as well. For example it is normal practice to use a small resistor in series with the output to sense the output current. Your typical el cheapo 50 microamp meter (which I used for both the voltage and current) needs to drop about 0.2 volts for full scale deflection and a shunt resistor is placed in parallel with the meter to do this. However at 20 amps the power dissipated in the current sense shunt is over 4 watts for full scale at 20 amps. The only way to avoid this problem is to use a very small current sense resistor and amplify the resultant very small voltage drop.

The main series inductor has to pass all the output current and, since it must have quite a long piece of wire to form the inductance, the piece of wire must be very thick. This is where things start to get interesting. The inductor is handling current which is being switched on and off at 100 kHz. At these frequencies electric current does not flow through the bulk of a piece of wire but tends to flow on the surface. This is known as the skin effect and for high power rf conductors copper tube is used as the inner part simply carries no current.

The higher the frequency the thinner the surface layer that carries current. If the inductor were to be wound using solid copper wire then, because the copper needs to be quite thick, the inner part of the wire would carry no current. The way to avoid wasting space in the coil like this is to not use one piece of wire but bundle several thinner strands together to form a cable (see construction details next month).

Another problem associated with high currents at high frequencies is in the filter capacitors. It would seem at first glance that a 2200 μF capacitor should have a negligible impedance. Regrettably this is not so. Aluminium electrolytic capacitors are made up of alternate layers of foil and spacer material soaked in electrolyte and rolled up. At high frequencies this rolled structure starts to behave more like an inductor than a capacitor. This is very much a function of the way the capacitor is made and the capacitor impedance varies from brand to brand so if you can't find any performance figures for the capacitor then it is better not to use it. Once again there are very high currents flowing in the output filter (not the full 20 amps but enough) and capacitors can





go bang too! The ERO brand capacitors used here are OK but others may not be, so check first.

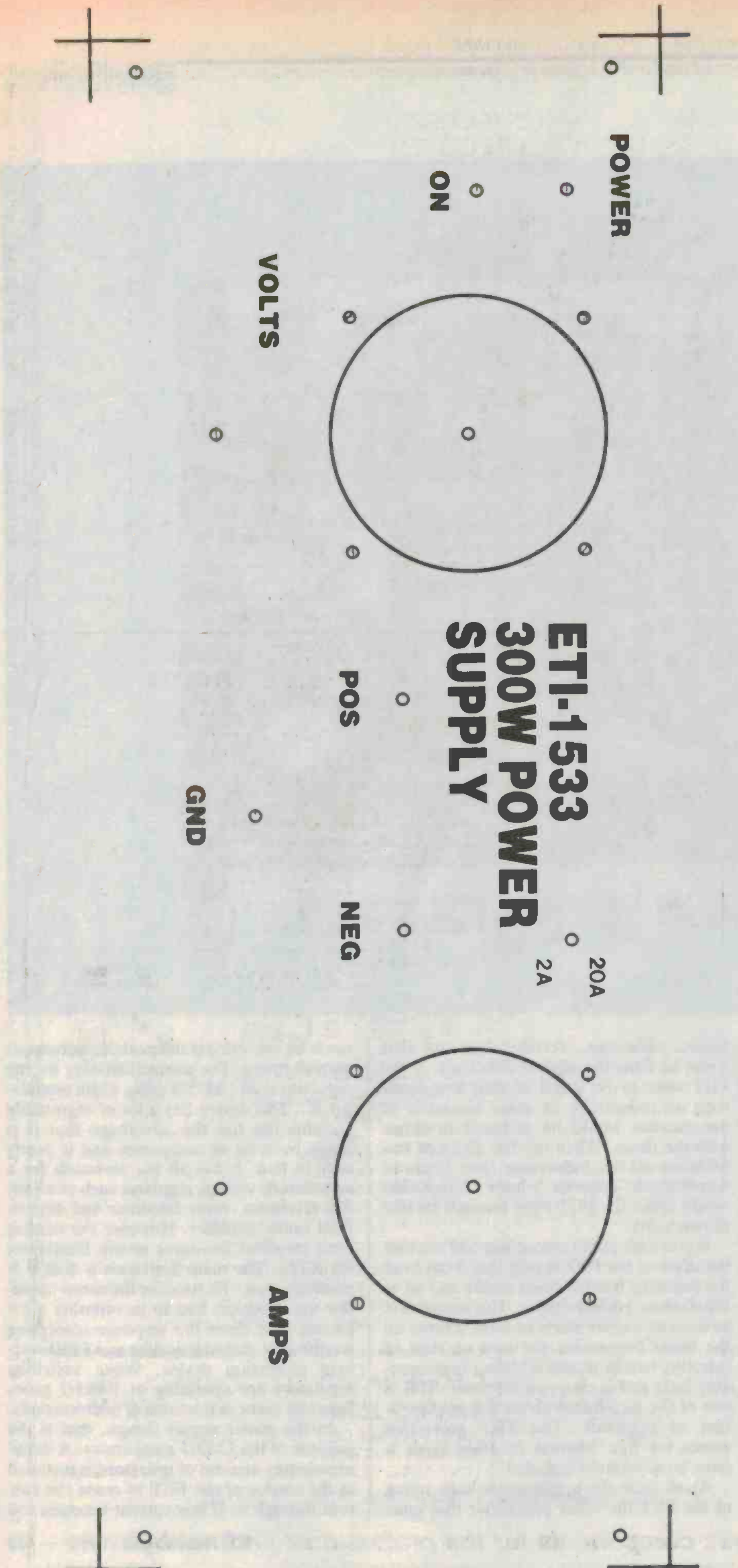
In the power supply the main switching FET and diode are mounted directly on the board. One reason is that the losses in the two devices are sufficiently low that the heatsink could be fitted on the board. This saves fiddling with wires, always a good thing to do. If the main switching devices were mounted on the rear of the unit on external heatsinks the leads to and from them would be both resistors (hot!) and inductors. The inductive effects alone could easily generate transient voltages that could break things.

When using power FETs there are rules that absolutely must never be broken. One of these is that the FET drain-source maximum voltage must *never* be exceeded. As a matter of interest I attended a seminar once on power switching where I was informed that the FET's life could be saved if the load could be shed quickly enough — say 10 nanoseconds max. Terrific! Just how that could be done the adviser didn't say. If the FET were to be wired in with long leads then an inductance of some hundreds of nanohenries would be included in series with the drain. When the full 20 amps was switched off this inductance (just 10 cm of wire!) would generate a huge voltage that would spike the FET right through its tiny silicon heart.

If you look at the layout you will see that the drain of the FET is only 2 or 3 cm from the Schottky barrier diode anode and all of the distance is solid copper. This means that as soon as a spike starts to form it turns on the diode (remember the turn on time of Schottky barrier diodes is almost immeasurably fast) and is chopped off short. This is one of the nice things about this configuration of regulator. The FET protection comes for free whereas in other types it must be separately included.

Apart from the maximum voltage rating of the FET the other parameter that must never be exceeded is the peak instantaneous current rating. The control circuitry for the regulator is an LM3524 pulse width modulator IC. This device has a lot of regrettable features but has the advantage that it is made by a lot of companies and is pretty easy to find. It has all the essentials for a switchmode voltage regulator such as a voltage reference, error amplifier and current limit sense amplifier. However the current limit amplifier has some severe limitations for FETs. The main limitation is that it is painfully slow. To stabilise the sense amplifier the designers had to incorporate a capacitor that slows the response something terrible and makes it useless as a FET overload protection device. When switching regulators are operating at 100kHz problems can occur in fractions of microseconds.

In the power supply design, that is the purpose of the LM311 comparator. A deliberately tiny amount of resistance is included in the source of the FET to sense the current through it. If this current becomes too ▶



high for any reason (the usual one being overload during start up) then the comparator output goes negative and removes the gate drive. Positive feedback is applied around the comparator so that if it is triggered by an overload then the gate drive remains off for the whole of the switching cycle. An output is available from the LM3524 that is used to reset the comparator at the beginning of the next cycle.

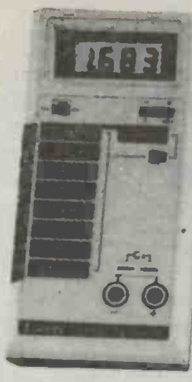
This solved the problem of instantaneous overcurrent but didn't help at all for steady state current sensing and constant current control. This problem was made even harder by the fact that all output voltages and current are referred to the positive rail but the LM3524 uses the unregulated negative rail as a reference ground.

Two separate operational amplifiers were finally used to sort out these problems. I've already hammered away at the fact that only small voltage drops can be tolerated if 20 amps is flowing. In this case I decided to make the drops very very small (as in a 1 milliohm resistor) and used parallelled lengths of copper wire. This makes it more of an inductor than a resistor but we can make out.

National Semiconductor makes a very nice operational amplifier in the LF355. This gizmo has two desirable features uncommon in most 741 pinout type op-amps (this is a good illustration of the point that, like oils, op-amps ain't op-amps). The first nice feature of the LF355 is its very low and stable input offset voltage. All operational amplifiers exhibit a tiny but noticeable voltage differential at their inputs which cannot be told apart from a dc input signal. Since the purpose of this op-amp is to sense just such a very small voltage then local interlopers cannot be allowed. The maximum voltage the op-amp must measure is only 20 mV which corresponds to the full 20 amps out. Fortunately the LF355 after offset adjustment to zero only has an offset voltage drift of 5 microvolts per degree C or, allowing for scaling, a total error of 5 mA per degree C in a 20 amp full scale reading.

The second nice feature of the LF355 is that the allowable common mode input voltage includes the positive rail for the amplifier. This allows the sense resistor (wires) to be placed in the positive output and avoid any possible offset movement problems (op-amp offsets often move about when the common mode input voltage is changed).

The output of the current sense amplifier is converted to a current by the transistor, Q4, and the scaling factor is set at a nice round 1 mA out of the collector, per amp of output current. The variable resistor, RV1, allows this scaling factor to be set exactly. The current sense amplifier is also used to provide some phase lead compensation to keep the power supply well behaved when in current limit. ●



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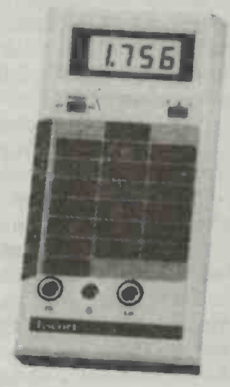

ESCORT ELC-120 L/C/R METER

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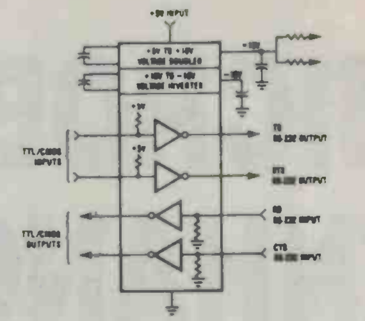

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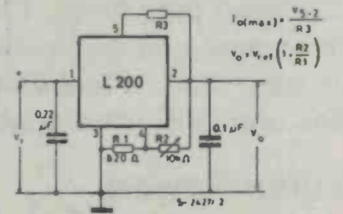

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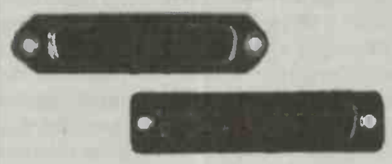

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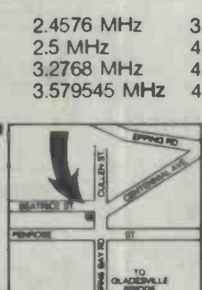

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MICROBEE OUTPUT ENHANCER

The definitive peripheral. This unit plugs on the back of your Microbee and gives you four joystick ports, a sound effects generator, a real time clock, a speech synthesiser, an ADC and DAC, and analogue and digital inputs galore.

Jonathon Powers

THE ETI-1606 MICROBEE enhancer is designed to turn the output port of your Microbee into something wonderful. It uses a combination of hardware and software to allow a multitude of interfacing options.

The software comes in the form of a ROM that can be plugged into the spare ROM socket on the Microbee, or alternatively as a cassette which can be downloaded in the usual way. The ROM is clearly preferable. Accessing the program is infinitely faster, but more importantly it doesn't take up space in the RAM. In small machines, where the 1606 would be most valuable, that could be quite significant.

The software consists of a suite of programs which can be called from BASIC using the USR instruction. They are, in fact, a series of machine code programs. To call them, you use the following format:

X = USR (B + Offset, control number)

B is a number which depends on the format in which the software is stored, as in Table 1.

TABLE 1.

Version	B
ROM	E000
16K cassette	3300
32K cassette	7000

Offset is a number which calls each particular routine and **control number** is an optional code that is sometimes required as an entry condition to the routine.

However, before getting too far into the software, it's a good idea to examine the hardware in a little more detail. This will give you some idea of the range of possibilities of the 1606.

Hardware

The circuit diagram looks immensely complex. However, recourse to the block diagram (Figure 1) will show you that it is really rather simple. The most important feature to note is that there are two primary busses for carting information around the place: the data bus and the control bus. Individual data lines are denoted Dn, and control lines CBn. Control logic at the top of the diagram interfaces these to the Microbee itself and allows their condition to be controlled or read by the data bus in the Microbee.

Going around the diagram in a clockwise fashion, and taking the blocks one at a time:

RTC: If we start top right, you will find a block named RTC or real time clock. This uses the vertical synchronizing pulse generated in the Microbee as a particularly stable 50 Hz reference signal. This VSYNC signal is used to provide the vertical flyback of the video screen. As such it is the most stable signal to be found in the Microbee.

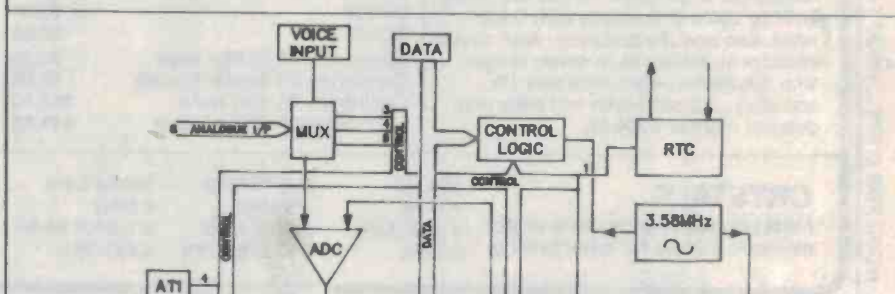
It is gated by one of the control bits, CB1, which effectively brings its output under software control. It is further gated by a multivibrator to give a precisely timed pulse and to synchronize it with other operations. It is then fed back to the Microbee and placed on the interrupt pin of the Z80. The effect of this is to send the processor off to a particular address once every 50 milliseconds.

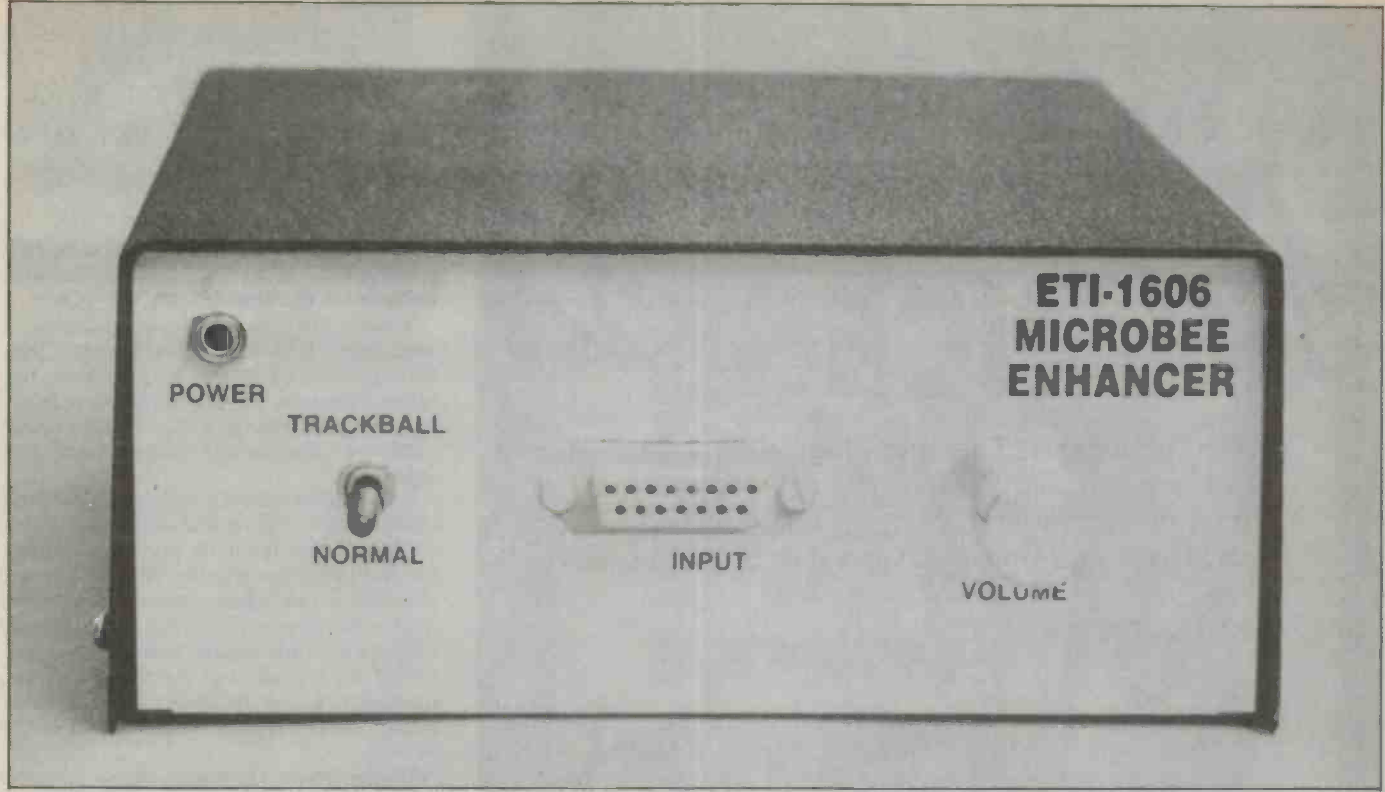
It could be used to generate an accurate stop watch, or even a clock on the screen. It can arbitrate between two fire buttons pressed almost simultaneously, and so on.

Clock: This is a bog standard 3.58 MHz square wave oscillator. Its output is used directly on various chips, and divided down for use on others.

Effects synthesiser: The effects synth has a noise generator and three tone generators. It is switched on by the control bus and directly accessed on the data bus. Each generator is individually controllable in frequency and volume. To set a particular feature of the synth, a control word is used. This word contains three address bits and a certain number

Figure 1. Block diagram





of control bits.

The addresses, the first three bits of a control word, are made up as in Table 2.

TABLE 2.

Addresses r2	r1	r0	control
0	0	0	tone 1 frequency
0	0	1	tone 1 volume
0	1	0	tone 2 frequency
0	1	1	tone 2 volume
1	0	0	tone 3 frequency
1	0	1	tone 3 volume
1	1	0	noise pitch
1	1	1	noise volume

Tone control is achieved using a formula:

$$n = \frac{111875}{f}$$

The number n is translated into a 10-digit binary number and then used to fill out two control words. Volume is controlled by a four-digit binary number, giving a level from 0 to 16.

So, to set the frequency of tone 2 to 1 kHz, we would need to assemble two control words like this:

tone 2 frequency = 010

n = 111875/1000, so n = 112, = 70H = 00 0111 0000 in 10-bit binary. So the control number looks like so:

1 r2 r1 r0 f3 f2 f1 f0 0 x f9 f8 f7 f6 f5 f4

1 0 1 0 0 0 0 0 0 0 0 0 1 1 1

which is 192 07 in decimal. Tone 2 volume would be assessed as in:

1 r2 r1 r0 v3 v2 v1 v0

To make the volume on tone about half we ▶

ETI-1606 — HOW IT WORKS

Clock: The clock consists of IC8b and IC8d connected in the standard oscillator arrangement with its frequency stabilized by a 3.58 MHz crystal, X1. This is buffered by IC11c and fed to IC4 and IC6. It also goes to IC9a and b (dual flipflops) which divide it down and pass it on to other parts of the circuit.

Sound generator: The sound generator consists of IC4 and its associated components. Most of the magic occurs inside the plastic. All we can see is the action on the data bus, which consists of a string of control words, and its chip select logic. This comes in the form of IC8a NANDed control bus line CB0 and the PARDY line from the parallel port.

The output is filtered by the network consisting of R34, C14 and R35, C20 and R45. It is finally decoupled by C19 and then fed to the amplifier.

Speech synthesiser: This almost mirrors the sound generator. Information is fed in off the data bus and outputted to the amplifier via R37, C13, R36 and associated components. Once again a large capacitor, C11, is used for decoupling.

RTC: The real time clock is simply a series of logic gates formed by IC11d, IC13c and IC17c. IC11d is driven by the CSYNC direct from the Microbee. It is buffered by IC11d, cleaned up by R32 and C10 and then fed into IC13c, where it is NANDed with CB1 from the control bus. This is then synchronized by the BSTBY line from IC16, a 74LS123 multivibrator with an on-time of 11 μs. Output from this gate is sent back to the Microbee's PIO.

Inputs: The four joystick ports can best be understood as a collection of digital and analogue inputs. The digital inputs are bussed into a buffer IC5 and then onto the data bus. The analogue lines are bussed up to a multiplexer formed by IC14, which turns them into three CB lines.

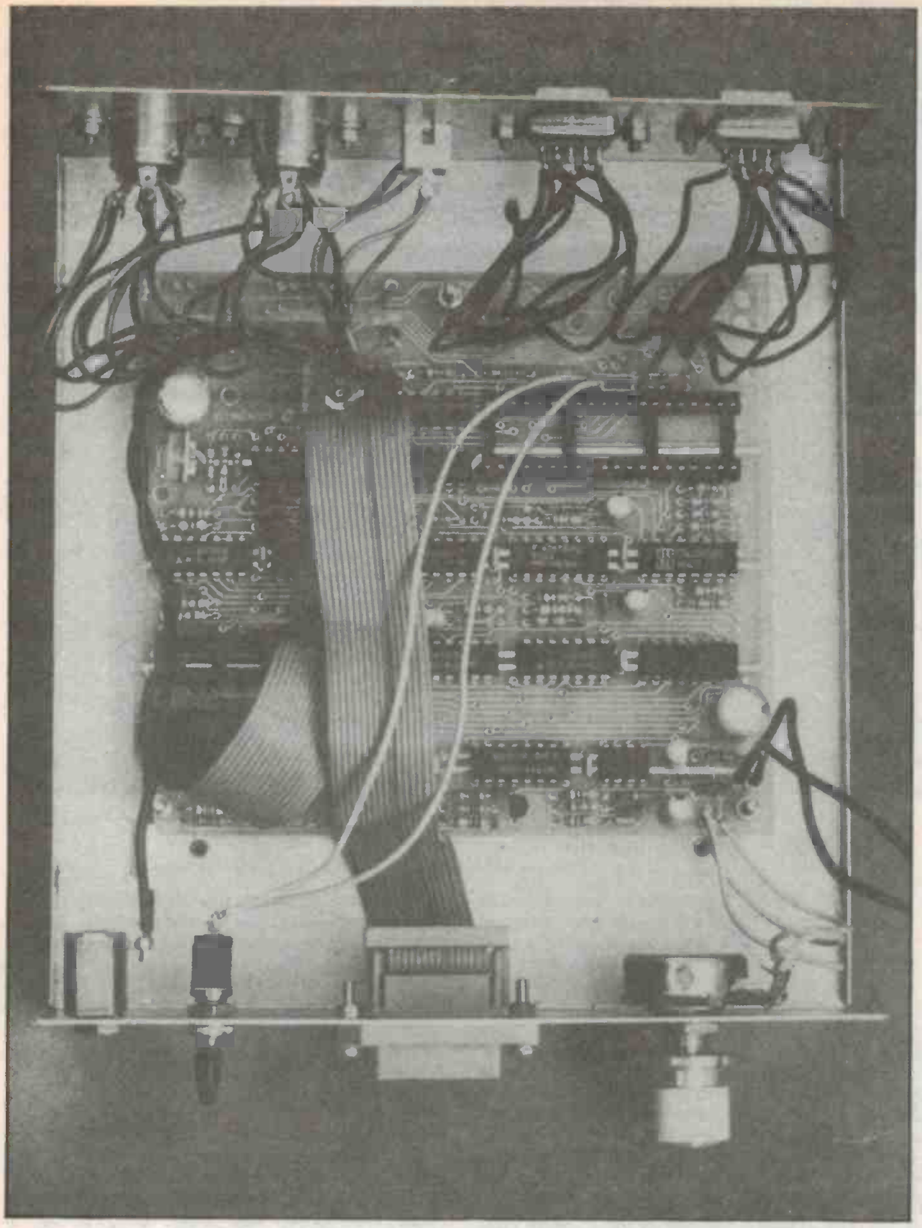
One of the analogue lines is reserved for the voice input socket. The network formed by R3, C16, D1, etc, shapes the signal and prepares it for multiplexing.

Note that SW1 is connected to CB4, effectively grounding it. This is to provide a solid ground to this line when a trackball is connected to the input port AT1. This is done because the trackball has considerable current requirements.

DAC: The DAC is built up around IC3. It's clocked by IC13d, itself driven by CB0 and CB7. When the clock is made active, the value on the data bus is read into the DAC. The outputs then assume a value dependent on the input, resulting in a total output voltage on the emitter of Q1. When CB0 is low, this is passed via the e-c junction to the audio amplifier.

ADC: Converting from analogue to digital is done using IC19d. This is a high quality comparator. Conversion starts when an analogue line is connected via IC14 through to the sample and hold SH capacitor, C7. When the SH gate is opened the analogue line charges up the capacitor. When it closes, the charge stays on the cap, since there is no discharge path. This voltage is also connected to the negative input of the comparator. The other side of the comparator is connected to the DAC output. Thus, there is a comparison between the voltage value on the SH cap and the value of the DAC.

Exactly how the conversion works is determined by the software, but one strategy might be to impress the analogue voltage on the SH cap, then set a certain voltage on the data bus, convert it in the DAC, and wait to see if the comparator changes shape. If it doesn't, one would apply the next highest voltage and do the same thing. In this way, the DAC would ramp up until it went one voltage step higher than the analogue voltage. This could then be taken as the value of the analogue input.



set the level to 8 = 1000 in binary and assemble the word as:

1 0 1 1 1 0 0 0

which is 184 in decimal.

So to send them down the line write **OUT 0,192:OUT 0,7** to set the frequency and **OUT 0,184** to set the volume.

Voice synthesiser: The voice synthesiser is accessed in much the same way, except that here the building blocks are phonemes, the smallest elements of meaningful sound. In effect, this gives you the ability to make up an unlimited vocabulary by just adding things together.

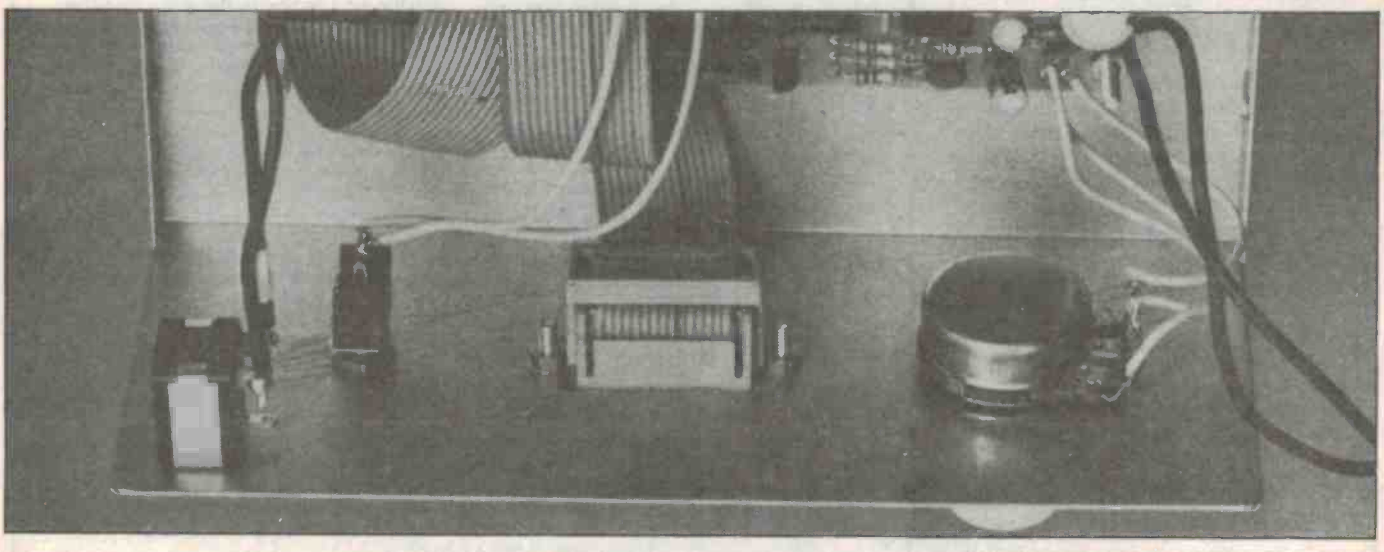
Printer: The printer interface has been included on the diagram and circuit board, but we did not build it into the prototype because we didn't think it worth the effort for our application. It's included so that you don't have to plug and unplug the printer when you are working with the enhancer as well. The interface is constructed so that the 1606 looks transparent from both directions, so both the printer and computer operate exactly as normal.

Digital input: The digital inputs actually consist of a number of lines connected up to the data bus via a buffer. Physically, these lines are accessed via the various joystick ports and, in fact, form an integral part of the joystick control mechanism.

Analogue input: Likewise, these are available to the world on the joystick ports. However, using them is slightly more complex. Firstly, the lines are all multiplexed onto three of the control lines, CB4, 5 and 6. Secondly, not all of them are the same. A17 is a special line reserved for voice input. It is brought out to a 3.5 mm microphone socket on the front panel, and has special line conditioning circuitry on it.

The joystick ports on the front panel play ▶

▲ From the top looking at circuitry. ▼ A close up of the front panel wiring.



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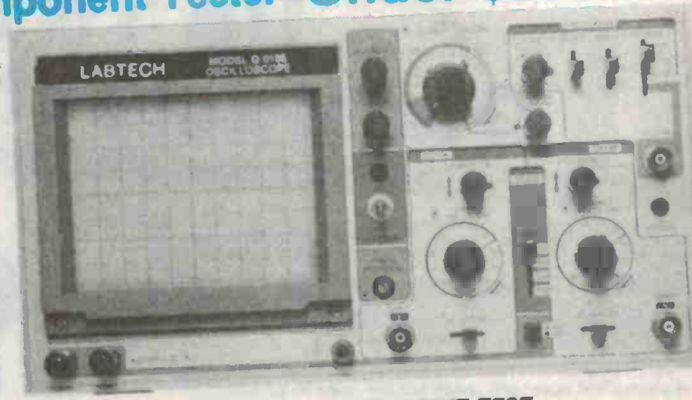

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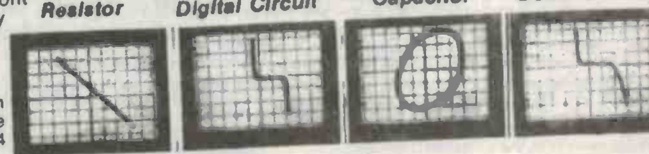

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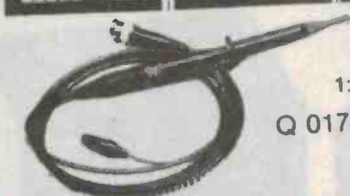

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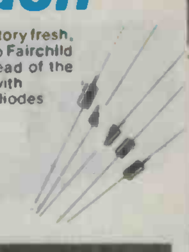

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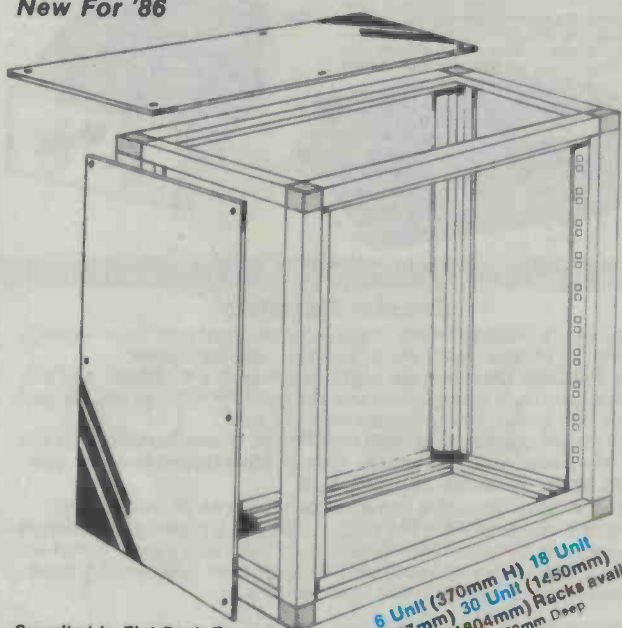

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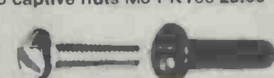

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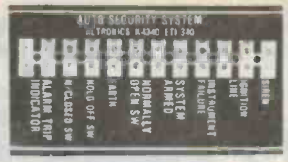

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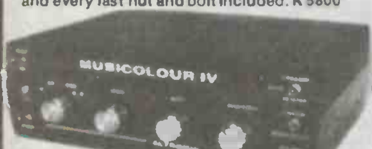

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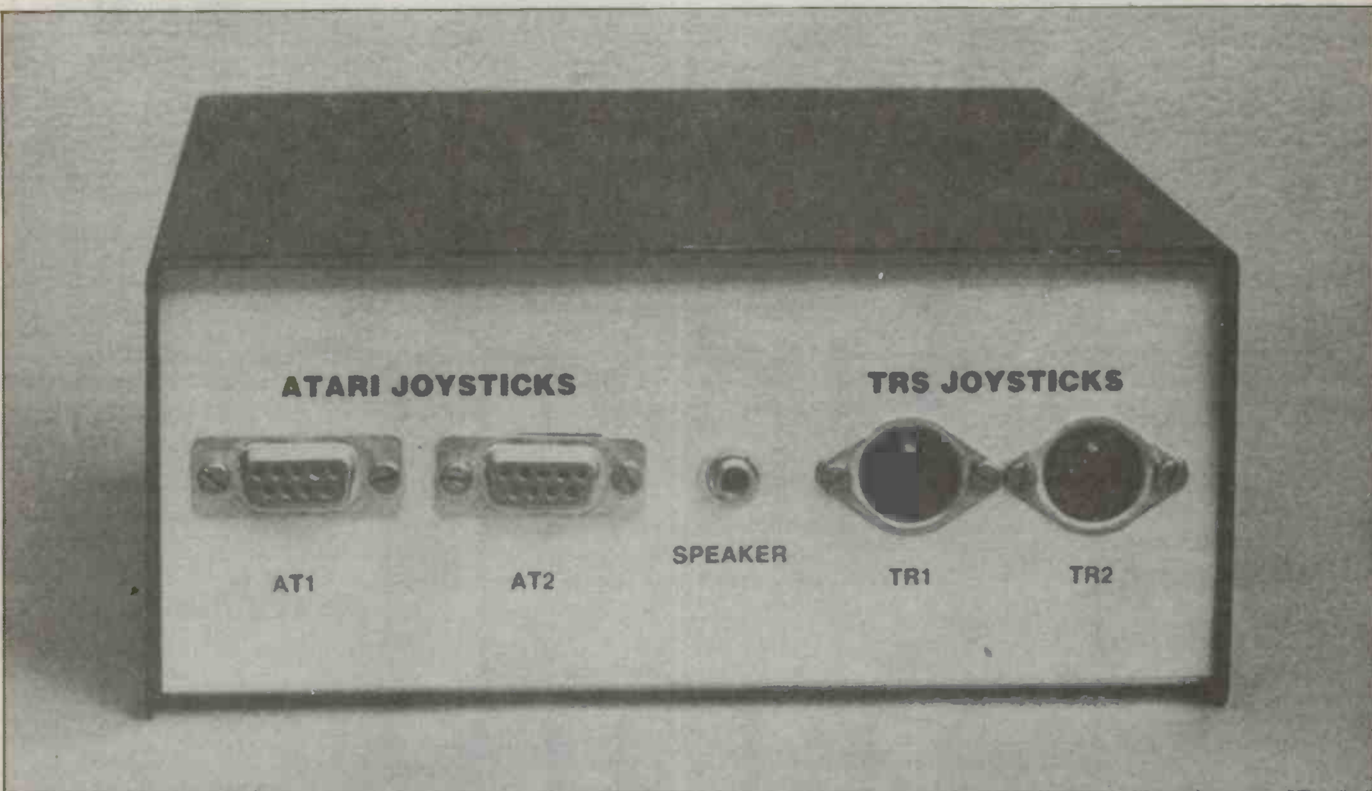


Rear view.

host to both the analogue and digital lines. They are configured so that two may be used with the Atari, Commodore style joysticks (called AT1 and AT2), and two may be used with the TRS80 style joystick (TR1 and TR2). Since many other input devices, like mice and graphics tablets conform to the standards of joysticks all these input devices can be used as well. There is also the possibility of using a trackball on one of the Atari ports. A trackball is a sort of inverse mouse, in which the device stays still, and you roll the ball around.

One complication is that it requires a hefty amount of current to drive it, current that the multiplexer could not handle safely. To solve this problem, CB4 and AT1 can be securely connected to earth via a switch on the front panel. This is not a particularly elegant solution to the problem, but it does solve it effectively. It means that the selection bits for the ports are not operational, so you can't have a combination of joysticks and trackball on the input.

DAC: The digital-to-analogue converter in the middle of the diagram is used to convert the contents of the data bus to an analogue output, which can be sent to the audio amplifier. The output is also used by the ADC.

ADC: The analogue-to-digital conversion is done by using the DAC circuitry and a comparator. The analogue input is supplied via the multiplexer. The comparator generates a single line digital output that is connected to D5. The state of D5 will thus tell the computer whether the analogue input is higher than the DAC output, or not.

Software

There are two ways of controlling the enhancer. One way is to call subroutines secured in ROM from your own BASIC programs. This is efficient in terms of programming time, but may not be quite as flexible as you want. So it has been made possible to address the machine directly. The key is the control bus, which is used to select the various options. Table 3 shows the values required.

TABLE 3.

CBn 0	1	2	3	4	5	6	7	Mode
x	x	x	0	0	x	x	x	AT1 and AT2 both enabled
x	x	x	0	1	x	x	x	AT1 enabled
x	x	x	1	0	x	x	x	AT2 enabled
x	x	x	1	1	x	x	x	read TR1 and TR2 fire buttons
x	1	x	x	x	x	x	x	enable RTC
x	x	0	x	x	x	x	x	sample and hold gate on ADC open
x	x	1	x	x	x	x	x	sample and hold gate closed
x	x	x	x	x	x	0	x	DAC audio enabled
x	x	x	x	x	x	1	x	DAC audio disabled
1	x	x	x	x	x	x	x	enable sound effects
0	x	x	x	x	x	x	0	select DAC
0	x	x	x	x	x	x	1	music synthesiser

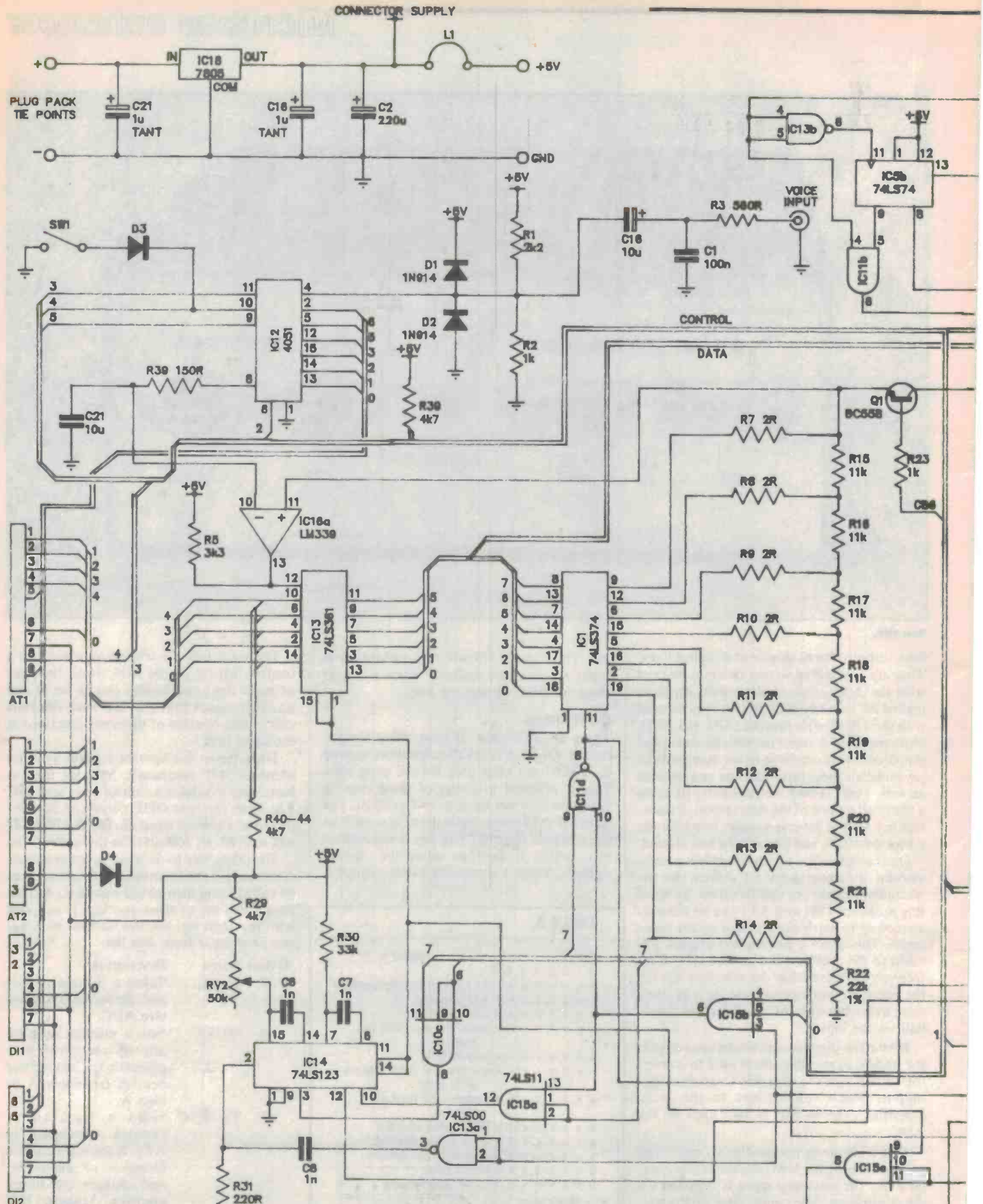
x = don't care

The eight bits are treated as a word in a control register on the 1606. Thus, the state of more than one facility can be set in one go. This means that you can have the 1606 carry out a number of different functions at the same time.

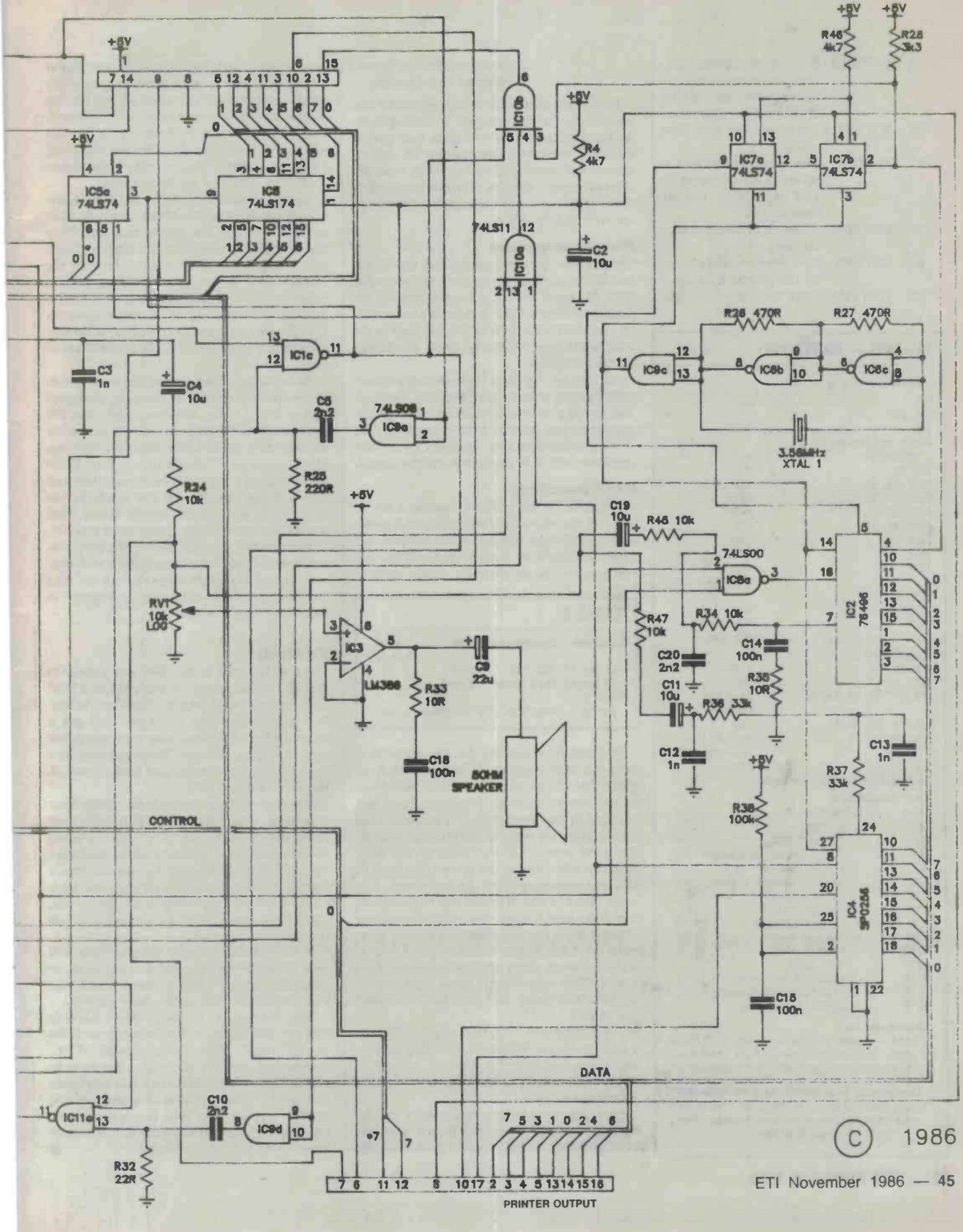
To write to the control register you use another OUT command. You set the enhancer up to receive a control word with **OUT 9,0**. Then the next OUT command is interpreted as a control word. So **OUT 9,0:OUT 0,87** will send 87, ie, 1000 0111 to the control bus.

The other way to do it is via the program. As we said at the beginning, subroutines may be called using their offset numbers. A comprehensive list of these routines is supplied with the 1606 kit, but the flavour of things can be gauged from this list:

Offset	Name	Description
3	VADC	Takes a 3.5 ms sample and performs a successive ADC.
6	MUSIC	Sets a musical note on any of the three tone generators. Covers four octaves from low A to high A.
18	TRAKSC	Scans a trackball or joystick connected to AT1. It scans the current direction of movement and changes the stored graphics cursor co-ordinates.



CONNECTOR SUPPLY
L1
IN
IC18 7805
OUT
COM
+5V
PLUG PACK TIE POINTS
C21 1u TANT
C16 1u TANT
C2 220u
GND
IC13b
IC5b 74LS74
SW1
D3
D1 1N914
D2 1N914
R1 2k2
R2 1k
C16 10u
C1 100n
R3 560R
VOICE INPUT
IC11b
CONTROL
DATA
IC12 4051
R39 150R
C21 10u
R39 4k7
Q1 BC558
R7 2R
R15 11k
R23 1k
R8 2R
R16 11k
R9 2R
R17 11k
R10 2R
R18 11k
R11 2R
R19 11k
R12 2R
R20 11k
R13 2R
R21 11k
R14 2R
R22 22k 1%
IC16a LM339
R5 3k3
IC13 74LS361
IC1 74LS374
IC11d
AT1
AT2
DI1
DI2
D4
R40–44 4k7
R29 4k7
RV2 50k
C8 1n
C7 1n
R30 33k
IC10c
IC14 74LS123
74LS11
IC15a
IC15b
74LS00
IC13a
IC15c
C6 1n
R31 220R



+5V
IC5a
74LS74
IC6
74LS174
IC10b
74LS11
IC10a
R4
4k7
C2
10u
R46
4k7
R28
3k3
IC7a
74LS74
IC7b
74LS74
C3
1n
C4
10u
IC1c
C5
2n2
74LS08
IC9a
R25
220R
R24
10k
RV1
10k
LOG
IC3
LM386
R33
10R
C18
100n
C9
22u
8OHM
SPEAKER
R26 470R
R27 470R
IC8c
IC8b
IC8c
3.58MHz
XTAL 1
C19
10u
R45 10k
74LS00
IC8a
R47
10k
R34 10k
C20
2n2
C14
100n
R35
10R
C11
10u
R36 33k
C12
1n
IC2
78496
C13
1n
R37
33k
R38
100k
IC4
SP0256
C15
100n
CONTROL
DATA
IC11a
C10
2n2
IC9d
R32
22R
PRINTER OUTPUT

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30	PADDLE	Does a resistance analogue-to-digital conversion up to about 1 m (the Atari paddle resistance).
36	RTCINI	Initializes the real time clock.
45	SETDIA	Draws a diamond on the screen at a position set by the graphics cursor coordinates.
54	RESTGC	Clears a drawn graphics cursor.
66	SETVER	Sets the vertical position of the graphics cursor.
78	GETTIM	Gets the time from the real-time clock in hours, minutes and seconds.

ETI-1606 — PARTS LIST

Resistors — all ¼ W, 5%

R1	2k2
R2, 23	1k
R3	560R
R4, 6, 29, 39, 40, 41, 42, 43, 44, 46	4k7
R5, 28	3k3
R24, 34, 45	10k
R25, 31, 32	220R
R26, 27	470R
R30, 36, 37	33k
R33, 35	10R
R38	100k
R39	150R 1% metal film
R7-14	11k
R15-22	22k
RV1	10k log
RV2	50k trim

Capacitors

C1, 15, 18	100n
C2	10n
C3, 6, 7, 8, 13, 14, 24	1n, 50 V ceramic
C4, 11, 12, 16, 17	10μ
C5, 10, 19, 20	2n2, 50 V ceramic
C9, 21	220μ

12 bypass 100n 50 V ceramic

Semiconductors

D1-4	1N914
Q1	BC558
IC1	74LS374 DAC
IC2	76496 sound generator
IC3	LM385 op-amp
IC4	SPO256 speech sythesis
IC5, 7	74LS74 flipflop
IC6, 11	74LS00 NAND
IC8	74LS174 NAND
IC9	74LS08 AND
IC10, 15	74LS11 AND
IC12	4051 MUX
IC13	74LS367 hex buffer
IC14	74LS123 multivibrator
IC16	LM339 comparator

Miscellaneous

3.58 MHz crystal; 1 x DB15 male socket; 2 x DB9 socket; 2 x 6-pin DIN sockets; 1 x 3.5 mm socket; 50k pot; 8 ohm speaker; SPST toggle switch.

This project is available as a kit from Rod Irving Electronics in Melbourne. Phone (03) 543-7877 for the mail order hotline. The cost is $149.

One of the more interesting aspects of this software is that it's designed to make graphics handling easier. We imagine that one of the most important applications of the enhancer will involve graphics, as in multiple joystick games, drawing exercises using touch tables and so on. The software has been written with this in mind.

Power supplies

The enhancer uses the supply from the Microbee, which is available on pin 1 of the output port. However, it can get quite hungry, especially if some of the options are connected up. For instance, the SPO256 chip used in the voice synth uses 100 mA by itself. Trackballs are also difficult.

As a result, we have built an independent power supply to run the enhancer if required. The supply comes in through the front panel, and can be any value of dc between about 7-12 V. It is stabilized and regulated by a 7805 regulator which is an option on the board.

Construction

Installation of this project requires a bit of work on the Microbee itself, and this is probably a good place to start. Three jumpers are required to go from various places on the circuit board to the parallel port, as per Table 4.

TABLE 4.

Location	Description	Name	Port pin No
IC1 pin 17	Z80 PIO	BSTB	19
IC9 pin 40	6545 video	VSYNC	6
IC34 pin 14	74LS139	PORT09EN	14

Proceed by removing the six screws that hold the case together. Watch the back-up battery as you do so. Lift the core board out of the case by carefully rocking it back and forward at the connector. If it is sealed with silicon you may need to cut through it to remove the board. Lie the board to one side. You can now remove the screws that hold in the rear connector and the keyboard. The main board is now free and can be removed, but make sure the speaker cable doesn't get stressed. Now you can solder the jumper wires onto the back of the board as per Table 4. Keep the wires short and the soldering neat. Check that you don't cause any solder bridges, and make sure you don't overheat the chips.

It's a good idea to go over your work with a multimeter to ensure that you have continuity where you expect it. Finally, put everything back together again, by reversing the procedure above.

Now you are ready to begin work on the enhancer proper. If you buy the kit, you will be working with a high quality professionally made board, and that reduces the possibility of mistakes, but I suggest you check carefully anyway for bridged or broken tracks. Do this as part of the cleaning process of the board, and take your time. Now lay the board flat and square in the bottom of the box and mark out the positions of the mounting holes. Leave sufficient space for all the sockets.

Mount all the components. Start by inserting all the IC sockets. Make sure you have some in the kit. If not, buy some extras. They are an absolute godsend if you make any mistakes in assembling it. Then install all the resistors, the diodes and capacitors in that order. It's not critical, but you will find it easier if you install the small components before the big ones, and also the less vulnerable ones first. Place the ICs in the sockets last of all.

At this stage, check that all the components are properly installed, in the right place and facing in the right direction. Then put the board aside and look at the box. Drill and cut all the holes. If the labels have not been applied, do so now. Mount the sockets. Place the board in its approximate position and measure how much wire you need for the flying leads. Solder these onto the board. Next mount the board using the metal standoffs. If you marked out the holes in the base correctly you should have no problems with this.

Solder all the leads on to the correct pins on their sockets. Use the overlay diagram to identify which is which.

Testing

The real fun part in building any project is turning on the power. It might make a loud noise and throw sparks at you. It might not. If it goes bang, then you know you got it wrong, which is a chastening experience, but somehow quite exciting. The worst cases just sit there in sullen silence and look at you. A bit like children really.

Anyway, if the enhancer is not doing what you want, what do you do about it? First thing: do you have continuity from the board of the Microbee to the board of the enhancer? Turn off all the power and do some continuity checks. If all is correct, check that you have power on every chip. As you are doing this, check again that everything is where it should be.

If this all looks good, but the beast still won't talk, then you must have problems on either the data or address busses. Make sure you don't have any of the lines shorted.

This is unlikely, however. More likely is that you will find part of the machine working at this stage. Run through some of the subroutines, and try to localize the fault to one particular subsystem. This will very often indicate the exact position of a fault, or else narrow it down to a very few components. One hint: be slow to blame the ICs. It's much more likely you are to blame. ●

Put Your PC To Work

□ Logic Analyzer

For the cost of 1 month lease, you can convert your accounts PC into a full 24 channel state and timing logic analyzer. 6 channels operate at up to 100MHz.
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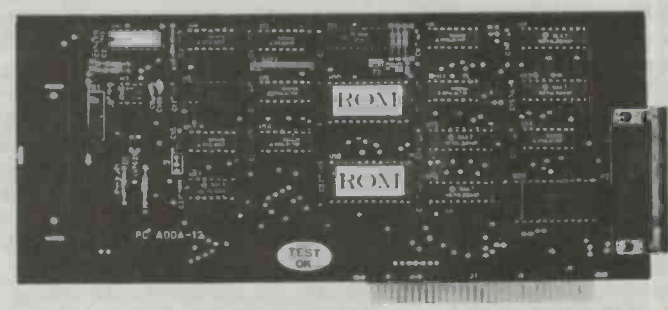
□ A-D/D-A Converters

12 bit resolution 16 channel A-D, 2 channel D-A. These units are ideal building blocks for data acquisition system.
D-A: ● 12 bit, 1 channel ● Output voltage 0-9V (adjust by



VR) ● Unipolar or bipolar (select by jumper 2) ● Current settling time 500nsec ● Nonlinearity 0.2%.
A-D: ● 12 bit, 16 channel ● Input voltage range 0-9V (adjust by VR) ● Unipolar ● Successive approximation method ● Conversion time 60μsec (each channel).

□ Eprom Programmer

Several models available to program 1, 4 or 10 EPROMS in a gang. A long list of components can be programmed, including all types of EPROM and CMOS EPROM including 2716, 2732, 2732A, 2764, 27128, 27256, and 27256A, (27512, 27512A, IBM only). ● Vpp can be automatically set to 25V, 21V or 12.5V ● Using intelligent programming 2764 in only 50 seconds ● Easy to use, no switch select required ● It can do programming from DISK file or save EPROM data in DISK.

Many Other Useful Boards

Many other boards available, including the following:

☐ High Speed 12 Bit Analog to Digital and Digital to Analog Converter with software.
☐ 16 Bit Analog to Digital and Digital to Analog Converter with software.
☐ Multi Output Card with 8 independent RS232 lines.
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Mark the box and send for further information to:

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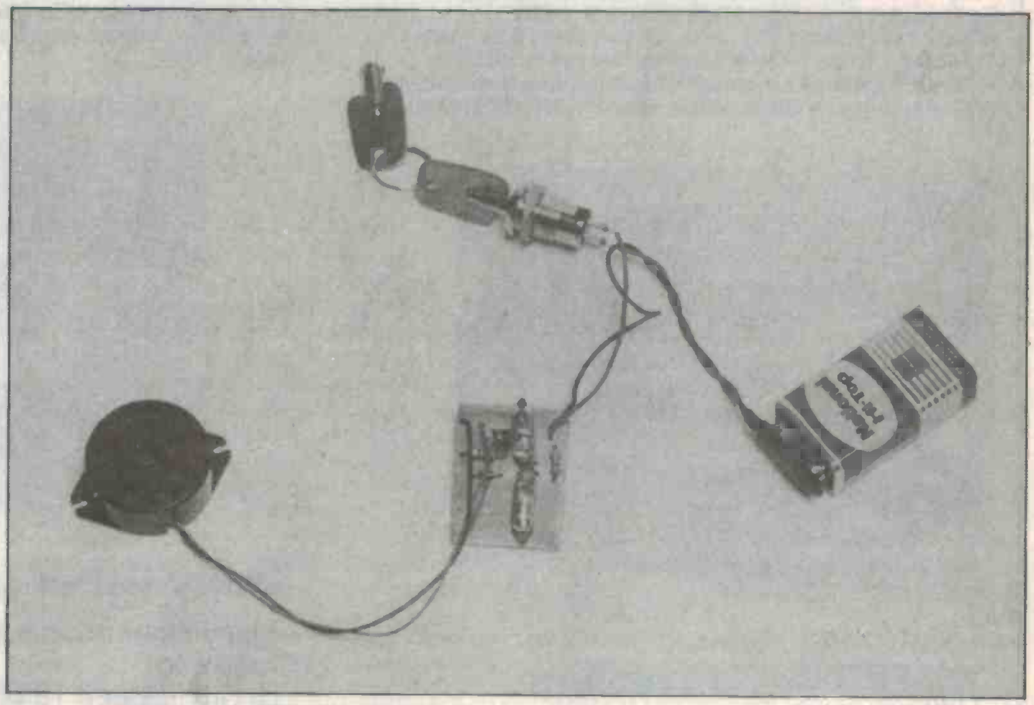
21 Bibby St, Chiswick, NSW 2046. Tel 712 2466.
208 Whitehorse Rd, Blackburn, VIC 3130. Tel 878 8788.

SIMPLE VCR ALARM

Gerry Nicholson

This project will take only a couple of hours to build, but could make life very difficult for a potential thief.



YOUR VIDEO CASSETTE recorder is in many cases the most expensive portable item in your home. It is also the easiest for a thief to 'fence'. The police force, boasting a clean up rate of between four and eight per cent, is next to useless. It's time to look to your own defences.

Our VCR alarm is not infallible. It, like most other alarms, can be beaten given sufficient knowledge and dedication. However, it is simple, inexpensive and in most cases will be effective in deterring a thief.

Its structure is quite simple. The circuit, on a small circuit board, is mounted inside the case of the VCR at any convenient spot. A speaker of suitable design, in this case a piezo buzzer, is secured next to an opening in the case so that its noise is not shielded by the box. The buzzer specified in this project has an ear-piercing howl rated at 80 dB. A battery is also involved. It must be secured in some way and connected to the circuit via a keyswitch.

The keyswitch is the only part of the circuit that protrudes from the VCR. As its name suggests, a keyswitch is a simple single pole single throw switch operated by a key only. You will need to cut a small hole in the box to accommodate it. Presumably the best place is in some inconspicuous spot around the back.

In operation, once the switch is closed power is supplied to the circuit. Current drain is in the order of microamps, and thus essentially negligible. The battery will last for its shelf life in this configuration. When the VCR is lifted, or indeed, disturbed in any way, the alarm switches on and latches. It can then only be turned off when the power is removed.

If sufficient care is taken to disguise the function of the keylock, the potential thief will be totally unable to see any way of turning off the alarm. He will thus be forced to either carry on with his nefarious activities, and risk being caught with a blaring VCR under his arm, or give the whole scheme away and look for a less well defended object.

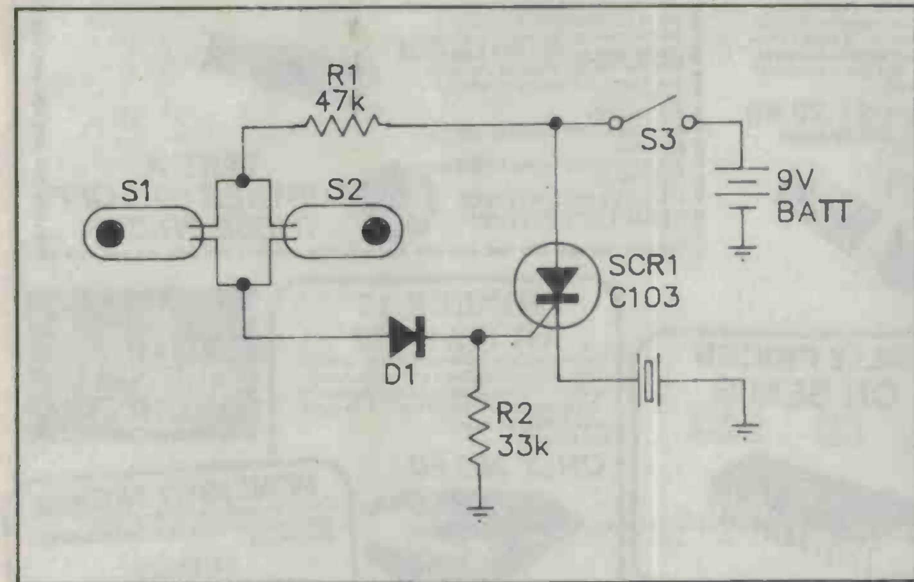
Construction

This circuit is very small, dominated by two large mercury switches. When you get the board, clean it properly and check as normal for broken or bridged tracks. Mount the two resistors and the diode, then the thyristor and finally, the two mercury switches.

Open up the VCR (or other appliance), and decide where things are going to go. First and foremost, look for a location for the keylock. On most systems, the back panel is ideal. Be careful when you drill out the hole unless you are happy with a bodgie job. A good tip is to pre-punch a small indent into the metal of the back panel so you can locate the drill precisely. This will also prevent the drill bit from sliding off as soon as you power it up and leaving you with a nasty scratch across your backpanel.

Secondly, locate a hole for the battery. If the worst comes to the worst you can tape it in somewhere, but it's a far more elegant solution if you can wedge it between a circuit board and the case, or in some other convenient space.

Finally, find a mounting position for the board itself. This must be such that the board itself lies flat. If this is not possible, then the mercury switches must be bent so that they point downward slightly to avoid triggering the unit while the VCR lies flat. When mounting the board, be careful not to short the bottom of the board against the



ETI-284 — PARTS LIST

Resistors................all ¼ W, 10%
R1..........................47k
R2..........................33k
Semiconductor
D1..........................1N4001
SCR1....................C103
Miscellaneous
ETI-284 pc board; keyswitch; 9 V battery and holder; 2 x mercury switches; one piezo electric transducer or similar.

Price estimate: $16

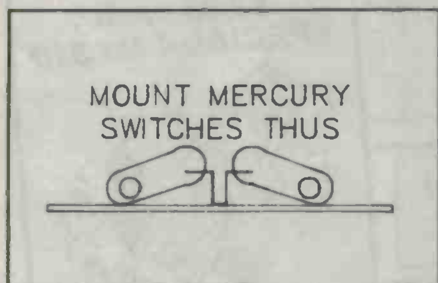


Figure 1. Mounting the mercury switches.

case. Double sided spongy tape is ideal. It provides an insulating layer and sticks the unit down.

When you finally sort out where everything is to go, size up four flying leads. Two run between the board and the speaker, and two to the battery. One of these goes via the keyswitch.

Testing

Testing is simplicity itself. Before inserting the unit into the VCR, check that it works. It's so simple there's little possibility that it won't. However, if you do have problems check the polarity of the battery, the diode and the SCR, and check your soldering.

After you've installed it, check that the key works properly. The alarm should go on, and stay on, until you disconnect the supply by operating the key. You can adjust the sensitivity of the unit by altering the angle at which the two mercury switches lie. Flat they will close with every vibration. Vertical the thief would have to turn the unit over to trigger it. At some intermediate position you will find the sweet spot. ●

ETI-284 — HOW IT WORKS

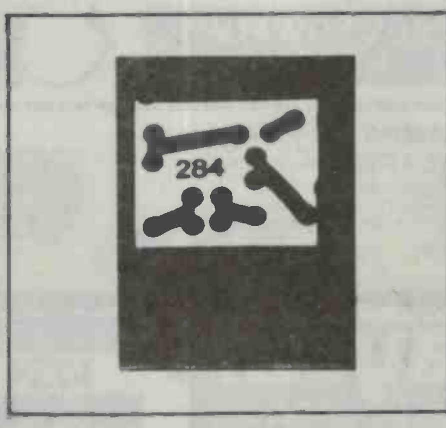
The centre of the circuit is a C103 thyristor. This device works like a diode with a switch in series. It has an anode and cathode like an ordinary diode, with a gate that controls the switch. As long as the gate is kept low, the switch is open and current flows. However, once the gate voltage rises to that of the cathode, the device turns on and it functions like a diode.

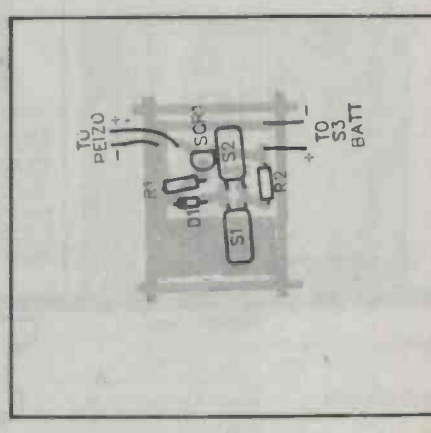
The interesting part of the thyristor's characteristic is that once in this situation, the voltage on the gate is irrelevant. The switch stays closed even if the voltage on the gate decays to zero. The only circumstance that will cause the switch to open again is when current stops flowing through the cathode-to-anode junction. In some applications this happens when the thyristor is subject to an alternating current. In this case, when the system is switched off.

To apply this to our circuit is very simple. The thyristor is connected in series with the transducer and the battery. When the thyristor is turned on the battery voltage is applied directly to the thyristor and (whoopee do), it makes a lot of noise.

The gate is controlled by the mercury switches. These consist of a glass envelope with a blob of mercury inside. Two wires pass through the glass of the envelope. They are arranged such that when the mercury flows to one side of the envelope it touches them and forms a short circuit.

When the switches close the 9 V rail is passed directly onto the gate. Current limiting is provided by R1, a 47k resistor. R2, the 33k resistor, functions to help discharge the gate after power is disconnected.





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EA 60/60 2 WAY

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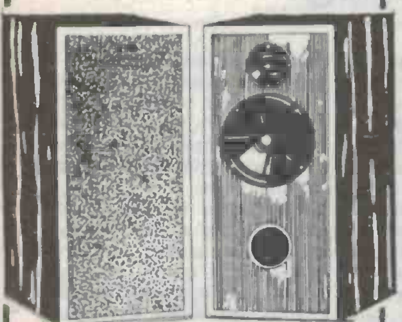

AEM 6103 3 WAY

COMPLETE
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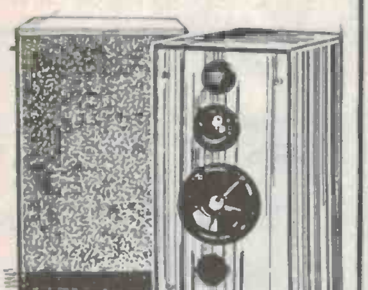

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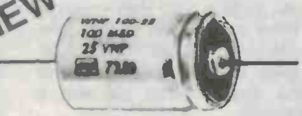

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See ETI October 1986

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Includes Piezo

Ref: EA August 1986

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See EA October 1986

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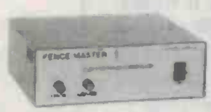

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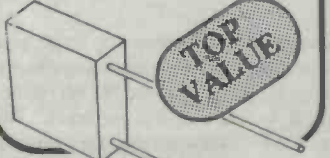

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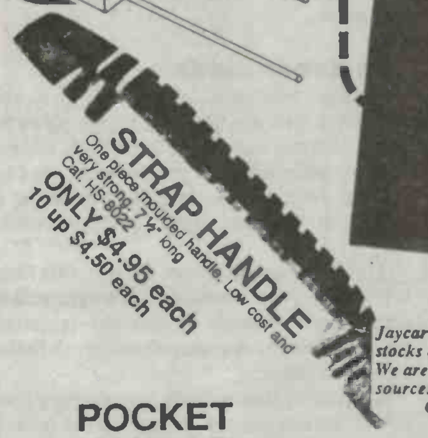

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The base of the unit (black phenolic) measures 84(L) x 70(W)mm. Mounted on the base is the buzzer assembly (under a black metal cover) and two heavy screw mounting terminals. It is attractive enough to wall mount.
A classic must in every home.
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QUALITY E-T-A GERMAN MAKE

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Full data supplied with both

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FEATURES:
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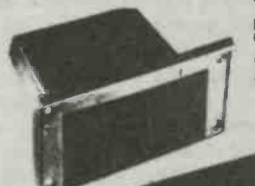

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Jaycar has just landed a great new range of high quality nylon PCB spacers. Fixing is by size 6 or 8 self tapping screws. The flat centre section can be gripped to prevent rotation while fixing.

Length	Pack Qty	Cat. No	Price
6mm	5	HP-0980	$1.00
12mm	5	HP-0982	$1.00
19mm	4	HP-0984	$1.00
25mm	4	HP-0986	$1.20
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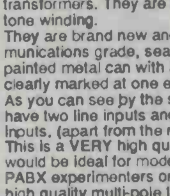
EXPERIMENTERS TELEPHONE LINE TRANSFORMERS

Another Jaycar SCOOP purchase!

We have acquired a limited quantity of Telecom type multiple line, line isolation transformers. They are also fitted with a tone winding.
They are brand new and are telecommunications grade, sealed in a grey painted metal can with all terminations clearly marked at one end.
As you can see by the schematic, they have two line inputs and two equipment inputs. (apart from the ring winding).
This is a VERY high quality transformer. It would be ideal for modem experimenters, PABX experimenters or anyone requiring a high quality multi-pole line isolating transformer.
Measures 90(H) x 58(W) x 48(D)mm.
Cat. MT-3800

$10.00 each
Limited Quantity

NOTE: Due to weight (a whisker under a kilo) the P&P is $5.



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COMMODORE COMPUTER EDGE CONNECTOR AT LAST!

A card edge connector that fits on the expansion port of Commodore computers.
This high quality connector features gold plated bifurcated contacts (2 rows of 12 contacts) on the correct pitch.
A very difficult to obtain part and a must for Commodore enthusiasts!
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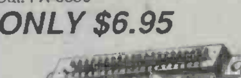
ONLY $6.95



LED/CdS CELL OPTO ISOLATOR

This handy component consists of a LED moulded into one end of a moulded plastic case and a Cadmium Sulphide cell moulded into the opposite end. By varying the brightness of the LED (by varying the current through it) the resistance of the CdS cell decreases proportionally.
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BRAND NEW UNISELECTOR SWITCHES

Basically a fantastic 6 pole, 14 way solenoid driven rotary switch!
Buy one, some day you will need it! These 'AEG' brand uniselector switches are very, very well made and are of very recent design. One day every experimenter will have a need for such a device.
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Measures: 80(L) x 55(W) x 45(D)mm
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This transformer is housed in a sturdy grey steel box with a removable matching lid.
The box measures 135(H) x 120(square)mm and weighs 4.3kg. Rubber grommetted entry and exit holes are provided.

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BUILDING THE ETI-281

This is the second part of our series on building a simple power supply. In Part 1 we covered transformers and rectification. This month it's the turn of the regulator. Find out what regulators are and how to use them.

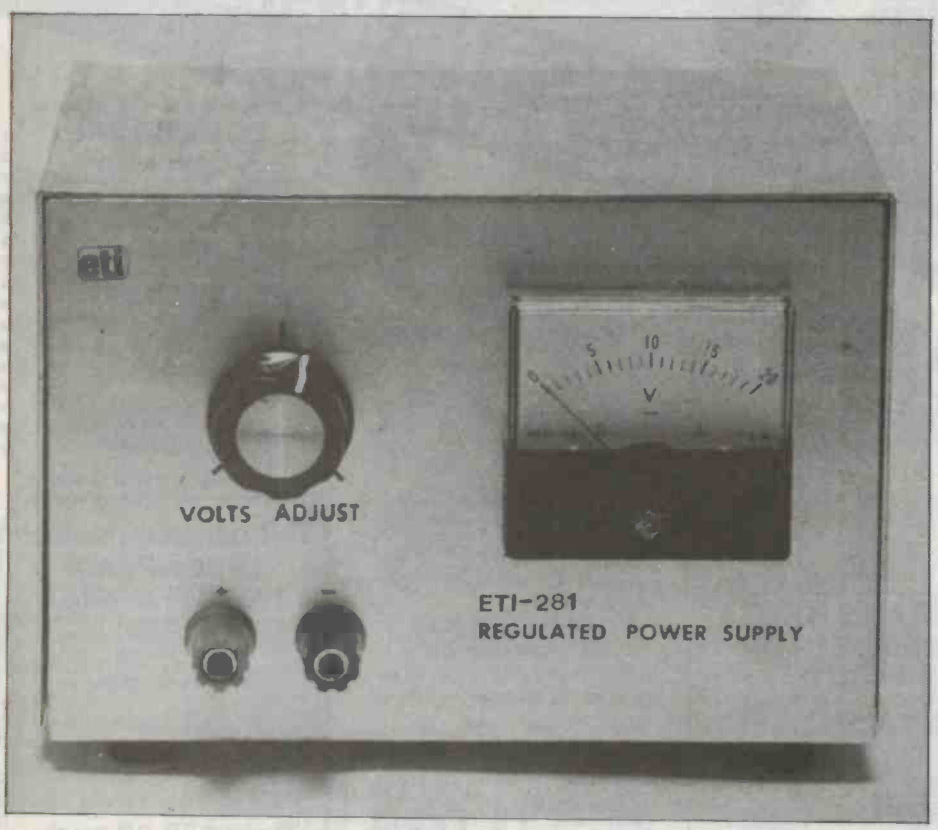
Peter Philips

THE REGULATOR is the section of a power supply used to generate constant supply voltage in the face of fluctuating inputs and loads. Line regulation is the quantity that relates supply change to output voltage change. It's usually expressed as %/V, or percentage change in output per volt change in input.

Load regulation, on the other hand, relates changes in the load with changes in the voltage across it. It, too, is expressed as volts. Ideally, it should be zero.

Regulation is often used in both electrical or mechanical systems to maintain a constant performance characteristic. As an example, consider the motor in a cassette player. How is it that even though the battery voltage changes, and the load on the motor varies as the tape transfers from the supply side to the take-up side, no speed variations occur? Simple! The motor speed is regulated, usually with a mechanical governor inside the motor casing. The governor senses the variations and ensures a constant speed regardless of the external environment.

Regulating the voltage from a power supply is done using various methods. One method samples the output voltage and compares it to a preset reference. If a variation is present, correction is applied to bring about the required equality between the output sample and the reference. This method uses feedback between the reference and the output, making the circuit somewhat complex. However, excellent regulation is provided. Another simpler technique requires the reference device itself to perform the regulating task. Thus, as well as providing the fixed reference voltage, it must also work to correct any changes. This system is simple, but not as effective as the method incorporating feedback. Both methods find applications and deserve discussion.



The Zener diode

A voltage 'reference' is a device, or circuit, that develops a constant voltage across its terminals despite variations in current, temperature or other extrinsic parameters. The ideal voltage reference is one that exhibits no change at all when other factors around it vary.

The Zener diode comes close to this ideal. It is a device that develops a constant voltage across its terminals if current is passed through it in the *opposite* direction to that of a normal diode.

Remember that a diode is a unidirectional device, meaning it conducts when the polarity of the applied voltage has the anode positive to the cathode. Reverse the polarity and no current flows, unless the voltage is high enough to cause breakdown and subsequent destruction. The Zener diode is a device *designed* to conduct in the reverse direction, providing the reverse current is kept within certain limits. It's named after Carl Zener who discovered the effect in 1934.

Figure 1 shows the characteristics of the Zener diode using a simple graph that relates voltage and current. Note how the device behaves as a normal diode when the anode is positive to the cathode, but conducts when the *Zener voltage* is reached for the opposite polarity. The most interesting aspect of Figure 1 is that the Zener voltage is virtually *constant* even though the current through the diode can be anywhere from a few milliamps to hundreds of milliamps. Providing the current does not exceed the capabilities of the device, the Zener diode will produce an almost constant voltage across its terminals for a wide range of currents flowing through it.

The Zener as a regulator

Figure 2 shows a simple arrangement that allows the Zener diode to control for variations in the input dc voltage and load current and sustain a constant voltage across the load. The series resistor R_s is just as important as the Zener diode, and both components work together to provide a constant output voltage. In this circuit, the Zener is connected directly across the output voltage, providing sensing where it is most needed. The circuit is often known as a *shunt* regulator, as the regulator is in parallel, or shunted across, the load resis-

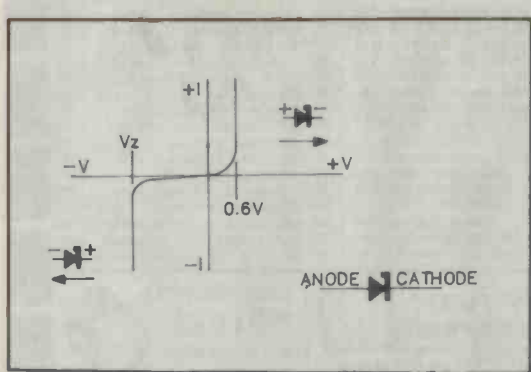


Figure 1. The Zener diode.

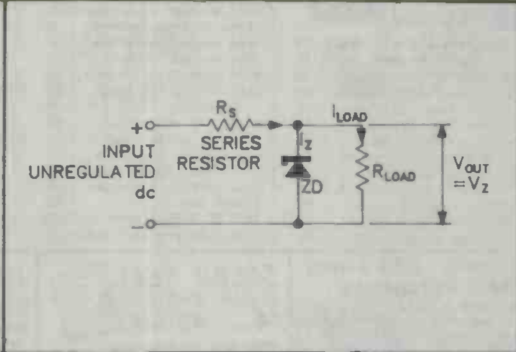


Figure 2. A Zener diode regulator.

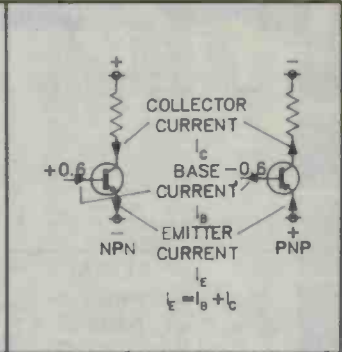


Figure 3. The transistor.

tor. The circuit operates by ensuring the total current flowing in R_s is sufficient to create a voltage drop across the resistor that subtracts from the input dc voltage to give the required Zener (and hence), output voltage.

The design of this simple circuit is interesting. The aim is to determine the value of R_s and the power rating of the Zener diode. The value of R_s must be low enough to ensure that a minimum value of Zener current flows (usually 10% of I_{Zmax}) under the worst case conditions when V_{IN} is a minimum and the load current is a maximum. Also, R_s must be high enough to prevent the value of I_Z exceeding the maximum rated value under the conditions of maximum V_{IN} and minimum load current.

Thus, R_s must be a value greater than the minimum value, but less than the maximum limit. The equations to determine the two limits for the value of R_s are based on the criteria already mentioned, and are:

$$R_{Smin} = \frac{V_{INmin} - V_Z}{I_{Lmin} + I_{Zmax}} \quad \ldots\ldots (1)$$

$$R_{Smax} = \frac{V_{INmax} - V_Z}{I_{Lmax} + I_{Zmin}} \quad \ldots\ldots (2)$$

$$\text{where } I_{Zmax} = \frac{\text{power rating of Zener}}{V_Z} \quad \ldots\ldots (3)$$

$$\text{and } I_{Zmin} = 0.1 \times I_{Zmax} \quad \ldots\ldots (4)$$

To use the equations, first guestimate a maximum value for I_{Zmax}, usually around the value of I_{Lmax}. Then using this value for I_{Zmax} and the derived value for I_{Zmin}, the two values for R_s can be determined. If the maximum value of R_s obtained is less than the minimum value, try a higher value of I_{ZMAX} in the two equations. Then, by trial and error, eventually the minimum value of R_s will be lower than the calculated maximum value. The difference between the values, if good design procedures are to be adopted, should provide a value of R_s at least 10% lower than the maximum allowed and 10% higher than the minimum. Then the power ratings of the Zener diode, and resistor R_s can be found using equations (5) and (6)

$$P_Z = V_Z \times I_{Zmax} \quad \ldots\ldots (5)$$

$$\text{power rating of } R_s = \frac{(V_{INmax} - V_Z)^2}{R_s} \quad \ldots\ldots (6)$$

The basic two-element Zener diode regulator circuit is useful for low power load requirements. However, regulation is only moderate, and the circuit is very inefficient, particularly when the load current is zero. But many applications on this circuit occur; and now you can design your own.

Transistors and Zeners as regulators

Now that the concept of regulation and a means of accomplishing this, have been described, we can move to circuits capable of handling greater power. Although integrated circuit regulators make the transistor/Zener diode combination less attractive, transistors are still often used, either in conjunction with an IC regulator or a Zener where high currents are involved. Also, the transistor is an essential part of electronics, and the operation and uses for it need to be presented. In effect this section will serve to introduce the transistor, and show its application in power supply design.

Transistors work on a very simple principle. The value of the current flowing between the base and emitter terminals determines the magnitude of the current flowing between the collector and emitter terminals. Figure 3 shows the symbols for the npn and the pnp types, the polarities of the applied voltages, and directions of the currents that flow in the devices. Both types operate in identical ways; only the directions of the currents differ. An approximate relationship, referred to as the dc current gain, exists between the values of the base current (I_B) and the collector current (I_C). The symbol beta (β) or the term H_{FE} are used denote this characteristic.

$$\text{Current gain } (\beta) \text{ or } H_{FE} = \frac{I_C}{I_B} \quad \ldots\ldots (7)$$

Thus a transistor allows a small current to control a large one; a very useful principle where a power supply is concerned. Obviously a transistor capable of passing a current of several amps is necessary if regulation of a power supply is required. A very simple regulator can be constructed using the circuit of Figure 4. This circuit is known as a series regulator, because the regulating element is in series with the load. The output voltage of the circuit is V_Z-V_{BE} with V_{BE} usually equal to 0.6 volts. The output voltage is regulated because it is locked to the value of the Zener voltage with an offset of V_{BE}. Any change in the output voltage will cause the voltage across the base-emitter junction of the transistor to vary above or below 0.6 volts. This will bring about a subsequent variation in the base-emitter current (I_B), and thus the collector current, in a direction that will change the output voltage and restore V_{BE} to 0.6 volts.

An improvement to the basic circuit is shown in Figure 4(b), in which the current gain of the circuit is increased by using the Darlington configuration. This connection provides a total current gain equal to the *multiplication* of the individual β values of both transistors. This permits the use of a low power Zener diode, and reduces the Zener diode current variations with a subsequent improvement in the regulation. For both circuits shown in Figure 4, the value of R_s must lie between the two limits of preventing excessive Zener diode current and allowing enough base current to the transistor(s) when maximum load current is flowing. The method of determining the required value is similar to that already described.

Regulators with feedback

The regulator circuits so far have all used a Zener diode to perform the actual regulation. This type of circuit is simple, and in many cases suitable for fixed voltage operation. However, the lack of sophistication in the circuitry means a no-frills performance. Regulation is likely to be only moderate (5%-10%), and temperature variations will cause changes in the output voltage. Also, no overload protection is provided, and a fault ▶

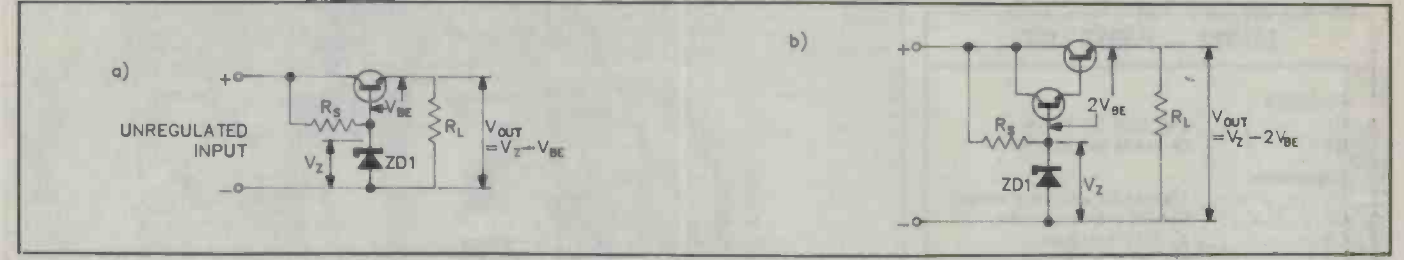


Figure 4. (a) Series transistor regulator and (b) transistor/Zener regulators.

in the load could possibly destroy the regulator circuitry, which might then result in the full-supply voltage being fed to the already faulty load circuit, and so on.

More sophisticated regulators use a system incorporating feedback, in which a sample of the actual output voltage is compared to a preset reference. Figure 5 shows an outline using an amplifier, a transistor and a Zener diode. Note that the amplifier has two inputs, one for the reference voltage established by the Zener diode, the other for the sample taken from the output. The amplifier will drive the series transistor to ensure that the output voltage provides a value at the junction of R2 and R3 that equals the reference voltage, thus ensuring equal voltages at both its input terminals. The ratio of the two resistors R2 and R3 establishes the output voltage, and making either one variable allows the output voltage to be varied. If R2 = R3 then the output voltage will equal twice the reference voltage. Other circuitry to protect against overload can be added that turns off the series transistor when a preset value of load current flows.

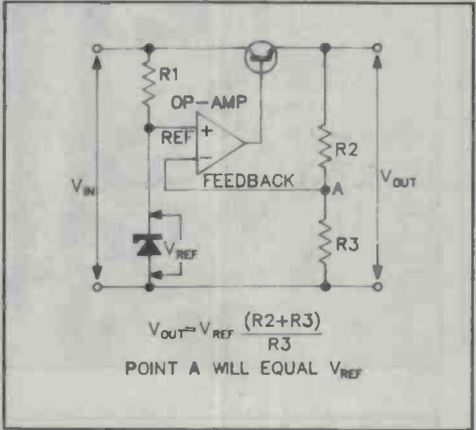


Figure 5. Regulator with feedback.

Integrated circuit regulators

Discrete component regulator circuits using feedback are numerous, but are now mostly obsolete due to the emergence of the IC voltage regulator. These devices incorporate in IC form the circuitry discussed above and come in various styles. The most common IC regulator is the 3-terminal regulator, although multi-pin DIL package types and 4-terminal devices are often found. Readers involved in using IC voltage regulators are strongly advised to purchase a linear data book, particularly one that provides applications. These books are usually available from most major parts suppliers, and provide much useful information for the novice and professional.

Three-terminal regulators provide not only excellent regulating characteristics, but include current limiting and over-temperature protection. Basically, these devices are either of the fixed or variable types, for either positive or negative voltages. Fixed voltage regulators are manufactured with output voltage values ranging from +5 V to +24 V and −5 V to −15 V. Adjustable regulators usually offer an output range of 1.2 V to 37 V. Type numbers are fairly standardized with the 7800 series being a fixed positive voltage device; its negative counterpart is found in the 7900 series.

Using fixed voltage 3-terminal regulators

When designing a power supply using a fixed voltage 3-terminal regulator, several considerations are required. The first concerns the current rating of the device. The 7800/7900 series allows currents of around 1 A to be controlled, but devices capable of 10 A are available. Exceeding the current rating of the device is usually impossible, due to the inherent current limiting circuitry, but severe loss of regulation will occur if excessive current flows. It is possible to add an external high current transistor to enhance the current carrying capabilities of the circuit, if required.

The next important design consideration is heat dissipation. Most package outlines permit the device to be mounted on a heatsink. Generally, if the IC is too hot to touch, the heatsink is too small. A black, finned heatsink, mounted vertically is the usual method, although making use of the metal box in which the circuitry is contained is often suitable. If the device gets too hot, it will shut down, rather than self-destruct.

In order for the device to effectively regulate, it is necessary to have an input voltage at least 2 V higher than the required output voltage. Any value less than this will cause loss of regulation, but increasing the voltage differential between input and output will increase the power dissipation, and hence the heat generated. As the 2 V differential is an absolute minimum, the ripple present on the input dc must be taken into account. If the ripple is large enough to cause the differential to fall below 2 V, regulation is lost and the output voltage will follow the input voltage ripple, an effect often called breakthrough. If a dc input voltage measured on a voltmeter indicates 5 V more than the regulator's output, then an approximate margin of ±3 V of ripple, (or a ripple of 6 V peak-to-peak) is provided. However, the power dissipation, at 1 A is 5 W. Thus, a trade off is required to ensure a high enough input voltage to prevent the effect of breakthrough, but low enough for a reasonable power dissipation.

The circuitry required is simple: a rectifier/fitter combination designed with the equations presented in Part 1 (last March), and the appropriate 3-terminal regulator with bypass capacitors. Figure 6 shows the complete circuit, as well as the pin connections for TO-220 and TO-3 packaged regulators. Connections for both polarities are shown; note particularly the differences in the pin connections. The bypass capacitors are necessary to improve stability and the ability to suppress transients. The circuit shown is for a positive regulator; for a negative regulator just reverse the polarity of the input voltage.

Adjustable voltage regulators

It could be argued that all 3-terminal voltage regulators are adjustable, as it is possible to connect them in a way that allows the output voltage to be varied. However, for best results, using a regulator designed for the purpose is suggested. For instance, the 317 is designed to pass currents up to 1.5 A over the output voltage range of 1.2 V to 37 V, and has all the usual features of current limiting and over-temperature protection. The circuit for the power supply is shown in Figure 7.

The supply is contained in an aluminium box; dimensions 152 x 132 x 103, (width x depth x height). The size or type of box is not critical, although an aluminium case is recommended as it serves as a heatsink for the regulator. The transformer has an output voltage of 20 Vac to permit a regulated dc output of up to 20 Vdc. You may wish to use a higher voltage and provide a dc output of up to, say 30 V, but limit the input to the regulator to no more than 40 Vdc. The minimum current rating of the transformer is 1 amp. ▶

ETI-281 — PARTS LIST

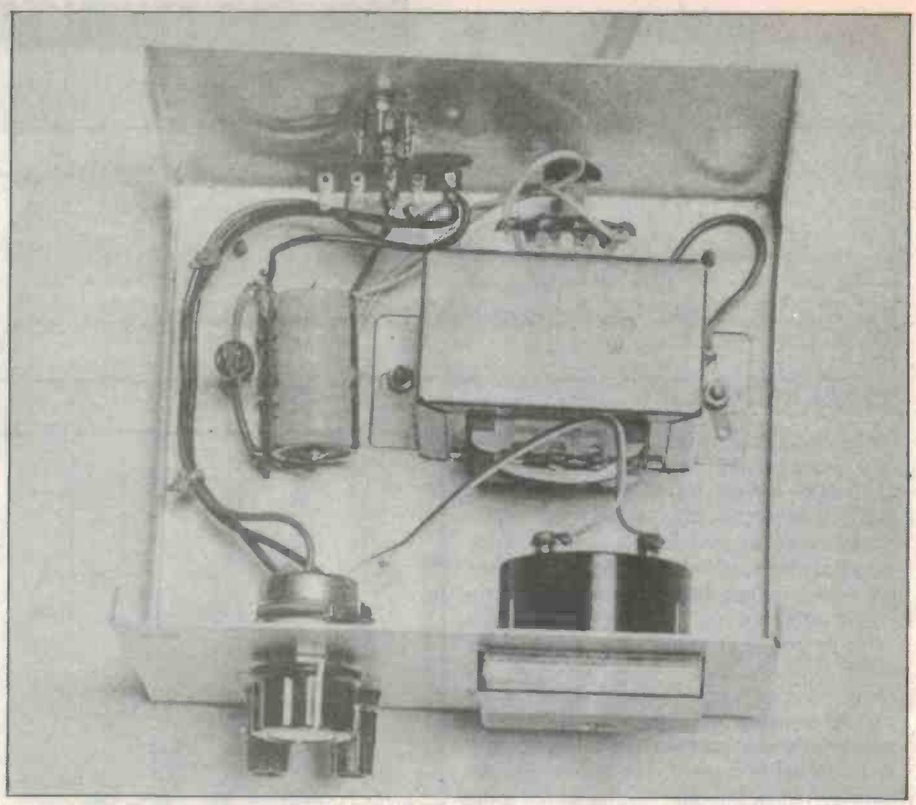
Resistors
R1 .... 240 ohm 1/4 W 5%
RV1 .... 5k linear potentiometer

Capacitors
C1 .... 1000µ 63 V axial lead electro
C2 .... 0µ1 50 V disc ceramic
C3 .... 1µ 35 V tantalum
C4 .... 10µ 63 V axial lead electro

Semiconductors
BR1 .... WO-4 or equivalent
IC1 .... 317K

Miscellaneous
Transformer, 20 V, 1 A eg, type 6672; 7-lug and 5-lug tagstrips; 3-core mains flex and plug; 2 x 4 mm terminal posts; grommet, TO-3 insulating kit; 2 x 6BA bolts, nuts and shakeproof washers; aluminium case, 152 x 132 x 103 mm; rubber feet; hookup wire; cable clamp; solder lug; control knob; optional 0-20 Vdc panel mount voltmeter or equivalent.

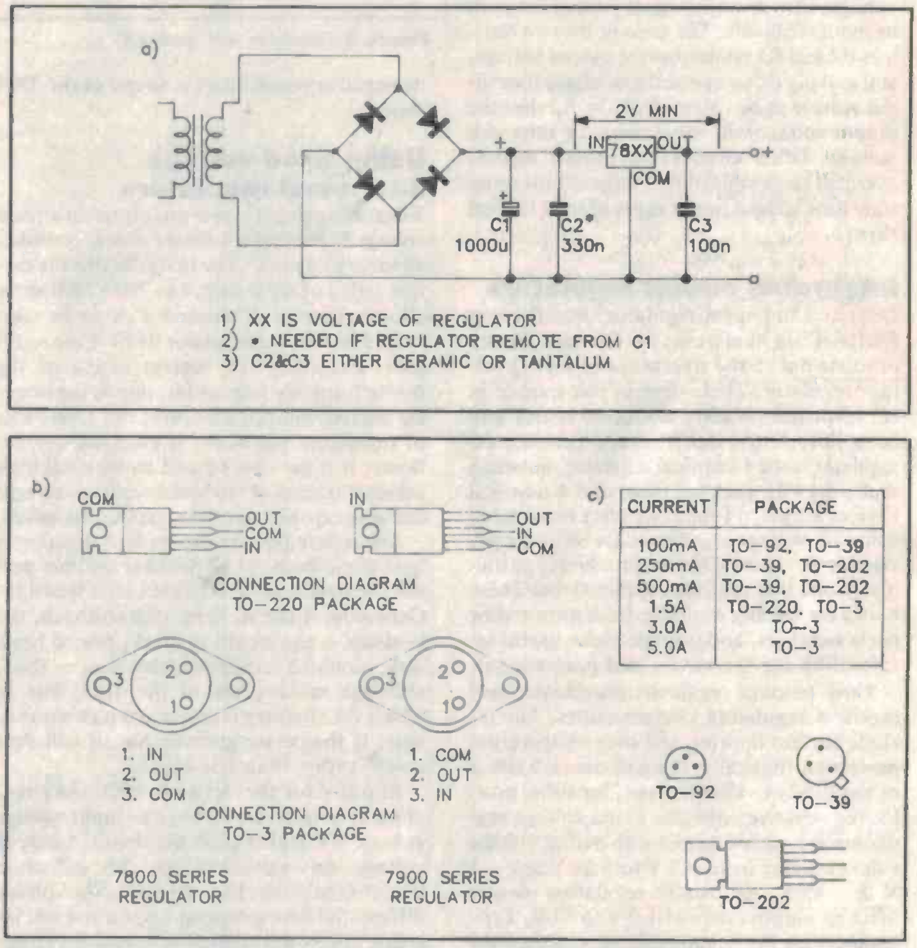
Price estimate: $25
$40 with meter



A 1.5 amp diode bridge, or four 1.5 A diodes with a 63 V, 1000 µF capacitor form the rectifier circuit, and can be mounted on a 7-lug tagstrip. The regulator is the 317K, which has a TO-3 case, and can be mounted on the rear of the case, suitably insulated with a TO-3 insulator. The bypass capacitors and the 240 ohm resistor are mounted on a 5-lug tag strip, with the centre lug held, and thus connected to one of the mounting bolts of the regulator. This connection is to the regulator's output, and shake-proof washers between the bolt head and the regulator case, and between the nut and mounting lug are recommended. The potentiometer has a 10 µF electrolytic capacitor mounted between the centre and outside terminals to reduce ripple on the output.

Mounting and connecting the transformer was detailed in Part 1; constructors may wish to add a fuse and an on-off switch. The meter is an optional extra; the budget conscious may like to scribe calibration marks around the output adjust knob instead of including the meter. The front panel design and type is up to the individual. We used a Scotchcal aluminium front panel, but good results are possible using lettering applied directly to the case, then sprayed with lacquer. Rubber feet under the case prevent scratching and give a non-slip purchase. The 4 mm output terminals, one red, one black, are spaced 19 mm apart to permit connection of standard instrument leads.

This treatment of power supplies has been necessarily brief but, we trust, useful. If the suggested project is constructed, then not only will you have learnt something, but a useful workshop power supply for further participation in this series has resulted.



CURRENT	PACKAGE
100mA	TO-92, TO-39
250mA	TO-39, TO-202
500mA	TO-39, TO-202
1.5A	TO-220, TO-3
3.0A	TO-3
5.0A	TO-3

Figure 6. Fixed voltage 3-terminal regulators: (a) general fixed output circuit; (b) pin connections; and (c) current rating and package outlines.

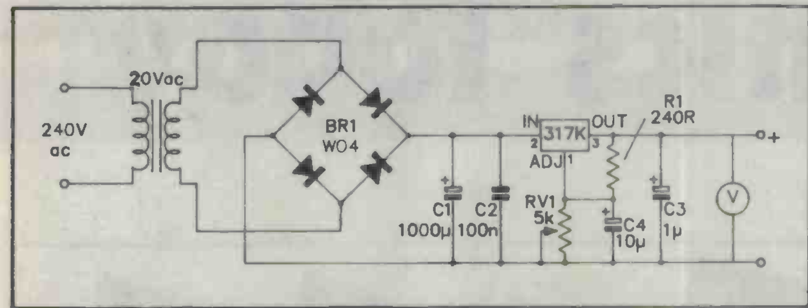
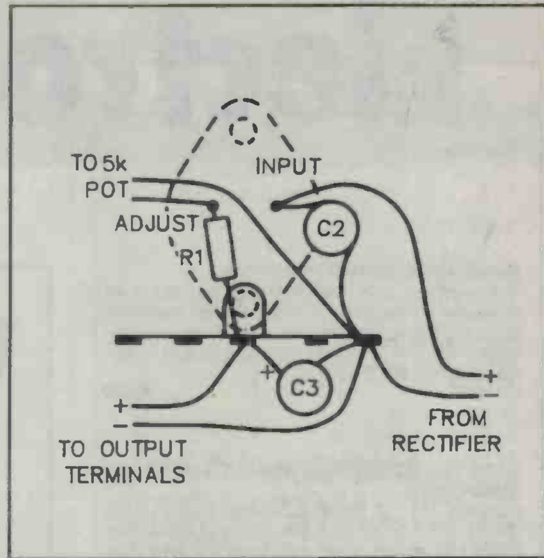


Figure 7: 281 circuit diagram.



ETI-281 — HOW IT WORKS

The heart of the circuit is the 317K, a TO-3 packaged, adjustable terminal voltage regulator. Other packages are available, but a TO-3 case is suggested for best heat dissipation. Five external components are associated with the regulator. The resistors R1 and RV1 establish the output voltage by comparing a sample of the output voltage to the internal reference of 1.25 V, according to the following equation:

$$V_{OUT} = 1.25\left(1 + \frac{RV1}{R1}\right)$$

The 5k pot allows the output to be varied from 1.25 V to a value determined by the input dc voltage. As the voltage differential across the IC must not exceed 40 V, the input dc voltage is limited to 40 V, thus providing a maximum output voltage of 37 V.

The circuit shown is for a maximum output of around 20 V. This value was selected as being typical for most applications, and to limit heat dissipation under worst case conditions. Even so, under circumstances of a load current of 1 A, at an output voltage of, say, 2 V, some 20 V is across the regulator. As power = volts x current, the dissipated power is still 20 W. If the input voltage is raised to around 40 V, then the worst case power dissipation becomes 40 W. It follows that the regulator is hottest at low output voltages.

The capacitors, C2 and C3 are included to give optimal stability and transient supression. C3 is a tantalum capacitor; C2 a ceramic type, and should be mounted close to the regulator. A lack of stability will cause oscillation on the output, with unpredictable results. C4 is connected across the potentiometer to reduce ripple on the output to virtually zero.

The diode bridge is a type WO-4 device, although any diode combination capable of passing 1.5 A or more is suitable. The output current of the power supply is rated at 1 A; higher current drains are not recommended. The main filter capacitor is C1, and should have a working voltage at least 25% higher than that appearing across it. The transformer should have a current rating of at least 1 A and a secondary voltage of around 20 V.

The voltmeter is optional; an alternative is calibration marks around the control knob. The meter can be either a pre-calibrated, 0-20 V voltmeter, or a meter movement with a series resistor. As the regulator should, ideally have a minimum load current of around 4 mA to maintain regulation, a 1 mA meter movement is fine. In this case, a series resistor of approximately 20 kohms will be required, although the final value, made up from a number of resistors, should be chosen by calibrating the meter to a known reference. Other options are an ammeter, a 240 V on-off switch and a mains fuse.

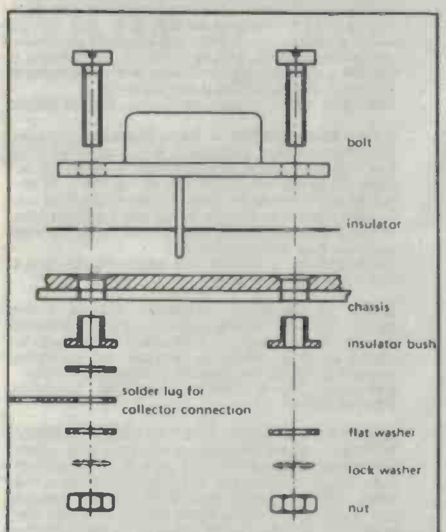


Figure 8. 281 mounting details.

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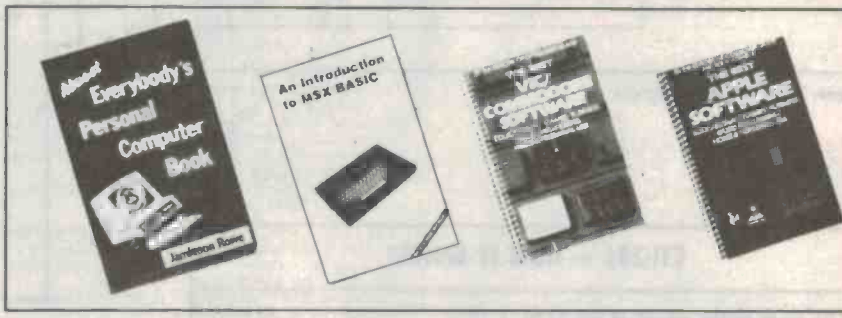

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NOVEMBER '86

Editorial

AUSSAT fairly swarms with TV signals. The ABC is there, as are various specialist rural broadcasters in a service known as HACBSS (Homestead and Community Broadcasting Satellite Service). SBS, two new networks from the west coast called Club Superstation and Skychannel, plus sundry other special interest groups like real estate agencies are there. The three major commercial networks use the satellite to send programs between their terrestrial transmitters as well. This service is called SPS, for special program services.

Now the Minister of Communications, Michael Duffy, has announced the encoding of SPS signals, thus shutting up the last unencoded signal on the satellite, with the exception of the ABC. The SPS service will use an encoded PAL format. It's not technically difficult to decode, but it is economically impossible. All the other signals are encoded by the special addressing functions of BMAC which stems from a header code transmitted with the signal. If you don't have the correct code built into your receiver, the signal is automatically scrambled.

In practice, SBS and SPS are available only to their intended regional terrestial translators, the Club Superstation signal only to licensed clubs, and Skychannel only in hotels. Even the HACBSS services are rigidly controlled. You can only receive one, depending on the area you live in. The satellite is closed up tight. Neither you nor I can use it to extend our range of viewing choice.

On the face of it, this is odd, is it not? Why go to all the trouble and expense of putting a satellite up and then limit its use to essentially zero? To be sure, city dwellers derive some benefit from the satellite, in the form of the Telecom links now being used for trunk data and telephony traffic. But these links could scarcely be used as a justification for establishing a satellite network. If the money had been pumped into Telecom, we would have had an optical fibre network in the ground just that much sooner, with more bandwidth per dollar.

Our minimal requirements for remote area telephony and data could have been handled more cost effectively by Intelsat. Broadcasting is the only real justification for Aussat, and the nation is being shortchanged.

We have the technical ability to put (say) 12 TV channels on the satellite and broadcast them to all Australia, PNG, New Zealand, bits of Indonesia and most of the South Pacific. The market (more than 15 million people) exists to support at least that many channels, going on US experience. On a nationwide basis, the advertising would exist to support three-quarters of them as fully commercial channels.

And this is not a problem that will go away. The dichotomy between what could be and what is will grow worse with time. The Aussat second generation is now on the drawing boards, and Aussat people are already making informal statements about the third generation. The increasing power of satellites, coupled with the use of spread spectrum and other techniques in downstations will make receiving them cheaper and easier. The final impediment to direct broadcasting from satellites (DBS), its price, will disappear.

In a story as old as Australia itself, the Government has caved into vested interest groups with scarely a murmer of protest from the public. The rural broadcast lobby, quite correctly, saw the satellite as a threat to the enormous profits it makes out of providing the minimum possible service in country areas. The major networks saw the satellite as a method of extending their monopoly to the whole country. All the groups involved saw the satellite as a vehicle for extending competition, improving programs and increasing viewer's choice.

And they quite cynically determined to prevent it.

In the ensuing bun fight, the rural producers got protection, and the networks lost nothing and gained a valuable networking tool. The real losers were the public.

It has not been a conclusion to the Government's liking. In the final analysis, however, the Government couldn't afford to get too far off side with the media moguls. It's just another example of the price we pay for that fact that successive Governments have allowed such concentrated media ownership. The satellite just furthers the process.

WHAT'S THE NOISE?

I HAVE BEEN reading your mag for quite a while now and am curious to know why your tests on compact disc to hi-fi tape cannot detect audible distortion.

When taping compact disc to hi-fi video (standard play) there is a fluttering effect – not flutter, more a BRRRR – simultaneously with the frequency on some very sharp transients. I have only encountered this on a few selections of music but it sounds awful through the monitors.

My equipment is JBL 4312 studio monitors, NAD 3020 amp, NAD 5255 CD, National 235X cassette deck (dbx), National hi-fi video/audio source s/analyser. When I record on the National cassette deck with dbx, the 'flutter' is unbelievable and amplified even more. Can you offer any suggestions.

K. Bamfield
Lindfield, NSW

The BRRRR effect is a difficult one to diagnose remotely. These sorts of problems can be checked out in the following possible ways:

(a) By carefully tracking down whether the phenomenon is associated with building, glazing, speaker box or speaker diaphragm resonances, none of which can be confirmed without one's presence in the room.

(b) If the CD player provides A-B repeat or recycle function, then this capability should be used to determine whether it is the speakers. By swapping speakers from channel A to channel B and vice versa, or by borrowing a set of replacement speakers (not necessarily the same type), this problem may be further isolated.

(c) If the problem is still manifesting itself with change of speakers, it would seem timely to take the CD player back to the retailer for assistance.

If I have interpreted the letter correctly, the problem is exacerbated by use of the cassette deck with dbx. This leads me to believe the problem is more likely to be associated with the speakers than with the CD player or cassette deck itself.

— Louis A. Challis

Minimart

WANTED: DRAKE R-7A, JRC NRD-515, Realistic DX-160 receivers and old QST mags. DXer would like to hear from owners of Drake R-7. (042) 29-2573 Tony.

FOR SALE: TELLUROMETER with 2.3 GHz FM link, tripods, dishes, qty 3 $150. Video tape 7" spools x ½" new $5. Crystal set, crystal holders old open type $3.50 posted. (02)81-2143.

FOR SALE: TRS80-CoCo. 64K extended basic, disk drive, joysticks, DMP105 printer, cables, manuals, original packing. Software: Scripsit, Flightsim, Database. $750, will separate. Norm McMillan (044)22-1473.

FOR SALE: VZ users monthly newsletter and magazine for 200/300 users. Includes BASIC, Assembly language and hardware. Send SAE to PO Box 154, Dural, NSW 2158.

FOR SALE: $45 ea; six new Philips TA-9A car t/decks, auto reverse, stereo. Ideal for dubbing. Matthew Maddock, PO Box 259, Narrandera, NSW 2700. (069)59-2972 ah.

FOR SALE: 1 LEAK 30/30 valve power amplifier in as new condition plus 2 valve radios. Ph (02) 451-4044.

FOR SALE: ICs – name your price! 8080, 2708, 8228, 8238, 8224, 7106, 57160 STAC, 40-pin IC sockets, transformers 10 V, 7 A + 18 V, 3 A + 10 V + 0.5 A, 3 m lengths of 30 core cable. Peter (02) 558-5137.

FOR SALE: VIC-20 programme library. High quality games, utilities, educational and misc programs available. Send SAE to Chris Groenhout, 25 Kerferd St, Watson, ACT 2602 for list.

WANTED: TO BORROW or buy, operational manual for Motorola 6800 D2 evaluation kit. Ph (02) 871-8760 after 5.30 pm, and ask for Andrew.

WANTED: Reasonably priced dot-matrix or similar printer to suit Commodore VIC-20 for school student. Contact: J. Turner, 5 Grey St, Auburn, NSW 2144.

FOR SALE: TRS-80 colour computer 2. 16K ECB. Comes with computer cassette recorder and cable, joysticks, $130 software, $40 of books – $400. Gerard Shea, 189 Oxley Highway, Port Macquarie, NSW 2444. (065) 83-6787.

INVESTMENT IN SA

JON FAIRALL'S ARTICLE on MICs (ETI Sept '86) reminds me of the prospectus of Enterprise Investments (SA) Ltd. I would gather this firm is of the same vintage as SAMIC of which I had never heard until I read of it in the listing, page 71.

It would seem South Australia may have four teams working at the same problem though possibly with different approaches and levels of technology in mind: SAMIC Ltd, Enterprise Investments, the Technology Park Corp (connected with the SA Institute of Technology, I gather) and the private enterprise 'Do It' company associated with Adelaide University (I think it's a Unisearch company).

I wonder what the differences between MICs and Enterprise Investments are? Working from memory, I believe government funding of Enterprise Investments is in the form of a guarantee on the interest and capital of the unsecured convertible notes issued by the SA Finance Authority to get the company going.

The ETI article brought to mind stories of Australian investment in innovative ideas around 1880. Among those that fell by the wayside was the steam tractor of Mr Elder (founder of that corner of Elders-IXL) which he bought for one of his stations north of Port Augusta. Another was the first petrol driven truck produced at Mannum, a bit over 20 years after the town had built its first and last river steamer.

Ian Compton
Richmond, SA

BUY AUSTRALIAN WHAT?

I READ WITH interest your excellent article 'Towards a Better Mousetrap' (September '86 ETI). Unfortunately, as a single inventor, it offered me little encouragement. It is to be regretted that the single inventor does not appear to have any support in Australia, as US data shows that 60 per cent of important inventions come from the single inventor.

The attitude of encouragement in the USA literature, and the advertising for inventions, is a far cry from the situation in Australia.

The last invention that I provisionally patented was a method of measuring blood pressure non-invasively. Like previous projects it aroused little interest as I am unable to produce a prototype, due to lack of finance. All approaches to relevant organizations result in the request for a prototype, with no suggestions as to how the prototype can be funded. A catch 22 situation with no answer.

Therefore inventing has become for me a hobby that fills my time, empties my pocket and occupies my mind. The ideas I have recently developed I have not bothered to patent, (due to cost), but have forwarded to manufacturers as suggestions, in an attempt to get some satisfaction.

The recent "Buy Australian" campaign, by the Federal Government, is a source of amusement to me. Many overseas products are in fact Australian ideas that have had to be sent overseas to be developed (such as, I understand, photocopiers which were developed at the University of Adelaide). It is hypocritical that we be asked to buy Australian products. Perhaps the Government should look to Japan. Japan is now the dominant country in the international financial system, which should cause some investigation as to the difference in status. I believe that the effort Japan has put into technology development is now paying handsome dividends.

R.J. Coonan
Mt Gambier, SA

Club Call

The **Australian Radio DX Club** for enthusiasts of long distance SW radio receiving offers its publication "Australian DX News" among others, to members. For further information send return postage to ARDXC, PO Box 36, North Brighton, Vic 3186.

Darts

The dart moves up and down opposite a dart board on the left. When the player hits the space bar the dart flies off and hits or misses the board. Points gained depend on which of the rings (if any) is hit.

The up and down movement of the darts speeds up with time. Three levels of difficulty are allowed for. Level 3 has the dart at the farthest distance.

Kiryl Shortman
Carlton North, Vic

```
00100 REM
00110 REM                    *********************
00120 REM                    *       DARTS       *
00130 REM                    *  BY K. SHORTMAN   *
00140 REM                    *********************
00150 REM
00160 REM
00170 REM The aim of this game is to hit the dart board with
00180 REM the dart.
00190 REM To  fire the  dart you  press the  space  bar once.
00200 REM The  game  will get harder as you pass more stages.
00210 REM If you ever wish to quit press break.
00220 REM
00230 REM Bulls-Eye=                  3 points
00240 REM Next to Bulls-Eye=          2 points
00250 REM Next to that=               1 point
00260 REM Missing altogether=        -1 point
00270 REM
00280 ON ERROR GOTO 700:REM TRAPPING ANY GOSUB ERRORS.
00290 Q=1:H=1:W=101: REM SETTING STAGE & SPEED
00300 REM          ...SETTING DISTANCE FROM TARGET...
00310 CLS:INPUT "LEVEL OF PLAY, 1-EASY, 2-NORMAL, 3-HARD";C
00320 IF C=1 THEN LET A=32
00330 IF C=2 THEN LET A=50
00340 IF C=3 THEN LET A=60
00350 LET S=0:REM SETTING SCORE COUNTER TO 0
00360 REM           ...SETTING UP TARGET & BORDER...
00370 CLS:HIRES
00380 PLOT 1,223 TO 511,223 TO 511,10 TO 1,10 TO 1,223
00390 PLOT 5,80 TO 5,160 TO 10,160 TO 10,80 TO 5,80
00400 PLOT 10,95 TO 15,95 TO 15,145 TO 10,145
00410 PLOT 15,112 TO 20,112 TO 20,129 TO 15,129
00420 NORMAL:B=10:REM OUT OF HIRES & SETTING UP STARTING POSITION.
00430 CURS 16,1:PRINT "SCORE=";V;".                 STAGE=";H:REM SCORE BOARD.
00440 REM         ...MOVEMENT OF DART UP & DOWN...
00450 LET B=B+1:GOSUB 480 :IF B=14 THEN GOTO 470 ELSE GOTO 450
00460 REM         ...IS PERSON THROWING DART?...
00470 LET B=B-1:GOSUB 480 :IF B=4 THEN GOTO 450 ELSE GOTO 470
00480 CURSA,B : PRINT"<--=":IF LEN(KEY$)=1 THEN GOTO 510
00490 FOR O=Q TO W:NEXT D:REM SPEED OF AIMING DART.
00500 CURS A,B:PRINT "    ":RETURN
00510 CURS A,B:PRINT "<--=":FOR E=1 TO 30:NEXT E:CURS A,B:PRINT "    "
00520 A=A-1:REM MOVING DART TOWARDS TARGET.
00530 REM            ...SCORE FOR WHAT DART HITS...
00540 IF A=2 AND B=7 OR A=2 AND B=11 THEN LET S=S+1:GOTO 600
00550 IF A=3 AND B=8 OR A=3 AND B=10 THEN LET S=S+2:GOTO 600
00560 IF A=4 AND B=9 THEN GOTO 620
00570 IF B>11 AND A=1 OR B<7 AND A=1 THEN LET S=0:GOTO 610
00580 GOTO 510
00590 REM    ...WHAT TO DO WHEN DART HAS BEEN THROWN...
00600 CURS 26,9:PRINT "...HIT...":PLAY 20,6:LET W=W-5:V=V+S:H=H+1:IF W<10 THEN G
OTO 640 ELSE GOTO 320
00610 CURS 26,9:PRINT "...MISSED...":PLAY 1,8:V=V-1:GOTO 320
00620 CURS 23,9:PRINT "...BULLS-EYE...":PLAY 22,6:W=W-10:V=V+3:H=H+1:IF W<10 THE
N GOTO 640 ELSE GOTO 320
00630 REM            ...WHEN PERSON HAS WON...
00640 CLS:CURS 20,6:PRINT "YOU ARE TOO GOOD FOR ME!!!"
00650 PLAY 1,1;2,1;3,1;4,1;5,1;6,1;7,1;8,1;9,1;10,1;11,1;12,1;13,1;14,1;15,1;16,
1;17,1;18,1;19,1;20,1;21,1;22,1
00660 CURS 20,7:PRINT "YOU TOOK ";H;" GOES TO WIN"
00670 CURS 20,8:PRINT "AND YOUR SCORE WAS ";V;""
00680 CURS 20,9:INPUT "PRESS RETURN TO PLAY AGAIN.";K1$
00690 GOTO 290:REM STARTING AGAIN
00700 RETURN
```

Commodore cup

This is a horse racing and betting game for the VIC 20 taking up most of the memory and using simple music, colour and hi-res graphics systems on the VIC 20.

On running the program the first screen tells you the odds. These will be equal when you first start then change with more play. Hit any key at this point in order to bet. You start with $200. Type in which horse you bet on and the amount you bet, then the race will begin. If your horse wins, the amount you bet will be multiplied by the odds for that horse and the program will go back to the first page with appropriate changes made to the odds on each horse.

Jonathan Millard
The Grange, Qld

```
READY.

1 FORI=1TO3:OD(I)=10:NEXT:POKE52,28:POKE56,28:POKE36879,29
2 M=200:POKE788,191
3 GOSUB7:GOSUB20:GOSUB25:GOSUB38:GOSUB44:GOSUB57:GOTO3
4 END
5 PRINT"":POKE36879,29:POKE36869,240
6 H(1)=7336:H(2)=7504:H(3)=7672:RESTORE
7 PRINT"COMMODORE CUP":PRINT"BY J.MILLARD"
8 POKE36869,240:PRINT"THE ODDS ON THE NEXT":PRINT"RACE ARE:- "
9 PRINT"RED   "OD(1):PRINT"GREEN"OD(2):PRINT"BLUE  "OD(3)
10 PRINT"HIT ANY KEY  "
11 WAIT198,1:POKE198,0
12 PRINT"COMMODORE CUP":PRINT"BY J.MILLARD"
13 POKE36869,240
14 PRINT"YOU HAVE":PRINT"$";M
15 PRINT"YOU MAY BET ON:-
16 PRINT"1.RED2.GREEN3.BLUE"
17 INPUT" THE HORSE  ";H:IFH<1ORH>3THEN17:PRINT""
18 INPUT" THE BET    ";B:IFB<0ORB>MTHEN18
19 RETURN
20 H(1)=7168+(8*21):H(2)=7168+(8*42):H(3)=7168+(8*63):RESTORE:PRINT"CHARACTER
 SET.
21 FORI=7168TO7679:POKEI,0:NEXT
22 FORI=7168TO7168+7:READA:POKEI,A:NEXT:POKE36869,255
23 DATA40,40,40,56,56,40,40,40
24 RETURN
25 C=0:PRINT"":FORI=7688TO8172STEP22:POKEI,0:POKEI+30720,4:NEXT
26 FORI=7694TO8178STEP22:POKEI,0:POKEI+30720,4:NEXT
27 PRINT"END"
28 PRINT"START"
29 FORI=7702+10TO8142+10STEP22
30 C=C+1
31 POKEI,C:POKEI+1,C+21:POKEI+2,C+42
32 POKEI+30720,2:POKEI+30721,5:POKEI+30722,6
33 NEXT
34 PRINT""
35 PRINT""
36 GOSUB44
37 RETURN
38 MO=INT(RND(TI)*3)+1
39 IFPEEK(7184)<>0THENW=1:RETURN
40 IFPEEK(7352)<>0THENW=2:RETURN
41 IFPEEK(7520)<>0THENW=3:RETURN
42 POKE36878,15
43 H(MO)=H(MO)-1:POKEH(MO),24:POKEH(MO)+6,0:POKE36877,255:POKE36877,0:GOTO38
44 RESTORE
45 POKE36878,15
46 READP
47 IFP=-1THEN55
48 READO
49 POKE36876,P
50 FORN=1TOO:NEXTN
51 POKE36876,0
52 FORN=1TO20:NEXTN
53 GOTO46
54 POKE36878,0
55 RETURN
56 DATA128,130,132,134,136,139,140,142,144,146,14[illegible],[illegible],[illegible],1000,[illegible]
57 IFW=HTHENM=M+(B*OD(W))
58 IFW<>HTHENM=M-B
59 IFM<>0THENGOSUB63:GOTO3
60 PRINT"YOU WENT BROKE !!!"
62 POKE36869,240:END
63 IFW=1THENOD(1)=OD(1)-2:OD(2)=OD(2)+1:OD(3)=OD(3)+1
64 IFW=2THENOD(2)=OD(2)-2:OD(1)=OD(1)+1:OD(3)=OD(3)+1
65 IFW=3THENOD(3)=OD(3)-2:OD(2)=OD(2)+1:OD(1)=OD(1)+1
66 RETURN

READY.
```

Real 3D graphs

This program is an extension of M. Kostecki's "3D Graph Generator" (June '84). A few modifications to the original program enable stereographs to be produced.

Two pictures for each graph are generated as it is seen from slightly different angles. By focusing one eye at each picture the illusion of depth is introduced. For a more realistic effect, the graphs are drawn in perspective. Segments that are closer to the viewer are made longer than those farther away using variables X2 and Z2. Note that the angles are arranged in the conventional configuration:

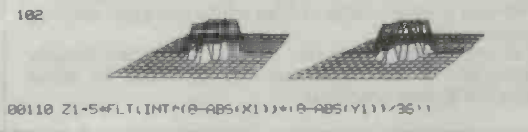
These stereographs are best viewed at a distance of about 40 cm. With the graphs in front of you, focus on infinity. The graphs should begin to merge and appear blurry. You might need to tilt your head to get a complete superimposition. Concentrate on the central figure, trying to bring it into sharp focus and there you have it, a real 3D graph.

Below are some interesting functions you might like to try. Retype line 110 using the new expressions for Z1.

K. Doan
Mt Lawley, WA

```
Z1=SIN(X1/3)#4-Y1#Y1/12
Z1=EXP(-ABS(X1#Y1-8)/3)#4.5
Z1=(SQR(64-X1#X1)+SQR(64-Y1#Y1))#(ABS(X1)+ABS(Y1))/24+3
Z1=3#SIN((X1+Y1)/4)
Z1=-EXP((-X1#X1-Y1#Y1)/16)#8
Z1=-1.0#SIN(0.833#SQR(X1#X1+Y1#Y1))
Z1=1.0#COS(0.6942#SQR(X1#X1+Y1#Y1))-3

00010 REM *** REAL 3D GRAPH ***
00020 REM ***    GENERATOR     ***
00030 REM ***  Khanh   Doan    ***
00040 REM
00050 DIM T(16,16,2):SD 4:HIRES
00060 ON ERROR GOTO 290
00070 FOR X=16 TO 0 STEP -1:FOR Y=0 TO 16:REM #Y slices
00080 X1=FLT(X-8):Y1=FLT(Y-8)
00090 X2=(X1+42)/50
00100 REM #Equation
00110 Z1=5#FLT(INT((8-ABS(X1))#(8-ABS(Y1))/36))
00120 Z2=(50-Z1)/50
00130 A=INT((Y1#8-X1#5)#X2)+352:REM #Right pisture
00140 U=INT((Z1#6-X1#3#Z2)#X2)+128
00150 E=INT((Y1#8-X1#4)#X2)+16..REM #Left picture
00160 IF Y=0 THEN 190
00170 PLOT B,C TO A,U
00180 PLOT F,C TO E,U:CURS 0:PRINT USED;
00190 B=A:F=E:C=U:T(X,Y,0)=A:T(X,Y,1)=U:T(X,Y,2)=E
00200 NEXT Y:NEXT X
00210 FOR Y=0 TO 16:FOR X=0 TO 16:REM #X slices
00220 A=T(X,Y,0):U=T(X,Y,1):E=T(X,Y,2):REM #Stored points
00230 IF X=0 THEN 260
00240 PLOT B,C TO A,U
00250 PLOT F,C TO E,U:CURS 0:PRINT USED;
00260 B=A:F=E:C=U:NEXT X:NEXT Y
00270 CURS 1,14:LIST 110
00280 REM #Insert screendump routine here
00290 GOTO 290
```



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Valley driver

This program uses advanced machine code scrolling of the screen. You are driving for your life up a valley of mad drivers. Press the fire button for turbo boost. Survive the drive.

C. Sydney,
Mt Gravatt East, Qld

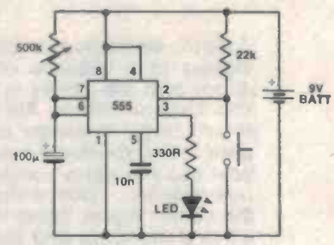
```
0 REM*************************VALLEY DRIVER*************************
1 POKE36879,14:POKE37154,127
2 POKE36878,1:POKE36874,128:POKE36875,128:POKE36877,0
4 PRINT"█"
5 PRINT"▯"
10 IFPEEK(784)=10THEN80
20 POKE784,10
30 FORA=820TO864:READB:POKEA,B:NEXT
40 DATA162,249,189,0,31,157,22,31,189,0,151,157,22,151,202,224,255,240,3,76,54,3
50 DATA162,255,189,0,30,157,22,30,189,0,150,157,22,150,202,224,255,240,3,76,76,3
,96
60 FORA=7168TO7183:READB:POKEA,B:NEXT:FORA=7424TO7431:POKEA,0:NEXT
70 DATA66,126,66,24,24,219,255,203,203,255,219,24,24,66,126,66
80 FORA=7184TO7191:POKEA,INT(RND(1)*256):NEXT
90 POKE36869,255
100 A=8:U=7910
110 PRINT"█BBBBBBBBBBBBBBBBBBBBBBB"
120 PRINT"█"TAB(A)"      ";:IFRND(1)<.2THENPRINT"██"TAB(A+1+INT(RND(1)*5))"A"
130 A=A+(INT(RND(1)*3)*3-3)/3
135 IFA>15THENA=15
140 IFA<1THENA=1
150 P1=PEEK(37137):P2=PEEK(37152)
160 IFP1=110ORP1=78THENPOKEU,32:U=U-1:IFPEEK(U)<>32THEN210
170 IFP2=119THENPOKEU,32:U=U+1:IFPEEK(U)<>32THEN210
175 POKEU,32
180 IFP1>100THEN200
190 SYS820:IFPEEK(U)<>32THEN210
200 SYS820:IFPEEK(U)<>32THEN210
205 POKEU+30720,6:POKEU,0:GOTO110
210 POKE36874,0:POKE36875,0:FORA=15TO0STEP-.2:POKE36878,A:POKE36877,180
220 POKE36879,INT(RND(1)*256)OR11:NEXT:RUN

READY.
```

Trivial Pursuit timer

This simple but cunning circuit can solve the problem of how much time it took to answer that last critical Trivial Pursuit question. Just push the button, and the LED will illuminate. When it goes out, it's answer time.

The 500k variable resistor and the 100µ capacitor determine the range of on-times for the LED; the 500k variable resistor sets particular time.

R. Higgins,
Cheltenham, Vic.



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

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Title of idea/program ....

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

Name ....

Address ....

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

'Idea of the month' contest

Scope Laboratories, which manufactures and distributes soldering irons and accessory tools, is sponsoring this contest with a prize given away every month for the best item submitted for publication in the 'Ideas for Experimenters' column — one of the most consistently popular features in ETI Magazine. Each month, we will be giving away a Scope Soldering Station (code ETC601) worth approximately $191.

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

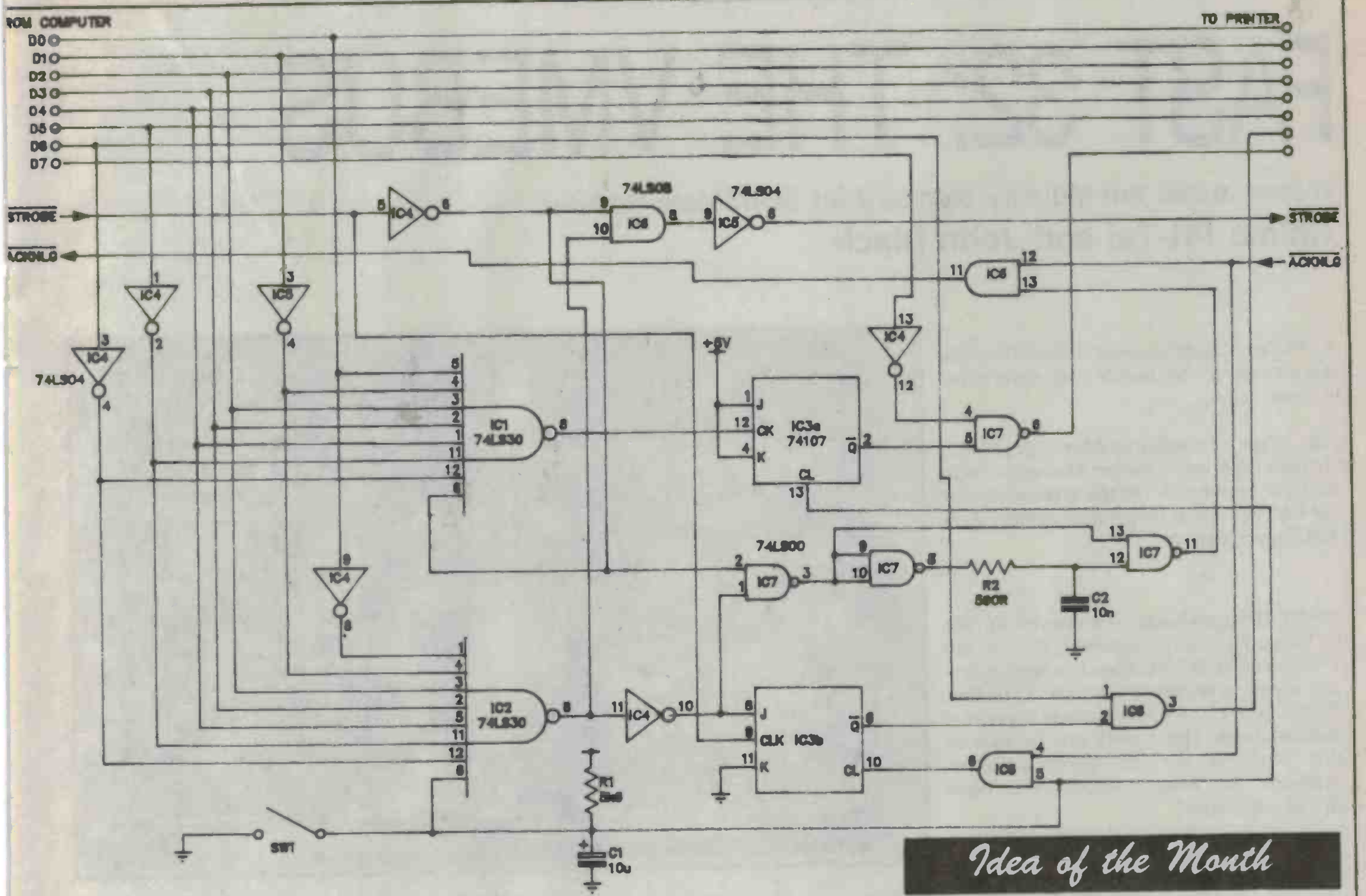
RULES

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

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

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

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



Wordstar parallel printer interface

This circuit was designed as an interface between a Microbee Computer and a DP-100 printer. It allows the selection of the complete range of print styles as well as other printer settings from within a Wordstar text file. It only requires two user defined print commands.

When using the interface, Wordstar must be installed using WINSTALL so that two user defined printer commands send the characters hex 1D and 1C respectively. These two control codes are used to control the interface circuit and are not used by the printer. Control PQ is used to send 1D and control PW to send 1C.

When Wordstar is printing out a file and control Q is encountered in the file, a bit pattern corresponding to hex 1D is sent to the parallel port. This bit pattern is detected by IC1, and IC1's output toggles the flipflop (IC3a). The bit pattern does not affect the printer. The data line D7 is set high by this flipflop irrespective of incoming data. All the data characters following control Q will be printed as their equivalents from the top half of the printer's character generator (eg, italic, graphic and Greek). When another control Q is encountered, the flipflop is toggled again, the D7 data line returns to low and the following characters are printed as normal.

When a control W is in the file being printed, a bit pattern corresponding to hex 1C is detected by IC2. An AND gate (IC6c) prevents the STROBE signal from being sent to the printer. Instead, the STROBE sets IC3b and an acknowledge signal is sent to the computer by the NAND gates (IC7a, c and d), resistor R2 and capacitor C2. This signal tells the computer that the character has been received, even though it has not been transferred to the printer.

By setting IC3b the data line D6 is artificially forced low. This means that if the character 'A' (hex 41) is sent immediately after the control W, the printer receives the character control A (hex 01). Therefore, any of the control codes (hex 00 to 1F, which cannot normally be included in a Wordstar text file) can now be sent. This is done by using control W followed by the character corresponding to the desired control code (ie, hex 40 to hex 5F). As soon as a character is sent followed by a control W, IC3b automatically resets, thus there is no need for a second control W to toggle it to normal.

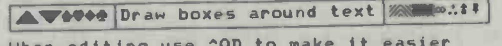
When more than one control code must be sent, use control W immediately before each corresponding character. The hex 1C sent by control W must not be received by the printer, because an escape sequence must not be interrupted by an extra code (even though it is not used by the printer).

R1 and C1 ensure that the circuit is powered up in the normal state. SW1 has the effect of bypassing the circuit and may be necessary when not using Wordstar. The 5 V supply rail comes from the Microbee's parallel port and the circuit's current drain poses no problem to the Microbee. Finally, note that the Microbee printer cable has a small circuit board built into it and this must come before the interface circuit.

G. McKay
Annandale, NSW

Examples

```
Text file: This is ^Qthe Italic^Q print style.
Result:    This is the Italic print style.

Text file: ^WN Hex OE - enlarged print
Results: H e x   O E   -   e n l a r g e d   p r i n t

Text file: ^W[R^WU ESC+R+21(Dec)
                     selects ASCII+Greek ^Qabcdefgh^Q

Results: ESC+R+21(Dec) selects ASCII+Greek αβγδεζηθ

Text file: ^W[R^WJ ESC+R+10(Dec) -
                         ASCII+Graphic ^Q1234567890:^Q
           ^W[A^WH ESC+A+8(Dec)  -
                         Line spacing at 8/72 inch

      ^Q85555555515555555555555555555555555559^Q
      ^Q6DEFGHIJK6^QDraw boxes around text^Q6QRSTz(|)6^Q
      ^Q:5555555055555555555555555555555555555;^Q

Results: ESC+R+10(Dec) - ASCII+Graphic ┤├‾–|⌐⊥└
         ESC+A+8(Dec)  - Line spacing at 8/72 inch
```




```
Hint:   When editing use ^OD to make it easier
                to see what is going on.
```

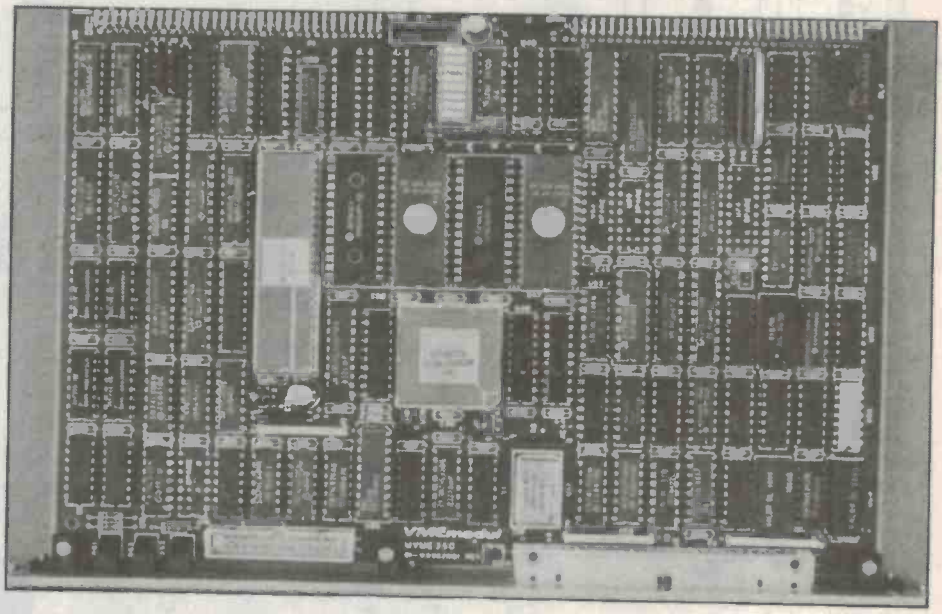
FAST 32: THE VMEBUS

A look inside the industry standard for 32-bit data transfer

Shlmo Pri-Tai and John Black

S. Pri-Tai is a staff engineer with VMEsystem Architecture, Motorola Microsystems, Arizona USA.

John Black is President of Micrology pbt Inc, Arizona USA, and a former Motorola design engineer responsible for the development of the VMEbus. He is the primary author of the VME specification.



SINCE ITS introduction in December of 1981 by Motorola, Philips/Signetics, Mostek and Thomson CSF the VMEbus has unquestionably grown to be the most popular 32-bit bus. Today over 150 vendors actively support it with products. This growth rate far exceeds that observed for any previous microcomputer bus. What accounts for its rapid rise in popularity?

The performance that it offers makes it a natural choice for use with the new 32-bit microprocessors being introduced by such companies as Motorola and National. These new microprocessors offer performance levels that rival many mainframe computers. But while they make possible the design of very high performance microcomputers, they also offer difficult challenges to unfamiliar microcomputer designers. In recognition of this fact, the document that describes the VMEbus protocols is more than just a specification. It offers practical advice which could otherwise only be learned through trial and error.

The VMEbus is used by processors and DMA (direct memory access) devices to select globally shared peripherals or memory, and to transfer data to or from them. Its structure can be described from two points of view: its mechanical structure and its functional structure.

Structure

The functional structure of the VMEbus consists of backplane interface logic, four groups of signal lines called "busses", and a collection of "functional modules". Each of these four busses and its associated functional modules work together to perform specific duties.

The Data Transfer Bus is one of the four busses provided by the VMEbus backplane. It allows bus Masters to direct the transfer of binary data between Masters and Slaves. In addition to the Master and Slave, the Data Transfer Bus's collection of functional modules also includes the Location Monitor and the Bus Timer.

To provide for newer technologies, while maintaining compatibility with the old, the VMEbus protocol is totally asynchronous. The NMOS technology used in first generation microprocessors is limited, because of heat dissipation problems, to about 10 MHz. Several new 16- and 32-bit microprocessors make use of CMOS technology to reduce power dissipation and run at clock rates from 10 to 16 MHz. Further development will likely lead to 20 MHz clock rates. During the transition period, most systems will contain both the old and new technology chips. The VMEbus's asynchronous protocol makes this possible.

The Master initiates Data Transfer Bus cycles in order to transfer data between itself and a Slave module. A Data Transfer Bus cycle is a sequence of level transitions on the signal lines of the Data Transfer Bus that result in the transfer of an address or an address and data between a Master and a Slave. There are nine basic types of Data Transfer Bus cycles: read, write, unaligned read, unaligned write, block read, block write, read-modify-write, address-only, and interrupt acknowledge cycle.

The Slave detects Data Transfer Bus cycles initiated by a Master and, when those cycles specify its participation, transfers data between itself and the Master.

The Location Monitor monitors data transfers over the Data Transfer Bus in order to detect accesses to the locations it has been assigned to watch. When access occurs to one of these assigned locations, the Location Monitor alerts its on-board logic. For example, it might signal its on-board processor by means of an interrupt. In such a configuration, if processor board A writes into a location of the global VMEbus memory monitored by processor B's Location Monitor, processor B will be interrupted.

The Bus Timer measures how long each data transfer takes, and terminates the Data Transfer Bus cycle if a transfer takes too long. A Bus Timer is useful when a Master tries to transfer data to or from a non-existent Slave location. Since the Master waits for a Slave to respond, it might wait forever. The Bus Timer prevents this by terminating the cycle.

The Priority Interrupt Bus is the second bus defined by the VMEbus specification. It allows Interrupter modules to request interrupts from Interrupt Handler modules, and consists of seven interrupt request lines, one interrupt acknowledge line, and an interrupt acknowledge daisy-chain. The Priority Interrupt Bus allows VMEbus boards to generate directed interrupts to each other.

The Interrupter generates an interrupt request by driving one of the seven interrupt request lines on the Priority Interrupt Bus. When that request is acknowledged by an Interrupt Handler, the Interrupter identifies itself, or describes its status to the Interrupt Handler, allowing the Interrupt Handler to service the interrupt.

The Interrupt Handler detects interrupt requests generated by Interrupters, and responds to those requests by asking for status or identification information. This information is received from the Interrupter during a special kind of Data Transfer Bus cycle — the interrupt acknowledge cycle. After reading the status or identification information from the Interrupter, the Interrupt Handler initiates the appropriate interrupt servicing sequence.

The IACK Daisy-Chain Driver is the third functional module defined for use on the Priority Interrupt Bus. Its function is to activate the interrupt acknowledge daisy-chain whenever an Interrupt Handler acknowledges an interrupt request. This daisy-chain ensures that only one Interrupter responds with its status or identification when more than one has generated an interrupt request.

The Arbitration Bus coordinates use of the Data Transfer Bus among several Masters and Interrupt Handlers which may need it. Before transferring any data over the Data Transfer Bus, a Master or Interrupt Handler must get permission to use the bus. The process which determines which Master may use the Data Transfer Bus is called arbitration. The Arbitration Bus consists of four bus request lines, four daisy-chained bus grant lines, and two other lines called bus clear and bus busy. It allows an Arbiter module and several Requester modules to coordinate use of the Data Transfer Bus.

The Requester resides on the same board as a Master or Interrupt Handler, and requests use of the Data Transfer Bus whenever asked to do so by its Master or Interrupt Handler. It then waits for the Arbiter to grant it exclusive use of the Data Transfer Bus. When granted the bus, the Requester takes control by driving the bus busy line, and then signals its on-board Master or Interrupt Handler that the bus is available.

The Arbiter accepts bus requests from Requester modules, as described in the previous paragraph, and grants control of the Data Transfer Bus to only one Requester at a time. Some Arbiters have a built-in time-out feature that causes them to withdraw a bus grant if the requesting board does not start using the bus within a prescribed time. In addition, some Arbiters drive the bus clear line to the active Master when they detect a request for the bus from a Requester whose priority is higher than the one that is currently using the bus.

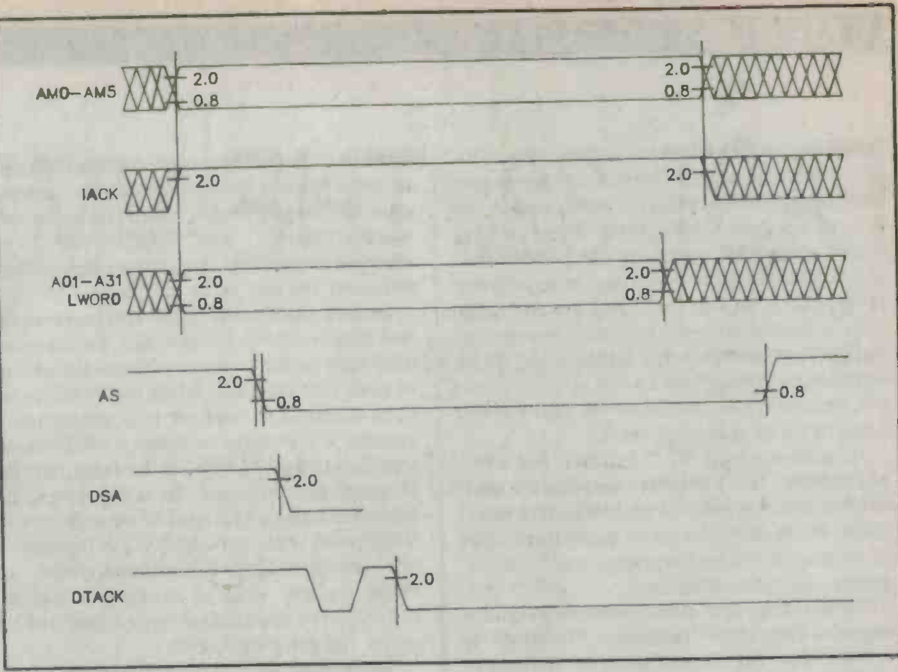


Figure 1. Timing diagram example.

The Utility Bus includes signals that provide periodic timing and coordinate the power-up and power-down sequences of the VMEbus system. Three modules are defined by the Utility Bus: the System Clock Driver, the Serial Clock Driver, and the Power Monitor.

The System Clock Driver provides a fixed frequency, 16 MHz signal. It is located on the system controller board in slot number 1. Its 16 MHz clock waveform is useful for counting off time delays. However, it has no fixed phase relationships with other VMEbus timing.

The Serial Clock Driver provides a periodic timing signal that synchronizes operation of the VMSbus. The VMSbus is part of the VMEsystem architecture, and provides a serial inter-processor communication path. Although the VMEbus specification reserves two backplane signal lines for use by the VMSbus, the VMSbus and timing and protocols are completely independent of the VMEbus.

The Power Monitor module monitors the status of the primary power source to the VMEbus system. When power strays outside the limits required for reliable system operation, it broadcasts a warning to all boards on the VMEbus system in time to effect graceful shut-down.

Since most systems are powered by an ac source, the power monitor is typically designed to detect drop-out or brown-out conditions on the ac line. When power is then restored to the system the Power Monitor broadcasts a reset signal to ensure that all other VMEbus modules are initialized. The Power Monitor also monitors a manually operated pushbutton, and initializes the VMEbus system whenever that button is depressed by the operator. Since the Power Monitor is an optional module, other VMEbus boards may include a pushbutton so that manual system initialization may be achieved.

The System Controller Board resides in slot number 1 of the VMEbus backplane, and includes all the one-of-a-kind functions that are required by the VMEbus system. These functions include the System Clock Driver, the Arbiter, the IACK Daisy-Chain Driver, and the Bus Timer. Some system controller boards also include an optional Serial Clock Driver, and a Power Monitor. The system controller board might also include other functions that users find useful in their VMEbus systems, eg, a global interrupter, a time-of-day clock, additional serial ports, a printer port, diagnostic PROMS, etc.

Protocol

Two basic kinds of protocol are used on the VMEbus: closed loop protocols and open loop protocols. Closed loop protocols use interlocked bus signals while open loop protocols use broadcast bus signals.

Interlocked Bus signals are sent from one specific module to another specific module. The signal is acknowledged by the receiving module. An interlocked relationship exists between the two modules until the signal is acknowledged. For example, an Interrupter can send an interrupt request which is answered later with an interrupt acknowledge signal (no time limit is prescribed by the VMEbus specification). The Interrupter doesn't remove the interrupt request until the Interrupt Handler acknowledges it. Interlocked bus signals coordinate internal functions of the VMEbus system, as opposed to interacting with external stimuli. Each interlocked signal has a source module and destination module which are defined within the VMEbus specification.

Broadcast Bus Signals are generated by modules in response to an event. There is no protocol for acknowledging a broadcast signal. Instead, the broadcast is maintained long ▶

enough to ensure that all appropriate modules detect the signal. Broadcast signals are sometimes also monitored from outside the system to gain information about system status. Broadcast signals might be activated at any time, irrespective of any other activity taking place on the bus. They are each sent over a dedicated signal line. Some examples are the system reset and ac failure lines. These signal lines are not sent to any specific module, but rather announce to all modules the occurrence of a special event.

In keeping with its "designer friendly" philosophy, the VMEbus specification provides many examples of typical system operation. These examples make use of three types of diagrams: timing diagrams, sequence diagrams, and flow diagrams.

Timing diagrams show the timing relationships between signal transitions. The times involved have minimum and/or maximum limits associated with them. Some of the timing parameters specify the behaviour of the backplane interface logic, while others specify the interlocked behaviour of the functional modules. Figure 1 is an example of a timing diagram.

Sequence diagrams are similar to timing diagrams but show only the interlocked timing relationships of the functional modules. They specify the sequence of events, rather than the times involved. For example, a sequence diagram might indicate that a module cannot generate signal transition A until it detects that some other module has generated a transition on signal B. Figure 2 is an example of a sequence diagram.

Flow diagrams show the stream of events as they would occur during a VMEbus operation. The events are stated in words and result from the interaction between two or more functional modules. Flow diagrams describe VMEbus operations in a sequential manner and, at the same time, show the interaction between functional modules.

Keywords

The VMEbus specification offers a great deal of useful advice. Designers may choose to use or discard this advice. However, certain rules must be followed to ensure compatibility. To avoid confusion, and to make very clear what the requirements for compliance are, many of the paragraphs in the VMEbus specification are labelled with keywords. These keywords indicate the type of information the paragraph contains. There are five keywords: rule, recommendation, suggestion, permission and observation.

Any text not labelled with one of these keywords, describes the VMEbus structure or operation. It is easily recognized by its narrative style and exclusive use of the present tense.

Rules form the basic framework of the VMEbus specification. They are sometimes expressed in text form and sometimes in the form of figures, tables, or drawings. All rules must be followed to ensure compatibility between VMEbus designs. Rules are characterized by an imperative style. The upper-case words "MUST" and "MUST NOT" are reserved exclusively for stating rules, and are not used for any other purpose.

Recommendations offer designers advice that they would be wise to take. Doing otherwise may result in some awkward problems or poor performance. While the VMEbus has been designed to support high performance systems, it is possible to design a VMEbus system that complies with all the rules, but has abysmal performance. In many cases, designers need a certain level of experience with VMEbus in order to design boards that deliver top performance. Recommendations are based on this kind of experience and are provided for designers to speed their traversal of the learning curve.

Suggestions offer advice which is helpful but not vital. The reader is encouraged to consider the advice before discarding it. Some design decisions that must be made are difficult until experience has been gained with VMEbus. Suggestions are included to help a designer who has not yet gained this experience. Some suggestions have to do with designing boards that can be easily reconfigured for compatibility with other boards, while others offer ways to design the board so that the job of system debugging is made easier.

Permissions are helpful where a VMEbus rule does not specifically prohibit a certain design approach, but the reader might be left wondering whether that approach might violate the spirit of a rule, or whether it might lead to some subtle problem. Permissions reassure the reader that a certain approach is acceptable, and will cause no problems. The upper-case word "MAY" is reserved exclusively for stating permissions, and is not used for any other purpose.

Observations do not offer any specific advice. They usually follow naturally from what has just been discussed. They spell out the implications of certain rules, and bring attention to things that might be otherwise overlooked. They also give the rationale behind certain rules, so that the reader understands why the rule must be followed.

Electrics

Some bus specifications prescribe maximum or minimum rise and fall times for the signal lines. This creates a dilemma for board designers, since they have very little control over these times. If the backplane is heavily loaded, the rise and fall times will be very long. If it is lightly loaded, these times may be very short. Even if designers know what the maximum and minimum loading will be, they must spend time in the lab, experimenting to find out which drivers will provide the needed rise and fall times.

In fact, rise and fall times are the result of a complex set of interactions involving the signal line's impedance, its terminations, its capacitive and resistive loading, and the source impedance of the driver. In order to take into account all of these factors, the board designer would have to study transmission line theory, as well as certain specific parameters of drivers and receivers which are not normally found in most manufacturers' data sheets.

In keeping with its "designer friendly" philosophy, the VMEbus specification does not specify rise and fall times. Instead, it specifies the required parameters for the drivers and receivers. These specifications take into account the characteristics of the backplane: the maximum length of its signal lines, the maximum number of slots, its signal line impedance, propagation time, termination values, etc. To help the designer find components that meet these requirements some widely available parts are also suggested.

Options

As mentioned earlier, the VMEbus's wide acceptance is largely due to its great versatility. Designers are permitted to choose from a long list of optional capabilities which have been carefully defined to avoid introducing incompatibility. These optional capabilities are discussed below.

Addressing capabilities

The smallest addressable unit of storage on the VMEbus is the byte. A set of four byte locations, whose addresses differ only in the two least significant bits, is called a 4-byte group. Masters can access some or all of the bytes in a 4-byte group simultaneously using a single Data Transfer Bus cycle.

Masters broadcast the address over the Data Transfer Bus at the beginning of each cycle. These addresses might consist of 16-, 24-, or 32-bits. The 16-bit addresses are called "short addresses", the 24-bit addresses are called "standard addresses", and the 32-bit addresses are called "extended addresses". The Master broadcasts 6-bit Address Modifier (AM) code along with each address to tell Slaves whether the address is short, standard, or extended.

Short addressing is intended primarily for addressing I/O. It allows I/O Slaves to be designed with less logic, since they do not have to decode as many address lines. While I/O boards can be designed to decode standard addresses and extended addresses, short addressing usually makes this unnecessary.

Standard and extended addressing modes are intended primarily for addressing memory, although there is no rule against designing I/O boards that also respond to these addressing modes. Standard and extended addressing modes allow much larger addressing ranges.

Basic Data Transfer capabilities

There are four basic data transfer capabilities associated with the Data Transfer Bus: D08 (EO) (even and odd byte), D08 (O) (odd byte only), D16 and D32. These capabilities allow

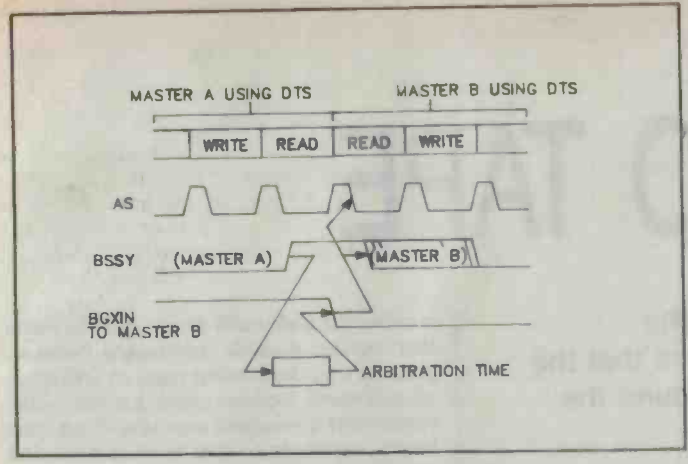


Figure 2. Data Transfer Bus Master exchange sequence — arbitration **during** the last data transfer.

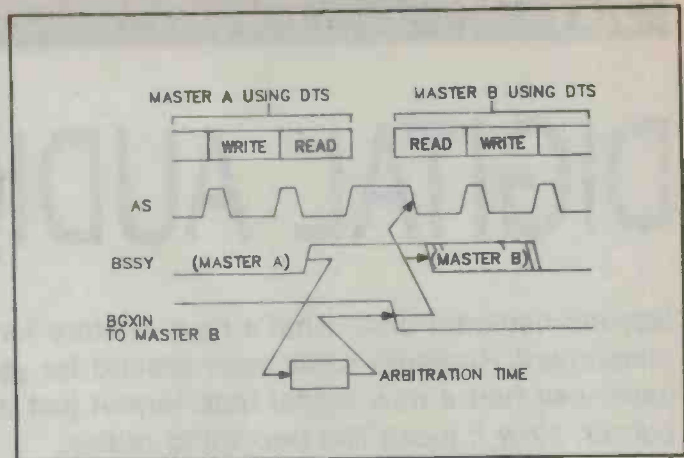


Figure 3. Data Transfer Bus Master exchange sequence — arbitration **after** the last data transfer.

flexibility when interfacing different types of processors and peripherals to the bus.

Eight-bit processors can be interfaced to the bus as D08 (EO) Masters. Sixteen-bit processors can be interfaced to the bus as D16 Masters. Sixteen-bit memory devices or 16-bit I/O Slaves can be interfaced to the bus as D16 Slaves.

Many existing peripheral chips have registers that are only 8 bits wide. While these chips often have several of these registers, they cannot provide the contents of two registers simultaneously when a D16 Master attempts to access two adjacent locations with a double byte read cycle. These 8-bit peripheral ICs can be interfaced to the Data Transfer Bus as a D08 (O) Slave.

D08 (O) Slaves provide only BYTE (1) or BYTE (3) locations, and respond only to single byte accesses. Since single byte accesses to these odd byte locations always take place over data lines D00-D07, D08 (O) Slaves do not need interface logic to transfer data over any other data lines. As D08 (O) Slaves cannot respond properly to quad byte data transfers that simultaneously select both BYTE (1) and BYTE (3), they ignore them.

Since most 32-bit microprocessors can also access memory 8 bits or 32 bits at a time, most 32-bit CPU boards are designed to behave as D08 (EO) and D16, as well as D32 Masters. This not only allows them to do 8-bit and 16-bit data transfers to and from memory, but also to access D08 (O) Slaves.

Since D08 (O) Slaves respond only to odd byte addresses, they cannot provide continuous memory. D08 (O) Slaves are typically I/O, status, or control registers, while D08 (EO), D16 and D32 Slaves might also be memory.

Data Transfer Bus

The bus arbitration protocol determines how and when the Data Transfer Bus is granted to the various types of Masters and Interrupt Handlers in the system. However, it does not dictate when Masters and Interrupt Handlers must release the Data Transfer Bus. Masters and Interrupt Handlers use several criteria in deciding when to release the Data Transfer Bus. Interrupt Handlers give up the bus after their interrupt acknowledge cycle. Masters give up the bus when they finish their data transfers.

Masters and Interrupt Handlers may release the Data Transfer Bus either during, or after their last data transfer. If a Requester releases the bus busy line during the last transfer, arbitration takes place during the last transfer. But if the Requester releases it after the last data transfer, the Data Transfer Bus remains idle while the arbitration is done. Figure 6 provides two examples that show possible sequences when a Master finishes using the Data Transfer Bus and allows arbitration to take place.

Some Masters also monitor the ac failure and the bus clear lines. Both of these signals inform the Master that the Data Transfer Bus is needed for some higher priority activity. The bus clear line is driven by the Priority Arbiter to inform the active Master that a higher priority request is pending. The active Master's design determines how long it takes to release the bus when the bus clear signal is driven low. For example, a DMA Master might not be able to relinquish the bus during a disc sector transfer without over-runs or under-runs so it might keep the bus until the sector transfer is finished.

The ac failure signal is driven by the Power Monitor module, and informs the Master that an ac power loss has been detected. The Master is then required to immediately relinquish use of the Data Transfer Bus, since whatever problems it will face in surrendering the bus are insignificant compared to the needs of the total system.

Interrupts

The VMEbus provides three ways that processors in a multi-processing system can interrupt each other:

1. Using interrupt request lines.
2. Using Location Monitors to create "virtual interrupt registers" anywhere in VMEbus memory.
3. Using the VMSbus.

However, we will focus only on the first of these three methods.

Any system which has interrupt capability includes software routines that are invoked by the interrupts, and are thus called interrupt service routines. Each of these routines may be thought of as a task which is activated by an interrupt. The VMEbus specification does not dictate what will happen when these interrupt service routines are activated.

Many widely used peripheral ICs generate interrupt requests. Unfortunately, there is no standard method for indicating to these ICs when it is time for them to remove their interrupt request from the bus. Three methods are used:

1. When the relevant processor senses an interrupt request from a peripheral device, it enters an interrupt service routine, and reads a status register in the device. The peripheral device interprets this read cycle on its status register as a signal to remove its interrupt request.
2. When the relevant processor senses an interrupt request from a peripheral device, it enters an interrupt service routine, and writes to a control register in the device. The peripheral device interprets this write cycle on its status register as a signal to remove its interrupt request.
3. When the relevant processor senses an interrupt request from a peripheral device, it reads a status or identification from the device. The peripheral device interprets this read cycle as a signal to remove its interrupt request.

Fault finding

The VMEbus protocol specifies the behaviour of boards during the power-up process. This facilitates the synchronization of the various system resources prior to starting normal system operation. This is done using the system fail line, which is part of the Utility Bus. It allows the operating system to determine the status of intelligent system resources, such as CPUs and IPCs. These intelligent boards drive the system fail line low when the system reset is activated and maintain it low until they successfully complete their on-board self test. By monitoring the system fail line, the operating system can determine whether any of the boards has failed.

Normal system operation can be resumed after the initial self test process has been completed. If any board in the system detects a failure after this point, it broadcasts this by driving the system fail line low. ●

DIGITAL AUDIO TAPE

Beyond compact disc, what's next in store for the consumer? Rumours have been around for years that the Japanese had a new digital tape format just around the corner. Now it looks like becoming reality.

DIGITAL AUDIO TAPE (DAT) will be released later this year in Japan, during the course of 1987 in the US, and here shortly afterwards. It will have performance equivalent to that of a compact disc, but come in a cassette muck like the ordinary cassettes we all know and love.

The launch of DAT has been, and continues to be, accompanied by a furious bun fight between all the big players in consumer electronics in Japan and Holland. Philips and Sony own the world patents to CD technology. Sony has also been centre stage in development of 8 mm video, which shares many of the features of DAT.

Meanwhile DAT has been standardized by all the big Japanese players. At a meeting in 1983 of 60 Japanese and 20 other companies the technical specifications were sorted out. Some of the major talking points were:

1. the possible applications of DAT in hi-fi, portable components, etc, (format, price, reliability, compatibility etc);
2. the possibility of utilizing a multi-sampling-frequency system that would be compatible with 16-bit quantization (same format as CD), and future digital multiplexing broadcasting;
3. designs that would make the DAT recorders easier to use than present cassette decks — longer recording time, quicker access, etc;
4. the production of pre-recorded tapes;
5. a new cassette design that would be superior to the current compact cassette in compactness, cost, durability and protection against dirt and dust.

It was assumed that the ultimate DAT format would be economical enough to cover initial increases in cost resulting from the newness of digital technology, while at the same time offering extra features for better utility.

Two working groups were formed within the committee, one assigned to studying the feasibility of the R-DAT (rotary-DAT) format and the other to that of S-DAT (stationary-DAT) format. After two years of study, the technical specifications for these two formats were drawn up in June 1985, but based on the opinion that "the feasibility study should be made for just one format," the committee decided to further study the R-DAT format because of its better chance of being implemented in the near future.

DAT, when it becomes a reality, will be capable of delivering sound on a par with digital master tapes, and yet it will be extremely compact. Digital copies will have the same sound quality as the original — there will be no deterioration. So, to discourage consumers from creating digital copies of compact discs, the committee decided to build a copyright protection feature into the format. It will prevent the user from using the 44.1 kHz mode for recording (44.1 kHz being the sampling frequency of CDs), though the mode can be used for playback. It was also agreed that a copy protection feature should be included to prohibit recording of a software program if it contains a copy-protect code. Naturally, the user can digitally copy whatever he records on his DAT recorder, and enjoy quality that's free of any sound deterioration.

Operation modes

To ensure compatibility with a number of digital sources, R-DAT recorders should operate in any of six modes — four for record and play, and two for play only. But of the six, the 48 kHz standard mode and 44.1 kHz play-only modes represent the minimum capability requirements for any R-DAT.

One of the two 44.1 kHz play-only modes is called the *wide track mode*. It's this mode that makes possible high-speed 'contact printing', ie, duplicating tapes at 200 times normal speed. Contact printing transfers the contents of a recorded tape to a blank tape by putting the two tapes back to back and running them through a biased magnetic field. In contact printing, metal or vacuum-evaporated tapes are employed as masters because of their high coercivity, while oxide-based tapes (barium ferrite, chromium dioxide, etc) are used for slaves. During the printing process, there is an inevitable loss in output, but it will be compensated for by the increase in track pitch by 1.5 times. This contact print method should make the mass-production of pre-recorded digital tapes easier and more cost-effective.

There are three 32 kHz optional modes. They are included for possible future applications like PCM digital broadcasts planned in Europe and Japan, extended recording and four-channel sound.

Signal format

In digital processing, signals need not be treated as continuous, and, thanks to the memory, they can be compressed in time domain for recording and playback. With the R-DAT format, recording is made noncontiguously over the 90-degree wrap of a tape on the 30 mm drum head (see Figure 1).

Signals read by the heads over the 90-degree wrap are held in memory where they are processed and errors are corrected before the next signal is picked up by the heads. Compressing signals in time requires a faster relative head-to-tape speed and a higher signal

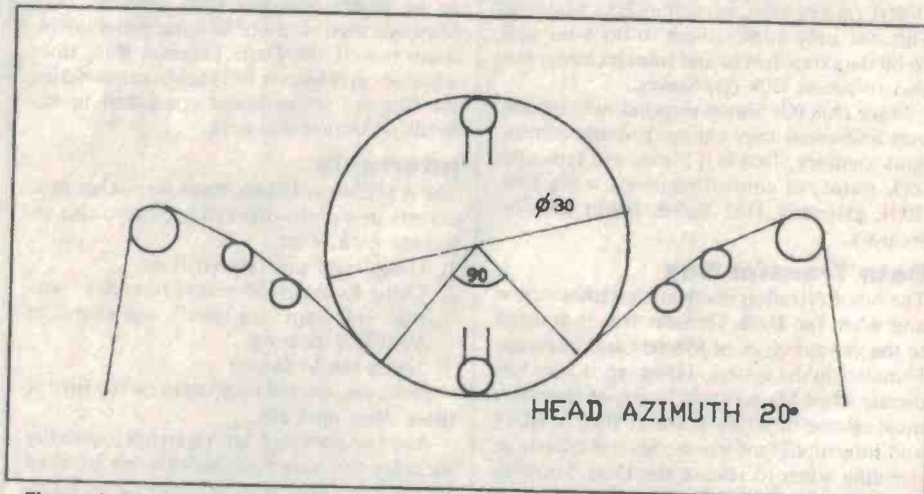


Figure 1. 30 mm 90° tape pass.

processing frequency, but it makes the signal immune from effects of external mechanical disturbances and vibration. Therefore, when the R-DAT is applied in portables or car audio components, it won't require special mechanisms to protect it from external vibration.

Signals on each track are assigned to specific areas (SUB, ATF, PCM) and are independent of one another, making it possible to replace old information in an area with new (see Figure 2). And to make processing easier, signals in each area are divided into blocks of suitable lengths — 196 in all per track — and each block is given an address and parity for checking. During high-speed search, variable-speed playback or other playback operation that involves playing more than two tracks at once, digital signals are identified and shuffled block by block. This makes the R-DAT a format that permits easy error correction, fast access and efficient editing.

The R-DAT employs a powerful double Reed-Solomon code, which can accurately correct errors due to dropouts, damaged tape guides and clogged heads. Moreover, so that the signal can be accurately interpolated even when one of the paired heads is clogged, it's interleaved over two segments of a tape (data dispersion). This feature is unique to the R-DAT format and it improves reliability greatly.

The R-DAT permits a high-speed search, a feature not available on conventional tape recording systems. Since it facilitates search at more than 200 times normal speed, a program 60 minutes long can be scanned in less than 9 seconds on the average. This has been made possible by a slow tape speed (8.15 mm/s), which in turn is made possible by high recording density and by block-formatted signals.

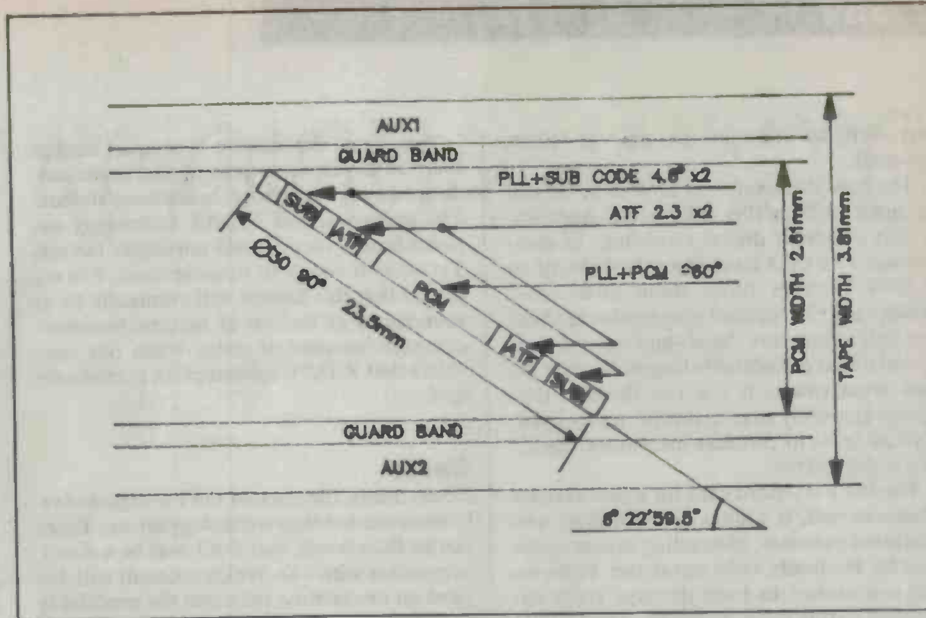


Figure 2. R-DAT track format.

Furthermore, the subcode can contain four times as much information as the subcode on compact discs. This represents a capacity sufficient to output a high-quality still picture every few seconds. The subcode area can also contain times, date, selection number, TOC (table of contents), and other display information. The PCM area for music also contains the ID code that's matched with recorded music, and its capacity is equal to that of compact discs.

Considering its extended recording capabilities, easy-to-use search and access functions, the R-DAT format can be described as being as convenient to use as compact discs.

The tracking system

The tracking system used for R-DAT is the ATF (Automatic Track Following). The system picks up the signals recorded on two adjacent tracks and compares their levels to centre the signal track (See Figure 3). The ARF signals are recorded at the ends of each track so that the heads can follow the track even if it is slightly skewed.

Since the ATF system controls the tape by checking the recorded reference signal, and does not require a stationary track control head, there's a significant improvement in compatibility and mechanical precision. Moreover, when new audio is dubbed on a recorded tape, the new sound is written in by reference to prerecorded tracking signals, so that results should be satisfactory.

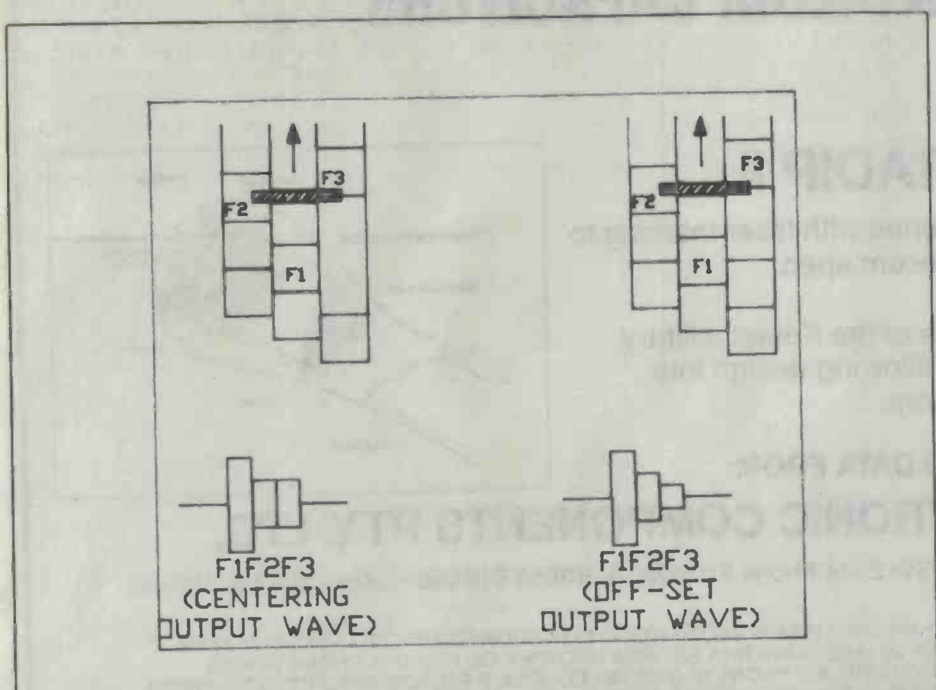


Figure 3. R-DAT tracking system.

Mechanical format

The R-DAT format uses recorder heads and tapes that should have nearly the same specifications as those for 8 mm video. It also uses no-guard, slant-azimuth scanning, the reason high-density recording is possible. As a result, it's possible to record two hours of music on a DAT (13 μm thick) that is equivalent to a C-90 tape (12 μm thick). Tape consumption per hour is only about one-third that of compact cassettes, and this means not only economy but also quicker access time. Of course, use of thinner 10 μm tapes — the equivalent of C-120 tapes 9 μm thick — or higher-performance vacuum-evaporated tapes will make still longer recording possible.

The R-DAT format employs a narrow 3.81 mm wide tape, a relatively small 90-degree wrap on the 30 mm head and two record/play heads, all to allow such features as quick search. Another reason for the 90-degree wrap is that it permits adding two more heads for monitoring, yet only one head is in contact with the drum at any time to reduce crosstalk.

The head diameter is set at 30 mm, but can be made still smaller because of noncontiguous nature of digital recording. In comparison with the 8 mm video, the drum of an R-DAT recorder turns about three times slower, and the required tape tension is about one half. Therefore, heads and tapes are expected to last considerably longer. Because the tape is narrower, it can run through tape guides smoothly over a shorter travel span. This all leads to compact mechanical design and quick search.

The DAT standard calls for a new cassette design as well. It's more enclosed than conventional cassettes, concealing access openings for the heads when not in use. Hubs inside are braked to keep the tape from unwinding during rough handling. The cassette has a solid lock which cannot be easily opened, to protect the tape inside. This much attention to tape protection is a necessity because high-density recordings can easily succumb to dropouts due to even slight amounts of dirt, dust or fingerprints. The cassette, though, is so enclosed, you can carry it in your pocket without worrying about possible damage.

The size of the cassette is compact enough that you can expect to enjoy digital sound outdoors as you do now on headphone stereos. The success of this R-DAT technology depends heavily on price and popularity factors. Yet when it comes to running costs, it is expected that this format will eventually be as economical as the use of high-performance compact cassettes of today when one considers that R-DAT consumption is relatively low.

Costs

Nevertheless, the price of DAT is expected to be more market than technology driven. There can be little doubt that DAT will be a direct competitor with CD. Which succeeds will depend on two factors: price and the availability of software.

After a number of years the availability of CDs is increasing dramatically. In fact, Japanese consumption has now reached more than 10 million a month, more in dollar value than production of vinyl, although the absolute number of records still outstrips CDs. On the other hand, no plans have apparently yet been announced to begin manufacture of prerecorded DAT tapes. If CD production facilities continue to grow at the present rate it will provide a moving target DAT will be hard pessed to hit. To make matters worse for DAT, this increase in supply must have the effect of driving CD prices down. It would take a major effort on the part of manufacturers to stop the trend and favour DAT.

Likewise, it would appear the price of the players will work against DAT. Just as the price of CD players is starting to ramp down sharply, manufacturers will be putting DAT on the market, and we may expect prices around $500-$1000 as they try to recover R and D costs in the first few years.

On the other hand, it might be necessary for manufacturers to prevent the price of CDs dropping too much in order to provide a viable market for DAT. This is quite on the cards because the same player, Sony figures so prominently in both camps. Philips is interested primarily in CD, and most other Japanese manufacturers in DAT. This means that while the supply of CDs can be controlled quite tightly by its two main manufacturers, the supply of DAT, essentially wide open to anyone, could be a lot more difficult to halt.

Whatever happens, the politics of DAT will afford interesting watching in the months ahead.

REPORTS ON MONTREAL

Arthur Cushen

Our SW correspondent, Arthur Cushen, makes waves around the world by other means than radio. Last July he was guest of honour at a broadcaster's convention in Montreal where he received some enthusiastic accolades.

THE 21st CONVENTION of the Association of North American Radio Clubs, hosted by Radio Canada International, was held in Montreal last July. The convention was a forum for broadcasters , frequency managers, monitors and shortwave listeners from all continents except Africa.

Seminars were held on frequency management, jamming, the ANARC Woodpecker project, computer bulletin boards and problems faced by newcomers to SW. Other seminars discussed the results of the ITU Region 2 mediumwave broadcasting conference and previewed the World Administrative Radio Conference scheduled for 1987. On a lighter note were the forums where audiences quizzed broadcasters on various aspects of transmission.

Radio France International put several news items to listeners worth reporting. It disclosed that it had cancelled a contract with Radio Beijing to broadcast English programs to North America from French Guiana and reported the corresponding cancellation of relays of RFI programs by Radio Beijing. The RFI official indicated that RFI was looking at India, Australia and Japan as possible areas from which the programs might be relayed while transmitters are being constructed at the new relay base in Sri Lanka.

Another point of interest at the convention was the proposed extension in the Americas of the mediumwave band from 1600 to 1700 kHz. Broadcasters were interested to know what listeners thought should be allocated to the extra frequencies, and how the channel could be made available in various countries. Although this is five years off, it will widen the frequency range of reception and increase the target audiences of many stations.

The convention brought together secretaries of the three radio umbrella organizations: Michael Murray, Secretary General of the European DX Council, Terry Colgan, Secretary of the Association of North American Radio Clubs, and myself as Secretary of the South Pacific Association of Radio Clubs, for discussion of the hobby on a global scale! I also had a chance to talk to Radio Canada's frequency management section about RCA's future broadcast plans, and about my work as its technical monitor since 1946. In the 1960s Radio Canada used the same two frequencies for 14 years with excellent results.

Of particular interest to me was a meeting with Jeanne Ferrell of Gilfer Shortwave, the North American agents of my book *The World in my Ears* — a substantial number of which were sold and autographed on the spot! I was very flattered that so many people had come to meet the author in person. Another literary element was there in the forms of Jens Frost, Editor in Chief, and Andy Sennitt, Assistant Editor, of *The World Radio and Television Handbook*. They were over from Copenhagen, celebrating the 40th anniversary of the book.

Expo '86

The convention was held at the Holiday Inn, a 40-storey building in Montreal. The exhibition halls on the sixth floor housed displays from the BBC, Radio Canada, Voice of America, Radio France International, Deutsche Welle, Voice of Free China, the International Red Cross and more. Radio Australia and Radio New Zealand as well as many North American radio clubs were represented along with the usual trade exhibits from radio manufacturers, booksellers and promoters.

Tributes

The high point of the convention for my wife and me came after the Saturday evening banquet when I received a number of awards. These included one from Radio Sweden for my involvement with "Sweden Calling DXers" since its beginning in 1948 and another from Radio Nederland for 20 years of continuous broadcasting on "Media Network" and its forerunner "DX Jukebox".

At a special function on the Saturday morning the Canadian Broadcasting Corporation presented me with the first stamp commemorating 50 years of the CBC. The stamp was not officially released until the following Wednesday.

Apart from this while in the US and Canada, I participated in programs for HCJB, Radio Nederland, Radio Canada, Radio Japan and Radio Australia.

Other meetings

Other SW forums held in North America around the same time attracted large attendances. A meeting of the Michigan Area Radio Enthusiasts in Detroit drew around 80 listeners from various parts of Ohio and Michigan. At this meeting Michael Murray and I discussed the work of EDXC and the South Pacific Association of Radio Clubs. At a meeting of the American Shortwave Listeners Club at Huntington Beach, California, I spoke along with Ian McFarland of Radio Canada whom I also accompanied in a guest spot on the Ray Briem Talkback program on ABC radio. The show was a great success and was extended from two to three hours as calls were received from across the US as well as Honolulu. The program originates from KABC, Los Angeles and is carried by ABC affiliate stations from New York to Honolulu. ●

Voicetracker

Fairlight's latest product, the Voicetracker, represents a new departure for the company best known for inventing sound sampling, and opens up new musical possibilities for many working musicians.

The Voicetracker is essentially a pitch-to-MIDI converter – but an extraordinarily fast and accurate one, with a number of special features which make it almost a new kind of instrument.

The Voicetracker can track any monophonic input, and instantly analyse the pitch to drive a MIDI or analogue synth. It can also extract the amplitude and timbre detail from the incoming sound, and these qualities can be superimposed on the synthesiser's voice. In other words, it has the ability to produce synthesized sounds without playing a keyboard.

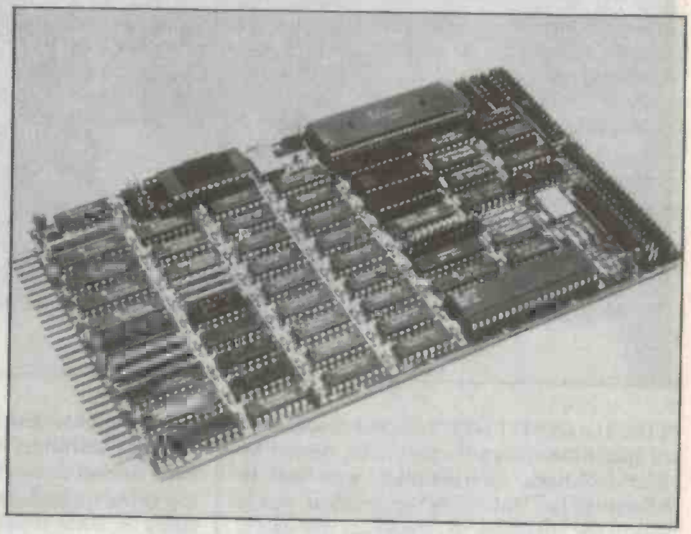
A video output allows the user to view the pitch and other details of the source on a screen while performing – providing instant visual feedback. A programmable internal synth also provides an audible point of reference for those who are using the Voicetracker for voice training or putting down a part to a MIDI sequencer by singing or whistling.

A number of presets enables the user to save the best configurations of the Voicetracker for use with any particular synthesizer or source sound. It can also perform intelligent harmonies on a single note in any musical key. For each single note sung or played into the Voicetracker, it can instruct a synth to produce up to seven extra notes harmonised to the original. Six harmony set-ups and their musical key signature can be held in the Voicetracker's memory as presets.

The Voicetracker offers a new method of composing and performing to many musicians who have previously not experimented with synthesizers, or who simply wish to play them in a way not dictated by a keyboard-playing style.

The Voicetracker costs $2750 (tax exempt) from **Fairlight Instruments, 15 Boundary Street, Rushcutters Bay NSW 2011. Phone (02) 331-6333 (Sydney), (03) 20-4300 (Melbourne).**

Single board computer



Microtrix of Melbourne has released a new high performance single board computer intended for data processing, acquisition and process control.

Based on the HD64180 the new high integration processor from Hitachi, the MicroMaster will run all current CP/M and Z80 software but with greater speed and efficiency.

It is STD bus compatible, with up to 512K of RAM on-board, two RS232 serial ports, a Centronics printer port, a floppy disk controller, and a full STD bus implementation. The floppy disk interface is totally adjustment-free for maximum reliability, providing support for all standard floppy disk sizes and formats. Any memory not used for the operating system is implemented as a RAM disk.

Other features include two DMA channels, a memory management unit, 12 source interrupt controller, and two 16-bit counter/timers. While software compatible with the Z80, the HD64180 executes most instructions in less time and provides several additional instructions, such as hardware multiply.

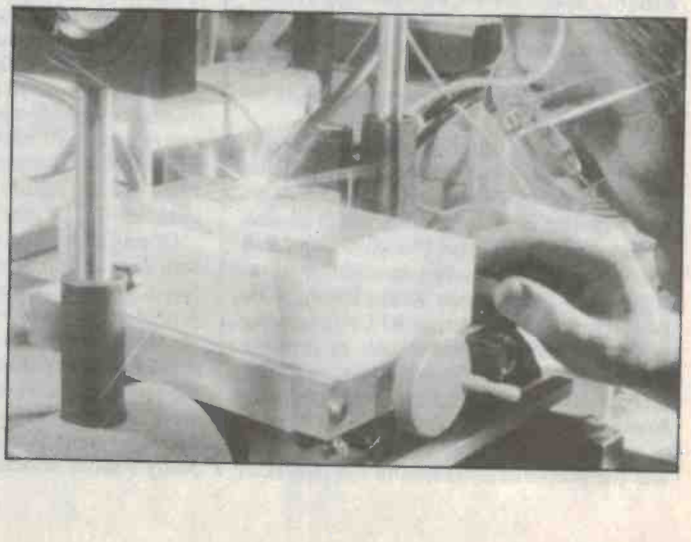
For single user processing applications, an enhanced CP/M-like operating system is available. Called Z-System, it will run all CP/M application programs, but provides many additional facilities and utilities with features similar to MS-DOS and UNIX. TurboDOS will be available for multi-user situations.

A full STD bus implementation ensures that the MicroMaster can be expanded into a professional multi-processor system with hard disks. In a process control or data acquisition environment, specialized cards can be purchased from other sources for use with the MicroMaster.

Microtrix says it is fully supported with development software such as assemblers, debuggers and operating systems. A full 12 months warranty is offered. Several supporting cards are already in development.

For more information please contact **Microtrix** on **(03) 439-5155.**

Soldering by laser



Combining the technologies of robotics and lasers, scientists are building a new soldering workstation capable of assembling circuits automatically, using surface mount technology.

Laser soldering is said to offer the advantages of speed, flexibility and precision; joints are said to be less brittle and more resistant to fatigue failures than those made by conventional methods.

A further advantage of using lasers for soldering is the ability of the laser to perform its function on exactly the area to be processed and, with the radiation and exposure being accurately controlled, only the precise amount of heat necessary for the bond need be used.

The new system incorporates a compact infrared laser based on research into radiofrequency gas discharges, and the total project results from a two-year collaborative program between Laser Applications Ltd, Quantel Ltd, Cambridge Interconnection Technology and Hull University's own company, Hull Unico Ltd.

Audio from Pioneer

Pioneer Electronics continues its quest for market domination by multiplying models faster than befuddled consumers can blink. This month the company has released news of four new products in the audio area.

Most interesting of all, the penetration of CD into the car sound industry is emphasized by a combination tuner CD unit. It's called the DEX 7715, and comes with some limited programability for the CD, like last track replay and disc replay functions. The radio has scan, 24 station preset and last station memory functions.

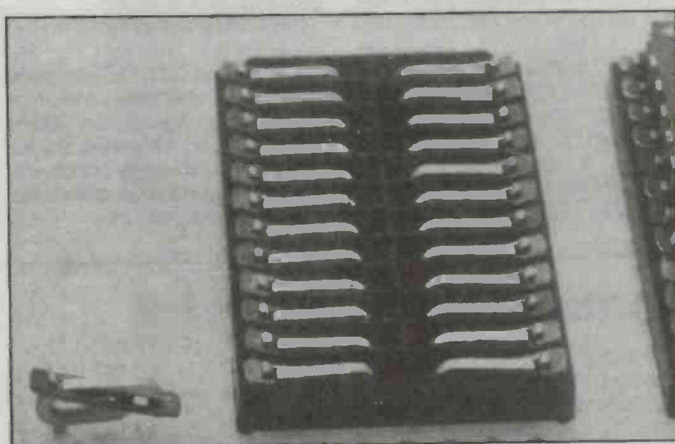
The performance of CD is so good that it's starting to give the marketing people something of a headache. When all products are equally good, how do you make yours stand out from the crowd? Pioneer is trying to sell its new PD 5030 hi-fi CD with the claim that it has "zero resonance". Of more interest, it's selling price is $599.

Pioneer also has two new car cassette decks out. These are the KPX 440 and 220. The 440 is a top end model, featuring full logic control and a processor controlled front panel. The 220 is somewhat cheaper, but still manages auto reverse, metal tape selection and music search.

A new tuner has also been released called the GEX 550. It also features a processor controlled front panel with all the usual remote functions on it.

Pioneer is beginning to offer theft protection on some of its items. The 7715 now uses a security code, which needs to be entered every time the power is disconnected from the unit. Another strategy to deter thieves is also used on the 7715. This involves splitting up the unit, so that one box is in the boot, another under the seat and so on. Only the control panel is on the dashboard. It takes longer to install, but it makes taking it out a nightmare.

Memories are made of this



Shaped memory alloy (SMA) has been around for quite a while. Now it's been applied to some electronic products developed by Raychem, and marketed here by Memorytech. The devices include chip carriers and surface mount components.

SMA is a metal, usually nickel and titanium, that can have two shapes depending on its temperature. For instance, a wire can be straight below 50°C, and become curved in some intricate shape above it. It is not subject to metal fatigue in the same manner as a bimetal strip or metal is required to move.

A number of electronic products have been designed using the unique properties of SMA. For instance, a zero insertion force pin grid array socket has been designed by Raychem. This consists of two layers of contacts formed by holes. At normal operating temperature these holes are slightly offset, and so nothing can be inserted into them. When cooled below a certain temperature, a bar of SMA moves, pulling one of the layers across so all the holes line up. A component can now be dropped in without applying any force at all. When the temperature comes back up to ambient, the layer tries to move back, but is prevented by the inserted pins. In this way it is possible to apply many times the normal force to the chip, while still preserving the advantages of zero insertion force.

Another application of SMA is in DIL sockets, where the sockets that receive the chip pins are themselves made of SMA. At normal temperature they are configured so that they grip the pins tightly. Cold they open up, once again providing true zero insertion force.

For more information about these and other SMA products contact **Frank Fitzgerald** on **(02) 639-6720.**

Virtual FAX

These days, $2500 will get you a sleek new Group 3 facsimile machine from any of half a dozen suppliers. Priced at less than one-quarter of what comparable equipment was selling for five years ago, some of the new machines will transmit a page-worth of electronic mail across the country in 15 seconds or less. Increasingly, however, FAX suppliers are being pressed by suppliers of virtual FAX-peripherals for PCs that can replace the FAX machine.

In the US, more than 30 suppliers are now offering scanners or cameras for personal computers, able to scan and digitize an image of a document, and transmit it to a remote destination. These scanners range in price from $200 to $15,000, depending upon resolution, features and capability.

The potential competition from low-cost PC scanners first began to worry the FAX vendors three years ago, but now it's having its first real market impact. The market worldwide has been growing rapidly during the past three years, but most US and European manufacturers have long been driven out of the business by aggressive Japanese pricing. However, it's the US manufacturers who are currently making the running in the PC scanner field.

One disadvantage of virtual FAX is that the user may have to go through a number of cumbersome steps in order to explain to his PC exactly where the image is to be sent, then explain to the PC at the receiving-end exactly how to print it out. There's a real shortage of software for virtual fax. Most commentators agree the whole thing works easiest with scanners that were designed with virtual fax in mind, rather than CAD/CAM, OCR, or other image-processing applications.

Three new chips from Total

Standard Microsystems Corporation has announced three new ICs through its Australian agents, Total Electronics. They are a universal disk data separator, a floppy controller and a controller for the IBM 3274/36 product attach protocol.

The universal disk controller is the HDC9227. It combines, in one package, all the digital functions necessary to control a hard disk data separator, plus a high resolution floppy disk data separator. According to SMC the 9227 is unique in providing data separation for the Winchester type disks and all three IBM-compatible floppy sizes.

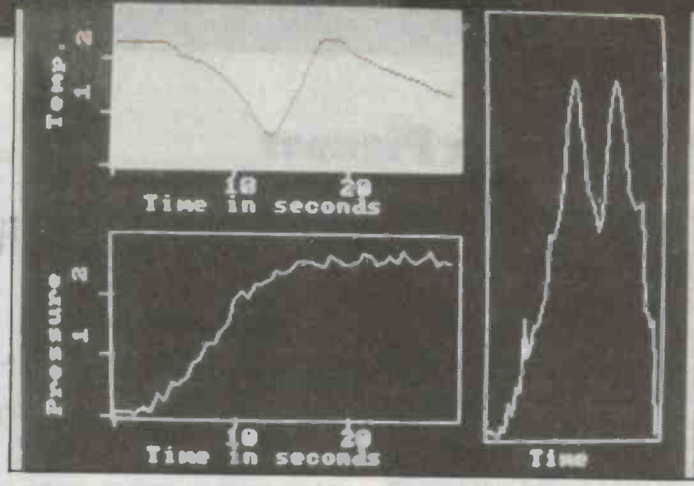
The 9227 is designed as part of the HDC 9224 universal disk controller family.

The new floppy disk controller is a version of the FDC 9266 with plastic J leads for use in surface mount boards. It's a combination of the 765A controller and the 9229 interface chip in one 44-pin PLCC package. It thus gives a controller, some precompendation logic and a patented digital data separator in one package.

The final chip is the COM 9064, a high performance VLSI controller for the IBM 3274/36. According to Total, it's the only chip on the market to implement the 3270 coax type A protocol. The list of peripheral equipment on the market that already uses this protocol includes terminals, printers, plotters I/O devices, protocol converters, LANs and so on.

Of particular interest is the fact that the type A protocol is being used for micro to mainframe links. The potential market here is enormous. According to recent market surveys, the number of people who have micros and would like to be able to gain access to large data bases is growing all the time.

The COM9064 establishes the physical link between the IBM 3274/76 and up to 32 separate peripheral devices. The half duplex communication takes place at 2.35 MHz over RG 62 coax. Handshaking, frame format, parity and error detection are all taken care of.



Data acquisition into Lotus 1-2-3

Laboratory Technologies Corp's Labtech Real Time Access, a software package that allows Microsoft MS-DOS applications programs to display access and analyze real time data has just been released by Novatech.

The software is the first data acquisition package we have heard of that directly plugs real time data into Lotus Development Corp's 1-2-3. There are similar products, however, they generally require custom applications for data analysis.

Real Time Access works as an option to the Labtech Notebook, which is a personal computer-based data acquisition package. Previously, Labtech Notebook could collect the data, but to move it into another package required putting the data on disk and then bringing it into the other package. Real Time Access eliminates the disk and moves data in the other package directly through memory. It turns out to be 10,000 times faster to transfer data to a Lotus spreadsheet.

Labtech Notebook is available from stock at $1,200. For further details contact Novatech Controls (03) 645-2377 or (02) 758-1122.

Controlling the fleets

Computer devices to control the movement of vehicle fleets are all the rage at the moment. In Victoria, Sepac Industries has developed the S140 Fleet Monitor. In Perth, the Beaver Corporation has also been busy.

The S140 is a single desktop unit that enables a base radio operator to identify incoming calls when the mobile radio is fitted with an inexpensive identification encoder. When fitted in parallel with a selective calling system, identification of incoming calls is enabled without the need for complete hardware changes at base or in the mobile.

Meanwhile, the West Australian based Beaver Corporation has developed a "Digital Diary" that has been invented to log the movement of motor vehicles. The Beaver Corporation has hung its publicity on the fringe benefit tax, which requires documentation on car movements for accounting purposes.

According to the publicity, at the touch of a single button the Digital Diary will automatically record date, time, odometer reading, distance travelled and so on. This information can then be printed out in the form of a standard document for use by the accounts department.

For more information about the Digital Diary contact **Beaver** on **(07) 361-7766.** The S140 is available from **Sepac Industries** on **(03) 785-1818.**

BRIEFS

Benmar
A range of Alpha microwave devices is now available in surface mounted packages. It includes pin diodes, low noise mixers and detection diodes, varactors and capacitors with operations between 50 MHz and 3 GHz.

Decoupling
MicroQ decoupling capacitors, which are designed to sit under ICs, are now available in configurations to suit Z80s, Z8002, the 80286 in a 68-lead PGA and the 68020 in a 114 lead PGA. Phone Fred Hoe and Co (07) 277-4311.

Photomultiplier catalogue
ETP Oxford now has a catalogue of photomultiplier tubes available from Thorn EMI. Phone (02) 858-5122 or (03) 347-0733.

NEC claims
NEC publicity is now claiming the uPD77239 is the fastest digital signal processor alive. The CMOS chip races through 32-bit full floating point arithmetic at 13.4 MFlops. Contact your local NEC shop for the good oil.

Audiophile connectors
Leisure Imports has released a new range of RCA connectors from Tiffany in the UK. They use a special Teflon dielectric and hard gold micron plating. Also on sale at Leisure Imports is QED's "passive preamp", designed to take high level signals from a CD player and feed them directly to a power amp via a volume control. Phone Leisure Imports on (02) 908-3944.

Keyboards
MEI is beginning production of the model T15 low profile full travel keyboard switches. They use a patented low bounce, sealed silver contact. For further information contact C and K on (02) 635-0799.

Soldering iron
Altronics has released a temperature controlled, temperature selecting soldering iron. The Micron Soldering Station is available through Altronics in Perth and Altronics resellers throughout Australia.

Jaycar connectors
Commodore enthusiasts can take heart from the new supply of a hard edge connector now stocked by Jaycar Electronics. This low priced connector fits onto the expansion port of Commodore computers.

Disk-ount offer
Rod Irving Electronics has reduced the price of its popular Microdot disks which should encourage further sales.

Dindima
Force Computers has a new RAM/ROM board called the SYS68K configured for 32-bit words. It holds a maximum of 16JDEC devices and comes with VMEbus and VMXbus interfacing. Contact Dindima at PO Box 166, Vermont Vic 3133.

Philips effects
Philips has launched a set of 28 CDs which together form a sound effects library with more than 3000 effects. A catalogue is available as a book or on disc.

National
A VAX 8600/8650 compatible memory board with 16M on board has just been released. It's called the NS865-16. Phone National on (02) 887-4455.

Brain for traffic lights

A traffic lights system that uses video cameras to count oncoming vehicles and measure their speed has been developed by scientific teams at two universities in northern England.

TRIP – traffic research and image processing – is designed to improve traffic flows by synchronizing lights to match the volume and speed of vehicles approaching a junction.

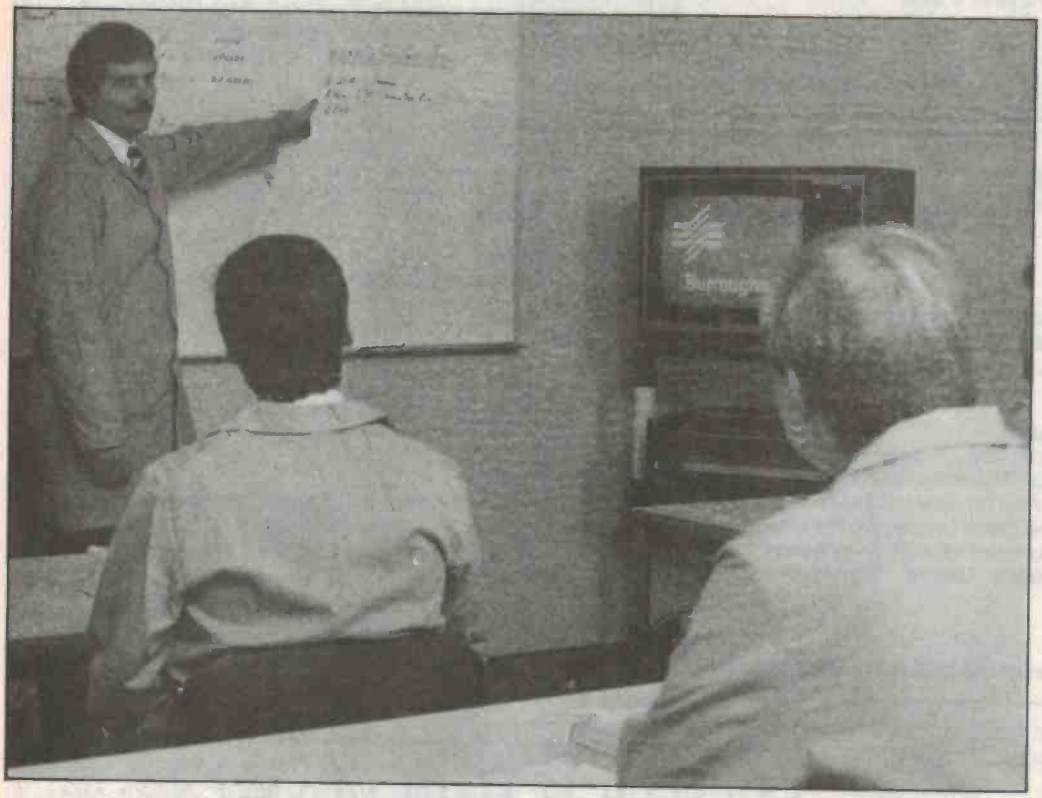
It is the result of three years of investigation by specialists at the University of Manchester Institute of Science and Technology (UMIST) and Sheffield University.

The system automatically 'captures' information from road traffic. Vehicles are counted accurately and their speeds measured as they approach junctions.

The project, which has been backed by a 200,000 pound grant by Britain's Transport and Road Research Laboratory, comes just over a century after the first gas-powered traffic lights were introduced.

The scientists are now seeking commercial backing.

Remote monitor



An Australian-developed system that enables engineers to monitor mainframe computers from a distance is being hailed as one of Burrough's latest technological breakthroughs.

It's called the Remote Performance Monitor and Burroughs now has it in service in the UK, USA and most countries worldwide.

Should a mainframe register a malfunction, details are immediately displayed on terminals, sometimes located hundreds of kilometres away.

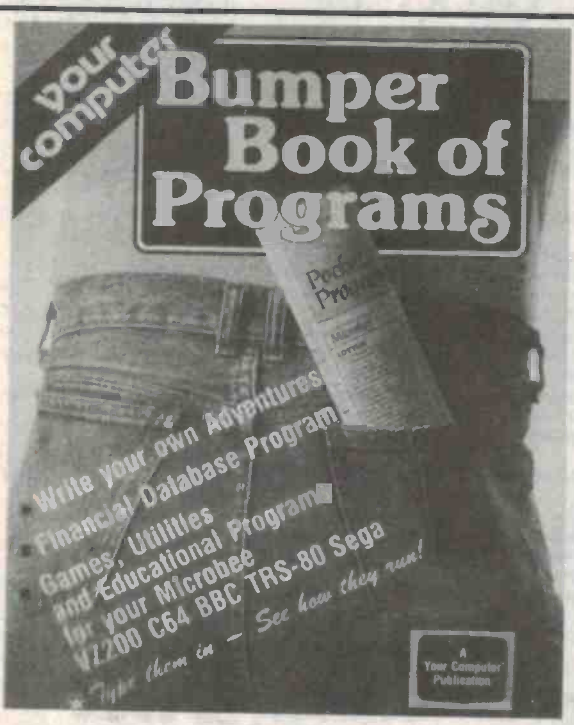
The service supervisor can interrogate the system as to the locations of all available field engineers who can be called via a pocket pager which is linked to the system.

While he is sending the message to the field engineer, he can also send one to the customers' data processing manager who is also equipped with a pocket pager connected to the system.

Another facility allows the engineer, via his terminal, to search the sites' parts inventory list and confirm the availability of a spare part on site.

To assist engineers in determining the fault, they can search the database of Burrough's colleagues in the UK, US and Asia to determine whether any similar types of fault have been detected. In addition the engineer can call up, on his terminal, other engineers from around Australia and internationally. Without leaving their desks they can examine and discuss the RPM data.

The network is connected throughout Australia via dedicated Telecom DDN land lines.



New school software

IBM Australia has signed a contract with Prologic of Melbourne to acquire the exclusive marketing rights of seven educational software packages designed to run on the IBM-JK personal computer.

The seven products are Geological History; Geologists at Work; What Chemical Is That?; Gapmaker ... Gaptaker; Working with Words; Woodland Foodwebs; and Designing an Energy Efficient House.

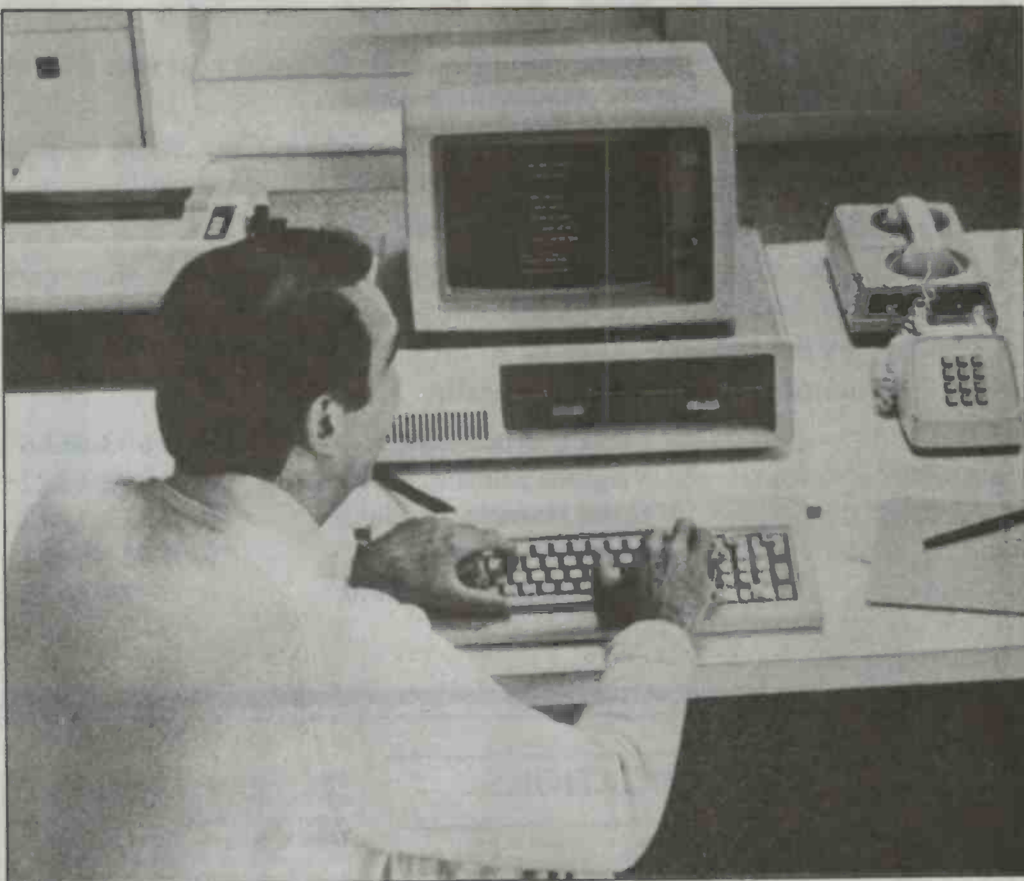
The packages are being released through IBM's Software Development Support Centre which assists local software manufacturers with the development of their products.

Prologic Marketing Director, John Cooper, said the seven software packages differed from comparable overseas products because they used data based on Australian conditions.

"Several Victorian teachers were seconded to Prologic for periods ranging from one to two years," Mr Cooper said. "These teachers assisted in the design of the programs to specifically suit Australian primary and secondary school curriculums.

"These secondments were part of an agreement between Prologic and the Victorian Department of Education. Due to the nature of the agreement with the Department, the contribution of the design skills of these teachers and the technology developed by Prologic ensures that the educational software produced is of the highest quality and curriculum relevance."

Boom market for add-on memory



Impending changes in the IBM product line will bring about an explosion in demand for both internal and external add-on memory. This is the conclusion of a study just completed by International Resource Development, a US-based market research firm. In the report, IRD attributes this growth in demand to the popularity of protected-mode computing using still to be introduced PC-DOS Version 5.0. Protected-mode computing, which is available but rarely used in today's PC AT, will under the new PC-DOS release have a theoretical limit of 16 Mb of RAM, up from the 640 Kb limit of today's PC XTs and real-mode PC ATs. It is entirely possible, however, that basic IBM offerings will in the future still be equipped with only 640 Kb basic RAM. This will create a major opportunity for vendors of add-on memory who wish to fill in the gap between the 640 Kb basic RAM and the 16 Mb theoretical limit.

The report notes that the popularization of protected-mode computing is not the only change that is in the winds. The 80386 chip, when introduced, will also greatly increase RAM over today's 8088- and 80286-based offerings. "Here," says IRD's Ken Bosomworth, "Big Blue may equip its basic offerings with more than 640 Kb RAM – maybe up to 2 Mb of RAM instead. However, this will still leave a 14 Mb gap for internal add-on memory vendors to fill." By 1996, according to the study, sales of expanded and protected-mode add-on memory boards will reach almost $3.5 billion.

The new, more powerful IBM offerings will have other consequences too. The add-on market for floppy disk drives will suffer, despite the recent introduction of high-capacity floppy drives. This is because with so much RAM, many users, especially those working in networks, will substitute that RAM for second floppy disk drives.

Simultaneously, demand for high-storage external memory offerings will rise, in response to the new applications made possible by the more powerful generation of 80386 and protected-mode computers – multitasking, graphics-based computing, and so on. By 1996, according to the study, there will be a $6.4 billion market for hard disk drives, of which $2 billion will be for add-on boards, while there will be an additional $1.6 billion market for optical disk drives.

Indeed, the new high-powered generation of personal computing will, in addition to being more shared (networked) and less 'personal', transform virtually all peripheral and add-on board markets. Windowing and the need for colour capabilities will change the requirements for display devices. Input peripherals will be affected by the demand for automated data entry devices, a demand that will arise out of the genuine viability, at long last, of the so-called 'electronic filing cabinet.' Demand for graphic adapter boards is predicted to soar in response to the advent of graphics-based computing. IRD's Bosomworth says, "We are at the threshold of an entirely new world of computing. Indeed, change in the PC world is coming almost too fast. It is unclear if end users can keep up with the rate of change. Three years ago, people finally got around to learning 'Wordstar'. Then, a year or two ago, they learned how to use '1-2-3'. Is it reasonable to expect them now to discard their hard-earned, albeit modest knowledge, and to trade in their basic PCs and PC XTs, for the brave new world of next-generation computing? When the smoke clears, the main challenge, not only for PC peripheral and add-on board vendors, but for IBM too, is to get users to keep buying tickets for the high-tech PC carousel."

Roland to manufacture

Roland is speeding up feasibility studies into the local manufacture of computer monitors and plotters following the continuing fall in the Australian dollar.

The existence of the study was revealed at the opening of Roland's new $1.3m office/warehouse complex in Dee Why West, NSW, by the President of Roland Corporation Japan, Mr Ikutaro Kakehashi.

According to the Managing Director of Roland Australia, John Egan, the new 2000 square metre building was planned to enable manufacturing to be carried out on-site, and he alluded to discussions between Australia and Japan on a technology transfer agreement.

In Australia Roland has only 33% equity, with the balance held by local interests and staff. Roland in Japan currently employs 15% of its resources in research and development. However, it is unlikely that any R&D will be done in Australia.

DESIGN WITH IMPACT

Leading laser printer company seeks Design Engineers

Impact Systems Limited, Australia's only laser printer manufacturer, requires a number of engineering graduates to join its team of design and development engineers.

The design activities of the company involve a diverse range of computer printer technology. The focus, however, has been on the development of laser printer technology culminating in the Laser 800 series.

This laser printer series has received recognition both through favourable reports in Australia, and through its considerable export program. It is now the Australian market leader in eight page per minute desktop laser printers.

Impact's ability to provide extensive interfacing to a wide range of host computer systems has led to the development of specialised models including the IBM System 34/36/38 and 3274/3276 compatible printers and the Wang compatible front end interface. This is in addition to the full standard range of laser printers which emulate Diablo, Epson, Qume, HP, and lineprinters.

Software development for all these printers is in 'C' and some 68000 assembler.

THE QUALITIES WE ARE SEEKING

We require a number of bright, enthusiastic graduates to join the Impact team, who have preferably had experience in microprocessor design or may feel they have some aptitude for this area of electronics design.

Impact's offices are located in attractive surroundings in Chatswood, Sydney and the company offers a rewarding remuneration package to those well suited to the job.

If you would like to discuss your future career with Impact, please don't hesitate to call David Johnstone (02) 406 6611 or write to:

Impact Systems Limited
7 Gibbes Street,
Chatswood, N.S.W. 2067.
Telex: AA 176123
Facsimile: (02) 406 6218.

IMPACT

TECHNICAL EXCELLENCE FROM DOWNUNDER

TINY POWER — the new TI-74

Jon Fairall

At last, a new BASIC programmable calculator from TI, the people who introduced the idea of the scientific calculator. It's lovely to use, but not without its share of problems.

LET ME SAY at the outset that Texas Instruments' new calculator, the all singing, all dancing TI-74 is a great little beast. In fact, I would go so far as to say that if you want a device to teach yourself how to program, or want something to do straightforward mathematical manipulations of the type you encounter at school or in most university courses, then you could spend your money a lot less wisely than giving it to the nice people at TI.

Physically, it's a good looking device, all in heavy duty black plastic with a multi-coloured keyboard and an LED display across the top. A module slides into the top right hand side for memory expansion and there is a small port around the back for peripherals. There is a rotary pot concealed on the side to change the angle of the liquid crystal display for optimum readability. It lives in a robust looking plastic case which protects it from the vicissitudes of life, and covers all the ports and adjustments.

So, what does it do and how does it do it?

The functions

There are two fundamental modes of operation, toggled by a single keystroke. These are BASIC and CALC. When the machine wakes up, it will be in the mode it was in when last used. Pressing the MODE button will change it.

The keyboard operates differently depending on the mode. In CALC, white numbers on the keypad to the right and blue operations on the alpha keys to the left are addressed. In addition natural inverse functions of the operations can be called by using the INV key beforehand. So x^2 becomes root x, sin becomes arc sin, log x becomes 10^x and so on.

In addition, the TI-74 has some heavy-duty statistic functions for use when in the CALC mode. All the old favourites like standard deviation and variance, mean, sum and sum of squares are available by pushing the yellow STAT key, and then looking for yellow operators.

If you then toggle the mode switch, the TI-74 goes into BASIC mode. The numbers on the keypad are still relevant, but the alpha keys change their meanings. The white letters on each key are operational, and it turns into a full QWERTY keyboard. One of the great pleasures of doing this review was discovering that I can actually touch type on such a tiny keyboard. Of course, I'm only a two-finger typist, so professionals will just have to watch me fly.

Most of the alpha keys have a secondary function, accessed by the FN (function) key. These are all colour-coded in a rather unfortunate shade of grey. For the most part they are BASIC commands that can be accessed by a single keystroke. Along the second row, for instance, we get FOR, TO, NEXT, IF, THEN, ELSE and so on.

A third function is found by operating the shift key. This gives the upper case letters, plus, in a small number of cases, operations lettered in white above the keys.

The result of all this is that one key can have up to four different meanings, depending on the mode of operation and previous keystrokes. This sounds complex, but in fact quickly becomes instinctive, mainly because of the colour coding.

The CALC mode turns the TI-74 into a high quality scientific calculator. There are nine memories, with facilities for storing, recalling and adding to memory. That's not many by modern standards, but TI probably figured that any application where you need more would be a BASIC rather than a CALC exercise anyway. An EXC key allows an exchange between a memory and the display.

One facility I particularly liked was the polar-to-rectangular conversion. This starts by using a two value entry mechanism. It works like this: enter **3**, then the (x,y) button, and the display shows **3,?**. Enter 4 and the display shows 3,4. Now press inv P/R to get a rectangular-to-polar conversion and the display shows r = 5. Pressing the x<>y button makes it display θ = 53.13 etc. In fact the x<>y button will then allow you to toggle between the argument and the angle indefinitely.

One thing I did not like about the CALC mode was the algebraic operating system, called AOS (an unnecessary mnemonic which proves that TI has been doing too much work for NASA lately). AOS is an attempt to implement the hierarchy of mathematical operations, so that 2 x 3 + 4 = 10, not 14. It works by delaying lower priority operations until higher priority operations are completed.

So, if you multiply 2 and 3 then press the add button, it will carry out the operation before you enter the next number to be added. However, if you add 2 and 3, it will hold both in separate registers and multiply the next number by the 3 in the display. Then it will add 2 to it, to provide the correct answer of 11.

This is all very fine, but I suspect that if you relied on AOS you could quickly wind up in strife. It's not very difficult to find equations that will defeat AOS if you enter them

as read: 2 + 4/3 = 3.333, not 2. Of course, if you enter what you mean: (2 + 4)/3, AOS works fine. The point is, AOS is not a substitute for thinking; but it's sufficiently good to fool you. Beware.

If I have reservations about AOS, however, they are as nothing compared to my horror at discovering that while the TI-74 has a perfectly standard scientific notation, it has no engineering notation at all, ie, it will display a number in the form 0.123 or 1.23×10^{-1}, but never in the form an electronics engineer wants it: 123×10^{-3}. This is a major oversight for anyone wanting to deal in millis and micros, picos and nanos.

On a more pleasant note, the BASIC mode of the 74 reveals a bog standard BASIC. It's fun to make it jump through hoops, and it turns out that 8K is quite sufficient for most of the problem solving programs that are likely to be written for a machine like this.

Learning to use the machine, I wrote a little program to calculate the determinant of a matrix of arbitary size up to about 10. The problem has stayed with me since first year university maths, when I tried to fit a similar program into the 512 lines of my Casio 602P. On the TI it turned out to be a relatively trivial exercise. On the Casio, I remember it as being impossible (and wasting 15 minutes getting the deteminant question wrong in the exams).

Finishing touches

It's quite pleasant to edit using the programming modes of the TI-74. You scroll through the program with the up and down arrows, and clear the screen for entering new lines with the CLR button. It's all quite viceless.

Editing a line is straightforward. Simply get it in the display, type the new entry on top of the old, and press return. To insert information, there is a special INSert button. To delete a character, use the DELete button. Control plus down arrow clears the display from the current cursor position.

There was one thing I didn't like about the BASIC. For reasons best known to itself TI has decided to ignore the standard practice of deleting a line by typing the line number followed by enter. Instead you have to write "delete" followed by the line number. Delete is one of the few keywords not having single stroke entry. This is frustrating if you want to delete a number of lines as frequently happens during editing.

The TI-74 comes with two manuals, both excellent. One is an operations manual, and lays out the basic operating procedure of the machine. The other is the programmer's guide, which tells you everything you were afraid you would need to know to make it go. There is no guide to BASIC programming, but there is a complete list of commands, with a detailed protocol description.

The TI-74 comes with a range of options. There is a spare 8K RAM pack which slides into a port on the right hand side of the machine. This cartridge can contain ROM in the form of a maths, stats, financial or Pascal pack. Other options include a printer and a cassette interface. Programs can be stored in the RAM pack using file names and normal file protocols, or on cassette. If you don't have any of these options, the TI-74 has onboard non-volatile RAM that will store the current program.

The TI-74 will be hitting the shops mid-December at $349. The RAM/ROM pack sells for between $55 and $69. The cassette cable is going to sell for $45 and the printer itself is $249. ●

BOOTING THE CD

Sony's CDX-J10 Discjockey

A CD player that loads up to 10 discs and mounts in your boot sounds different. It is. And the advantages of Sony's Discjockey don't only lie with the discrete remote control for inside the car. There are some very practical performance advantages.

Louis Challis

THE SONY DISCJOCKEY multi-play CD player caught my eye and ear at last January's Las Vegas Winter Consumer Electronics Show (see ETI April 1986) and I resolved that this was one piece of equipment which I would just have to review.

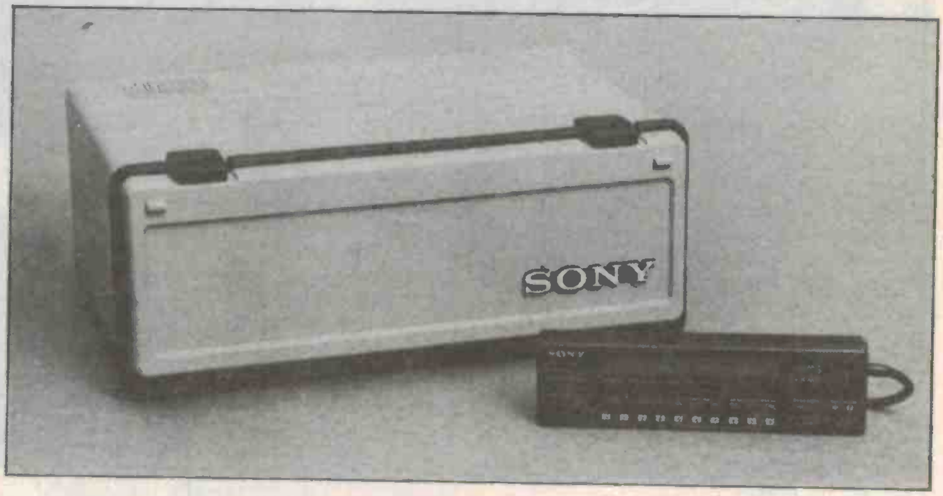
Why am I so interested in this particular piece? Well, the answer is really quite simple, for apart from the Yamaha solution of providing an automotive CD player with its own protective cartridge (see ETI April 1986), most users feel that a CD player in a car is like 'an accident waiting to happen.' Trying to load that unwieldy CD into a little slot set in the dashboard with one free hand while keeping your eyes on the road is a little uncomfortable.

Sony's latest solution to the problem is eminently practical and very sensible. Instead of putting the hardware in (or under) the car dashboard, where there is pitifully little space for it anyway, Sony has opted for its placement in the boot. In this location, it is neither visible (to attract the would-be thieves) nor restrictive, because you can load the internal cassette with up to 10 CD discs which theoretically provides you with up to 10 hours of music without having to repeat a single track.

Design and appearance

The Discjockey comes in two parts. The part that you see in your car is a small and relatively convenient control module, which Sony describes as the Commander and which is little more than half the size of a normal Sony TV remote controller. The Commander is moulded in matt black plastic and is hard wired by means of a 4 m long lead, which plugs into the back of the main module.

The Commander has its controls and displays on three levels. The top level incorporates two small control buttons and an elongated rear illuminated liquid crystal display, together with an ALL OFF button on the right-hand side. The first of the minor control buttons is the SE or sound effector button which is used to control the level of surround sound when four speakers are in use, or the level of dynamic range suppression which the unit sensibly provides. The advantages of the dynamic suppression circuit only become significant when you are trying to listen to music which may have a 90 decibel dynamic range in an environment which is only really capable of coping with about half that figure. The optimum dynamic range really depends on the speed at which you travel and the consequent amount of wind and road noise intruding into your car. The unit is capable of reducing a conventional 90 dB dynamic range to 65 dB in the DRS1 mode and 52 dB in the DRS2 mode.



SONY CDX-J10 (THE "DISCJOCKEY")

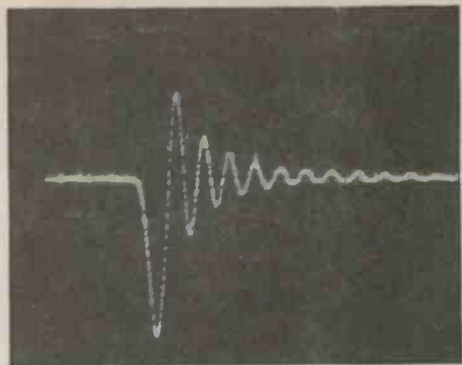
Dimensions:	
Main unit	*321 mm (wide) x 131 mm (high) x 220 mm (deep)*
Control unit	*48 mm (wide) x 170 mm (long) x 25 mm (deep).*
Weight:	
Main unit	*5.6 kg*
Control unit	*0.3 kg*
Manufacturer:	*Sony Corporation, Tokyo, Japan.*
RRP	*$1999*

The next (SELECT) button allows you to change the function of the main (and largest) sound control toggle switch, which is positioned immediately below. A liquid crystal display tells you which of the four possible modes this control is set to: VOLUME, BASS, TREBLE or BALANCE. After a five second delay, if not activated or modified, the SELECT control automatically reverts back to the volume control position. The volume level selected is indicated directly by a bar graph on the display. When setting the bass, treble and balance, the display shows a centre arrow with minus and plus signs, and a small bar display, which moves up or down relative to the central position.

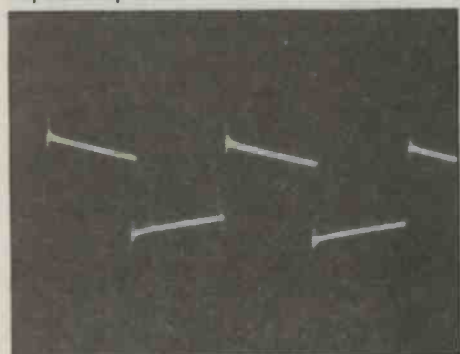
In the centre of the display module, the data on which of the 10 selected discs is playing is shown, as well as the TRACK number and at the extreme right hand end, the elapsed time in minutes and seconds for that track is shown.

The other controls are a MEMory button used for presetting the memory play program; the SENsor random music sensor (RMS) button for programming random music selection; the FAST FORWARD and FAST REVERSE buttons; the SCAN button which provides fast forward or fast reverse track by track. The last of the small buttons in the central row of controls is the PGM PLAY (program play) button which starts a pre-recorded memory program playing and when pressed again cancels the program.

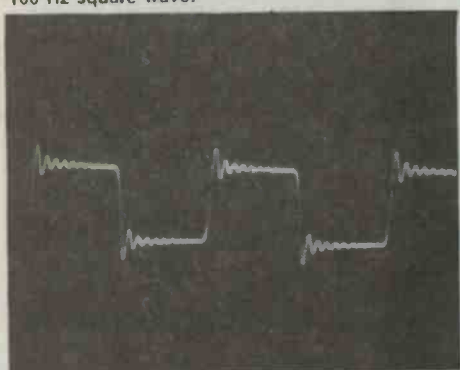
At the extreme right hand end of the Com-



Impulse response.



100 Hz square wave.



1 kHz square wave.

mander is the PAUSE/PLAY button. If the unit is deactivated, it will start playing at the start of the track that was being played before the unit was switched off. If the button is pressed twice, the player enters into the pause mode.

At the bottom of the Commander are a series of small white rear-illuminated numbered buttons which allow you to select a disc when immediately followed by the activation of the disc PLAY button. If the optional supplementary tuner has been selected (and is connected), these buttons allow you to select one of 10 preset station frequencies on either the AM or FM bands.

No other controls are provided and, frankly, no other controls are required.

The Commander is intended to hide either between or under the seats when not required and, because of the flexibility provided by the 4 m cable, may also be used by passengers in either front or rear seats. Alternatively, it may be fixed to the dashboard, suspended by a hook and eye system (which is provided) or positioned as convenient.

The compact disc auto changer unit has ▶

MEASURED PERFORMANCE OF SONY "DISCJOCKEY"
MODEL NO. CDX-310
SERIAL NO. 10645

1. FREQUENCY RESPONSE 20 Hz to 20 kHz +1 dB
5 Hz to 22.05 kHz +1 -5 dB

2. LINEARITY @ 1kHz

NOMINAL LEVEL	LEFT OUTPUT	RIGHT OUTPUT
0 dB	0.0	0.0
-1.0	-1.0	-1.0
-3.0	-3.0	-3.0
-6.0	-6.0	-6.0
-10.0	-10.0	-10.0
-20.0	-20.0	-20.0
-30.0	-30.0	-30.0
-40.0	-40.0	-40.0
-50.0	-50.0	-49.9
-60.0	-59.9	-59.9
-70.0	-69.8	-69.8
-80.0	-79.4	-79.5
-90.0	-87.6	-87.8

2. LINEARITY @ 1kHz in DRS 1 and DRS 2 modes

NOMINAL LEVEL	DRS 1 MODE	DRS 2 MODE
0 dB	-10.0	-10.0
-1.0	-11.0	-10.5
-3.0	-12.0	-11.5
-6.0	-13.6	-13.0
-10.0	-15.8	-15.0
-20.0	-21.2	-20.2
-30.0	-27.4	-25.5
-40.0	-34.1	-30.8
-50.0	-41.8	-36.4
-60.0	-50.5	-42.4
-70.0	-59.9	-49.0
-80.0	-69.9	-56.3
-90.0	-74.8	-61.7

3. CHANNEL SEPARATION

FREQUENCY	RIGHT INTO LEFT dB	LEFT INTO RIGHT dB
100 Hz	-82.9	-87.4
1kHz	-72.6	-73.1
10kHz	-53.3	-52.7
20kHz	-40.3	-38.8

4. DISTORTION @ 1kHz

Level	2nd	3rd	4th	5th	THD%
0	58.2	72.0	92.5	85.6	0.13
-1.0	59.2	73.3	89.7	87.3	0.11
-3.0	61.6	75.4	91.3	86.9	0.087
-6.0	65.4	78.4	-	88.0	0.055
-10	73.2	80.1	-	89.6	0.024
-20	76.1	78.2	-	87.8	0.021
-30	71.6	75.4	-	-	0.031
-40	68.9	73.1	-	-	0.042
-50	63.7	57.7	-	-	0.19
-60	-	53.8	-	49.5	0.39
-70	-	36.9	-	-	1.43
-80	-	27.8	34.5	34.4	4.90
-90	22.0	27.0	-	14.6	19.7
@ 100 Hz					
0	59.9	70.8	98.1	87.6	0.10
-20	76.6	78.4	93.9	92.1	0.02
-40	71.6	79.8	-	77.2	0.032
-60	64.0	56.7	-	55.6	0.23
@ 6.3 kHz					
0	48.2	56.1	-	-	0.42

5. EMPHASIS

Frequency	Recorded Level	Output Level (L)	Output Level (R)
1 kHz	-0.37 dB	-0.5	-0.5
5 kHz	-4.53 dB	-4.7	-4.7
16 kHz	-9.04 dB	-9.2	-9.4

6. SIGNAL TO NOISE RATIO

Without Emphasis	80.0 (Lin)	90.2 dB(A)
With Emphasis	77.5 (Lin)	91.4 dB(A)

7. FREQUENCY ACCURACY

(19.999 kHz) -1.0 Hz for 20 kHz test signal

8. SQUARE WAVE RESPONSE AND IMPULSE TEST

(See attached photos)

DIRTY RECORD TEST
Using Philips NR4A (410-056-2)

Interruption in Information Layer		Black Dot at Read out Side	
400 micrometer ;	Passed	300 micrometer ;	Passed
500 micrometer ;	Passed	500 micrometer ;	Passed
600 micrometer ;	Passed	600 micrometer ;	Passed
700 micrometer ;	Passed	800 micrometer ;	Passed
800 micrometer ;	Passed		
900 micrometer ;	Passed		

BLACK STRIPE TEST (passed)

VIBRATION OR DISPLACEMENT TEST
Acceleration level : 1.5 grms over range 5 Hz to 10 Hz : passed
Displacement test : 150mm @ 7.5 Hz excitation : passed

about three times the volume of a conventional car radio. It is a neat fawn colour with a hinge down lid, securely retained by two neat recessed overlocking catches. The lid seals against a full perimeter rubber seal, which ensures the exclusion of dust. Dust is obviously one of the potential hazards that will face the unit in practical installation, especially in a boot.

When you open the unit up, you observe a small blue ejection button. When pressed this starts the unit gently 'whirring' until the CD cartridge is ejected. Status lights are incorporated into the panel and if you push up the protective cover, you can peer into the operational inards of the unit. Inside you can see the rack and pinion sliding gear, sled motor, disc sliding gear and the tops of the printed circuits which contain 30 large scale integrated circuits, 111 diodes, 83 discrete transistors and four crystals. The mechanism uses a large number of special plastic mouldings, three motors and appears to be ruggedly designed, even though it is extremely complex in its operation.

The removable moulded plastic cartridge accepts 10 discs (the right way up) and on the back of the cartridge are 10 pairs of tiny lever slides which you move to withdraw any or all of the individual discs. The same levers are ▶

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SUPER IC SPECIAL 27512 — 1-9 $29.50 · 10+ $28.50

SUPER IC SPECIAL 6264 — 1-9 $6.50 · 10-99 $5.50 · 100+ $5.25

SUPER IC SPECIAL 6802 — 1-9 $5.00 · 10-99 $4.75 · 100+ $4.50

SUPER IC SPECIAL ZN429 — 1-9 $7.95 · 10-99 $7.50 · 100+ $6.95

SUPER IC SPECIAL 6116LP-3 — 1-9 $3.95 · 10-99 $3.75 · 100+ $3.50

SUPER IC SPECIAL 4164 — 1-9 $3.95 · 10-99 $3.75 · 100+ $3.50

SUPER IC SPECIAL INS8250 — 1-9 $24.50 · 10+ $22.50

SUPER IC SPECIAL 8087 — $299

SUPER IC SPECIAL 41256-15 — 1-9 $5.95 · 10-99 $5.50 · 100+ $4.95

SUPER IC SPECIAL AM 7910 WORLD MODEM CHIP — $24.95

SUPER IC SPECIAL ADC0820 — 1-9 $24.95 · 10+ $22.95

SUPER IC SPECIAL 27128 — 1-9 $7.00 · 10-99 $6.50 · 100+ $6.25

SUPER IC SPECIAL 2732 — 1-9 $8.25 · 10-99 $7.95 · 100+ $7.50

SUPER IC SPECIAL LM394CH — 1-9 $6.95 · 10-99 $6.75 · 100+ $6.50

SERIES 4000

4000 .50
4001 .50
4002 .50
4006 1.90
4007 .40
4008 1.20
4010 .90
4011 .40
4012 .40
4013 .60
4014 1.90
4015 1.90
4016 .75
4017 1.50
4018 1.90
4019 .90
4020 1.50
4021 1.50
4022 1.50
4023 1.50
4024 1.50
4025 1.50
4026 1.50
4027 1.50
4028 1.50
4029 1.50
4030 1.50
4031 2.95
4032 2.75
4033 2.75
4034 3.50
4035 1.95
4038 3.25
4040 1.20
4041 1.50
4042 1.00
4043 1.60
4044 1.20
4045 4.90
4046 2.50
4047 1.20
4048 1.20
4049 1.00
4050 1.00
4051 1.50
4052 1.50
4053 1.50
4054 3.90
4055 3.80
4056 4.20
4060 2.50
4063 2.00
4066 2.50
4067 9.90
4068 1.00
4069 1.00
4070 .90
4071 .40
4072 .90
4073 .90
4075 .90
4076 1.50
4077 .80
4078 .80
4081 .40
4082 .80
4085 2.20
4086 2.30
4093 .75
4094 3.35
4095 2.40
4096 2.40
4097 6.50
4098 2.90
4099 3.90
4175 1.60
4194 1.95
4433 2.75
MC14433 13.90
4510 1.50
4511 1.00
4512 1.10
4513 2.65
4514 2.90
4515 2.90
4516 1.45
4517 8.75
4518 2.50
4519 1.90
4520 1.20
4521 3.90
4522 1.90
4526 1.85
4527 2.65
4528 1.15
4529 1.60
4530 1.60
4531 1.65
4532 2.65
4534 8.90
4536 6.50
4539 1.65
4541 1.60
4543 2.50
4544 10.50
4549 7.25
4551 1.60
4553 5.50
4554 2.35
4555 1.10
4556 1.25
4557 7.85
4558 2.25
4559 7.25
4560 3.75
4561 1.80
4562 8.45
4566 3.00
4568 4.25
4569 2.60
4572 .75
4581 3.10
4582 2.25
4583 1.65
4584 .85
4585 2.10

74

7400 .35
7401 .45
7402 .45
7403 .45
7404 .60
7405 .80
7406 .80
7407 .60
7408 .60
7409 .60
7410 .60
7411 .70
7412 .70
7413 .70
7414 .80
7416 .80
7417 .80
7420 .60
7425 .90
7427 .80
7430 .70
7432 .70
7437 .80
7438 .90
7440 .90
7442 .90
7445 1.00
7446 1.20
7447 1.50
7449 1.20
7450 .90
7451 .90
7473 .90
7474 .70
7475 .70
7476 .80
7485 1.20
7486 1.20
7489 3.90
7490 1.00
7493 1.00
7495 1.00
7497 2.30
74100 1.65
74107 1.20
74109 .90
74110 1.50
74121 .90
74122 .90
74123 1.50
74125 1.00
74128 1.80
74132 1.00
74139 1.50
74145 1.45
74150 1.50
74151 1.20
74154 1.75
74155 1.20
74161 1.20
74163 1.40
74164 1.20
74165 1.20
74166 1.70
74174 1.45
74175 1.20
74180 1.20
74190 1.00
74191 1.45
74192 1.65
74193 .80
74194 1.10
74195 1.00
74197 1.10
74221 1.90
74367 1.50
74368 1.50
75107 2.50
75110 2.50
75150 2.50
75154 2.50
75450 1.50
75451 .90
75452 .90
75453 .90
75461 1.50
75462 1.50
75471 3.00
75472 3.00
75491 2.00
75492 2.00
75493 3.00

74LS

74LS00 .60
74LS01 .50
74LS02 .50
74LS03 .50
74LS04 .60
74LS05 .60
74LS08 .50
74LS09 .80
74LS10 .60
74LS11 .80
74LS12 .80
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74LS14 .80
74LS15 .80
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74LS24 .90
74LS26 .90
74LS27 .80
74LS28 .90
74LS30 .40
74LS32 .70
74LS33 .70
74LS37 .70
74LS38 .80
74LS40 .80
74LS42 .60
74LS47 1.00
74LS48 1.00
74LS49 1.80
74LS51 .70
74LS54 .80
74LS55 .80
74LS63 2.80
74LS73 .60
74LS74 .60
74LS75 .60
74LS76 1.00
74LS77 1.00
74LS78 1.10
74LS83 .70
74LS85 .80
74LS86 .80
74LS90 .80
74LS91 .60
74LS92 .80
74LS93 .70
74LS95 1.20
74LS96 1.20
74LS107 .90
74LS109 .60
74LS112 .70
74LS113 .70
74LS114 .80
74LS122 1.30
74LS123 .90
74LS125 .80
74LS126 1.20
74LS132 1.50
74LS133 4.90
74LS136 1.50
74LS138 .80
74LS139 .80
74LS145 2.10
74LS147 2.50
74LS148 1.90
74LS151 1.20
74LS152 1.95
74LS153 1.00
74LS154 2.95
74LS155 1.00
74LS156 1.50
74LS157 1.10
74LS158 1.00
74LS160 1.00
74LS161 .80
74LS162 1.50
74LS163 1.10
74LS164 .90
74LS165 1.00
74LS166 2.58
74LS169 2.45
74LS173 .90
74LS174 .90
74LS175 .80
74LS181 4.00
74LS190 1.50
74LS191 1.20
74LS192 1.20
74LS193 1.20
74LS194 1.20
74LS195 .90
74LS196 .90
74LS197 1.75
74LS221 2.00
74LS240 1.90
74LS241 1.90
74LS242 1.90
74LS243 1.90
74LS244 1.50
74LS245 2.60
74LS247 1.30
74LS248 1.50
74LS249 1.60
74LS251 1.50
74LS253 1.20
74LS257 .70
74LS258 1.20
74LS259 1.50
74LS261 2.50
74LS266 1.20
74LS273 1.95
74LS275 6.80
74LS279 .80
74LS280 2.60
74LS283 1.50
74LS290 1.50
74LS293 1.30
74LS295 1.75
74LS297 6.50
74LS298 1.20
74LS299 3.90
74LS320 3.95
74LS321 3.95
74LS322 6.75
74LS323 6.50
74LS324 2.20
74LS326 2.20
74LS327 2.20
74LS352 2.20
74LS353 2.20
74LS354 3.95
74LS365 1.00
74LS366 1.00
74LS367 .60
74LS368 1.00
74LS373 1.90
74LS374 1.80
74LS375 1.00
74LS377 2.18
74LS378 1.20
74LS379 1.90
74LS386 1.00
74LS390 1.80
74LS393 1.80
74LS395 2.00
74LS396 2.50
74LS398 3.00
74LS399 1.90
74LS424 5.50
74LS440 5.50
74LS441 5.50
74LS442 5.50
74LS443 5.50
74LS445 2.20
74LS446 5.50
74LS447 1.90
74LS448 5.50
74LS449 5.50
74LS490 3.20
74LS540 5.95
74LS541 3.95
74LS621 2.75
74LS622 2.75
74LS623 5.95
74LS629 5.95
74LS640 3.95
74LS642 2.75
74LS643 2.75
74LS644 2.75
74LS645 2.75
74LS668 1.75
74LS669 1.75
74LS670 2.75
74LS673 12.56
74LS674 12.58
74LS690 3.95
74LS691 3.95
74LS692 3.95
74LS693 3.95
74LS696 3.95
74LS699 3.95

74F SERIES

74F00 .79
74F02 .79
74F04 .92
74F08 .79
74F10 .79
74F11 .79
74F20 .79
74F32 .79
74F64 .79
74F74 .89
74F86 1.19
74F109 .99
74F138 1.79
74F139 1.79
74F151 1.79
74F153 1.79
74F157 1.79
74F158 1.79
74F175 2.78
74F181 5.98
74F182 2.73
74F189 7.44
74F190 4.86
74F191 4.86
74F194 2.41
74F241 3.72
74F243 4.34
74F244 3.72
74F251 1.93
74F253 1.93
74F257 1.93
74F258 1.93
74F350 4.34
74F352 1.93
74F353 1.93
74F373 4.84
74F374 4.84
74F399 2.78
74F521 4.22
74F533 4.84
74F534 4.84

74HC

74HC00 .60
74HC02 .60
74HC04 .60
74HC08 .60
74HC11 .60
74HC14 1.40
74HC27 .80
74HC30 .60
74HC32 .60
74HC74 1.10
74HC76 1.10
74HC85 1.40
74HC86 1.10
74HC123 1.40
74HC138 1.40
74HC139 1.40
74HC167 1.40
74HC165 2.50
74HC174 1.40
74HC221 3.80
74HC240 2.50
74HC244 2.50
74HC245 3.80
74HC367 1.40
74HC373 2.90

74C

74C00 1.00
74C02 1.00
74C04 1.00
74C08 1.00
74C10 1.00
74C14 1.40
74C20 1.00
74C30 1.00
74C32 1.00
74C42 1.90
74C48 2.50
74C73 1.40
74C74 1.70
74C76 1.90
74C83 2.30
74C85 2.30
74C86 1.50
74C89 8.90
74C90 1.90
74C93 1.90
74C95 2.00
74C107 1.20
74C150 8.50
74C151 4.20
74C154 6.00
74C157 3.75
74C160 1.90
74C161 1.90
74C162 2.00
74C163 2.00
74C164 2.50
74C165 2.50
74C173 1.90
74C174 1.90
74C175 1.90
74C192 2.00
74C192 2.00
74C193 2.00
74C195 2.00
74C200 14.00
74C221 2.75
74C240 3.75
74C244 3.95
74C373 4.75
74C374 4.45
74C901 3.00
74C902 2.50
74C903 2.50
74C904 2.50
74C905 15.00
74C906 2.90
74C907 2.90
74C908 2.75
74C910 14.00
74C911 12.50
74C912 12.50
74C914 4.50
74C915 4.00
74C917 15.50
74C918 2.90
74C920 12.50
74C921 12.50
74C922 7.50
74C923 7.90
74C925 12.90
74C926 12.90
74C927 9.80
74C928 9.00
74C929 9.60
74C930 2.75
74C932 2.50
74C941 2.50
74C989 8.90

74S

74S00 .60
74S02 1.00
74S03 1.00
74S04 1.00
74S05 1.50
74S08 1.00
74S09 1.50
74S10 1.00
74S11 1.00
74S15 1.60
74S20 1.20
74S22 1.00
74S30 1.00
74S32 1.00
74S37 1.70
74S38 1.70
74S40 1.20
74S51 1.20
74S64 1.20
74S65 1.20
74S74 1.30
74S85 1.30
74S109 2.20
74S112 1.30
74S113 1.30
74S133 1.20
74S134 1.40
74S135 1.30
74S138 3.30
74S139 3.30
74S140 1.90
74S151 3.10
74S153 2.00
74S157 3.10
74S158 3.10
74S160 5.90
74S161 5.90
74S162 7.90
74S163 7.90
74S168 11.50
74S169 11.50
74S174 4.50
74S175 4.50
74S181 8.50
74S182 3.40
74S189AN 4.10
74S189 8.50
74S194 3.30
74S195 2.90
74S196/82S90
74S197/82S91 4.90
74S201 9.90
74S214AN P.O.A.
74S225 10.90
74S226 7.90
74S240 6.90
74S241 6.90
74S244 9.90
74S251 3.90
74S253 4.90
74S257 3.30
74S258 3.30
74S260 2.90
74S274 POA
74S275 POA
74S280 5.80
74S281 POA
74S283 7.90
74S287 4.90
74S288 4.90
74S299 13.90
74S301 13.90
74S314 POA
74S330 POA
74S331 POA
74S373 9.90
74S374 9.90
74S381 9.90
74S387 3.30
74S412 8212 5.90
74S428 8212 7.90
74S470 9.90
74S471 9.90
74S472 9.90
74S473 9.90
74S474 9.90
74S475 9.90
74S482 11.90
74S489 7.90

LINEAR

LH0002 9.50
LH0042CH 9.50
LH0070 9.50
LH0071 9.50
TL061 1.50
TL062 2.00
TL064 4.90
TL071 1.20
TL072 2.90
TL073 3.20
TL074 4.90
TL081 1.90
TL082 2.50
TL083 2.90
TL084 3.45
TL494 4.90
TCA220 8.50
TCA280 4.50
TDA1024 2.80
TA7205P 3.90
TEA1002 17.50
UAA170 5.95
UAA180 8.75
LM10CH 7.50
LM301 1.00
LM301H 1.50
LM302H 6.50
LM305H 1.50
LM307CN 1.00
LM308 1.00
LM308H 1.80
LM309K 1.90
LM310N 3.20
LM310H 3.20
LM311 1.00
LM311H 1.80
LM317T 2.50
LM317K 3.20
LM318 1.80
LM319 4.90
LM324 1.00
LM325 4.50
LM326 4.50
LM329DZ .90
LM334Z 1.80
LM335Z 2.20
LM336 2.5V 2.95
LM336K 12.50
LM339 1.20
LM348 1.80
LM349 1.80
LM350K 10.50
LM351N 1.00
LM353 2.50
LM355N 2.40
LM357 2.40
LM358 1.40
LM361 3.50
LM377 4.90
LM378 6.50
LM380 8 pin 1.80
LM380 14 pin 1.90
LM381 3.50
LM382 3.50
LM383 3.90
LM384 3.50
LM386 1.95
LM387A 3.95
LM387 2.00
LM389 2.95
LM391 3.50
LM393 1.00
LM394CH 8.95
LM395T 9.95
LM396K 22.50
LF398 5.90
NE544 6.50
NE555 .50
NE556 1.00
NE558 5.00
NE560 4.60
NE567 2.00
NE570 5.90
NE571 5.90
NE592 6.90
NE594 9.50
LM709-14 1.50
UA710CN 1.00
LM711 1.20
LM723 .75
LM723CH 1.50
LM725 4.75
LM733 1.50
LM739 2.75
LM741 .60
UA747 1.30
UA748 1.00
MC1310 9.50
MC1312 7.95
MC1314 7.95
MC1315 8.95
MC1327 7.95
MC1350 1.95
MC1408L8 7.50
MC1437 4.95
MC1445 5.95
MC1456 1.95
MC1458 1.20
MC1466L 21.50
MC1469R 8.90
MC1488 1.20
MC1489 1.20
MC1494 8.40
MC1495 8.90
MC1496 2.50
LM1596 3.00
MC1648 8.90
LM1812 10.50
LM1830 3.90
LM2907 3.90
LM2917 8 PIN 4.90
LM2917 14 PIN 4.90
MN3001 17.50
CA3028 2.00
CA3046 1.90
CA3056 6.50
CA3059 5.95
CA3080 1.90
CA3086 1.90
CA3100E 7.95
CA3130E 2.90
CA3130T 3.50
CA3140E 2.20
CA3140T 2.95
CA3240E 11.95
CA3401 1.00
CA3900 1.20
CA3905 1.75
CA3909 2.95
LM3911 2.95
LM3914 6.90
LM3915 5.90
LM3916 5.90
LM3909Z 2.60
RL4136 1.95
RC4145 20.90
RC4194 3.90

CDP

CDP1802 10.50
CDP1864 17.50

CPU

6502 15.00
6502A 15.00
6522 15.00
6522A 15.00
6532 14.00
6545 19.50
6551 12.90
6800 6.00
6802 7.00
6808 12.50
6809 10.00
6810 3.50
6821 5.50
6840 6.50
6845 12.50
6847 3.60
6850 7.90
6875 15.00
Z80CPU 5.00
Z80ACPU 5.00
Z80BCPU 12.00
Z80P10 4.50
Z80AP10 4.50
Z80CTC 5.50
Z80ACTC 5.50
Z80DMA 16.00
Z80ADMA 16.00
Z80AS10 13.00
Z80S10 13.00
AD570 69.50
AD590 9.50
AD7524 17.50
AY-3-8910 14.50
AY-3-8912 14.50
MSM5832 16.50
MM58174 16.50
MM5309 14.50
MM5369 4.95
FD1771 19.00
FD1791 (8876) 39.00
FD1793 (8877) 39.00
FD1795 39.00
FD1797 39.00
WD1691 21.50
WD2143 14.50
WD1931 22.50
WD1933 34.00
WD1983 14.75
WD1993 59.00
WD2123 26.50
WD8250 24.50
TR1602 (S1883) 8.50
TR1853 8.90
COM8116 24.00
BR1941 23.00
CRT8002A 59.90

8000 SERIES

8035 7.90
8039 7.80
8080 8.00
8085 9.50
8086 19.50
8088 29.00
8121 5.00
8123 4.00
8130 6.95
8131 5.95
8136 6.95
8155 6.50
8156 11.50
8185 37.50
81LS95 3.75
81LS96 3.75
81LS97 3.75
81LS98 3.75
8202 52.50
8203 69.50
8212 2.90
8214 4.90
8224 3.50
8226 4.90
8228 6.50
8237 19.50
8238 9.50
8243 8.50
8251 6.90
8253 7.60
8255 5.50
8257 16.50
8259 6.50
8271 89.00
8272 33.00
8273 65.00
8274 42.50
8275 38.50
8276 28.50
8279 8.50
8282 6.90
8283 6.50
8284 8.50
8286 6.50
8287 6.50
8289 73.00
82S23 5.95
82S123 5.95
8303 5.50
8304 6.95
8311 5.95
8641 5.95
8741 57.50
8748 65.00
8749 58.50
8755 33.50
8820 6.95
8830 6.95
8832 6.95
8833 6.95
8834 8.95
8835 5.95
8T13 2.95
8T14 2.95
8T26 3.00
8T28 3.00
8T95 3.00
8T97 1.80

MEMORY

2016 6.90
2102 2.50
2114 2.95
2708 12.50
2716 8.90
2732 8.90
2764 5.95
27128 6.00
4116 3.95
4164 3.95
6116 5.50
6264 8.00
58725 (6116) 4.00
2101 (5101) (8101) 7.90
5101 7.90
8101 7.90
2532 12.50

OPTO

4N25 1.50
4N26 1.50
4N27 1.50
4N28 1.50
4N29 1.50
4N30 2.00
4N32 2.50
4N33 2.50
4N35 2.50
4N37 2.50
MCT6 2.50
MCT66 2.50
MCT2 1.50
ILD74 5.80
ILQ74 6.50
FND507 2.00
TIL31A 2.95
TIL81A 2.95
TIL306 22.50
MAN72 (DL702) 3.50
MAN74 (DL704) 3.50
BPW50 2.25

HP5082-2811 4.95
HLMP 6620 3.95

LEDS
3mm RED .25
2mm YELL .30
3mm GRN .30
5mm RED .15
5mm YELL .30
5mm GRN .30
5mm ONG .30
RED RECT .30
GRN RECT .30
YEL RECT .30
RED CHROME BEZEL 1.20
YELLOW CHME BEZEL 1.20
GRN CHRME BEZEL 1.20

SPECIAL FUNCTION

LM2240 2.45
NE5534N 3.95
NE5534AN 4.95
MC3340 2.90
MC3341 2.90
76477 8.95
76488 8.95
76489 9.95
8038 6.50
OM335 22.50
OM350 12.50
XR2206 8.95
XR2207 7.95
XR2208 6.90
XR2209 6.90
XR2211 7.95
XR2216 5.90
XR2240 6.95
XR2243 7.95
XR8038 7.50
95H90 8.50
11C90 16.50
LM7555 2.90
LM7556 3.50
MC10116L 1.50
LM13600 3.95
LF13741 .80
LF13741H 1.50
DM2502 22.50
SAK140 9.50
ZN414 1.95
ICL7106 19.50
ICL7116 19.50
ICL7117 21.50
ICL7611 6.95
ICL7660 5.90
ICM7211 12.50
ICM7216A 69.50
ICM7216B 69.50
ICM7226A 48.50
ICM7227A 19.95

ANALOG & DIGITAL

ADC0800LCN 22.50
ADC0801LCN 23.95
ADC0803LCN 7.60
ADC0804LCN 6.50
ADC0808LCN 14.95
ADC0820LCN 24.95
DAC0800 4.50
DAC0806 4.50
DAC0832LCN
DAC1020LCN 13.95
DAC1220LCN 14.95

TRANSISTORS

AC126 1.20
AC127 1.20
AC128 1.20
AC187 1.20
AC188 1.50
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AD162 2.90
AF118 2.50
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BC108 .50
BC177 .60
BC178 .60
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BC182L .40
BC212 .20
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BCY70 1.80
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BD139 .80
BD140 .80
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4.433618MHz 2.90
4.44MHz 2.90
4.75MHz 2.90
4.915200MHz 8.90
4.9682MHz 2.90
5.000MHz 2.90
5.0688MHz 2.90
6MHz 2.90
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6.5536MHz 2.90
8MHz 2.90
8.867238MHz 4.90
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12MHz 2.90
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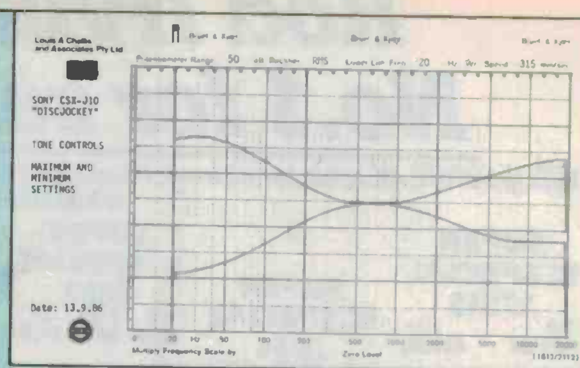
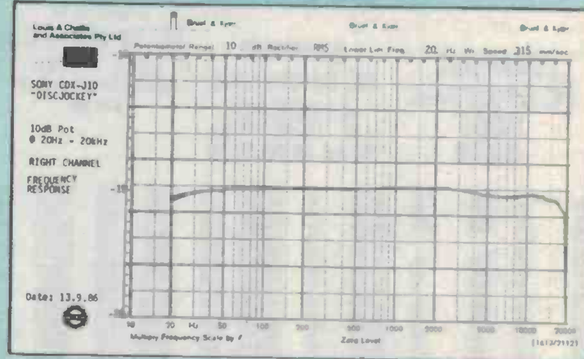
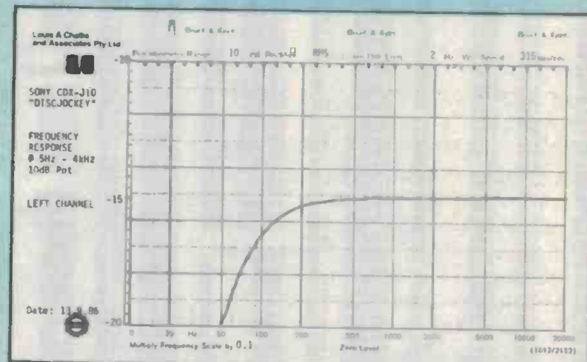


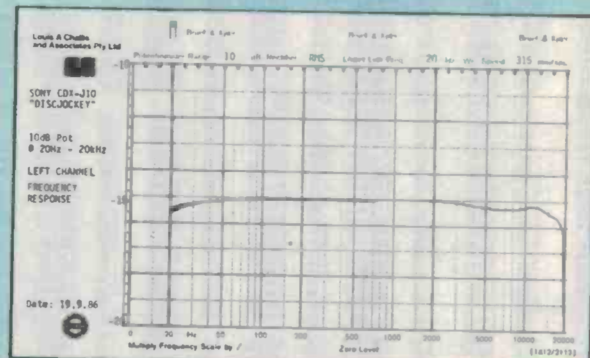
Louis A Challis and Associates Pty Ltd
SONY CSX-J10 "DISCJOCKEY"
TONE CONTROLS
MAXIMUM AND MINIMUM SETTINGS
Date: 13.9.86



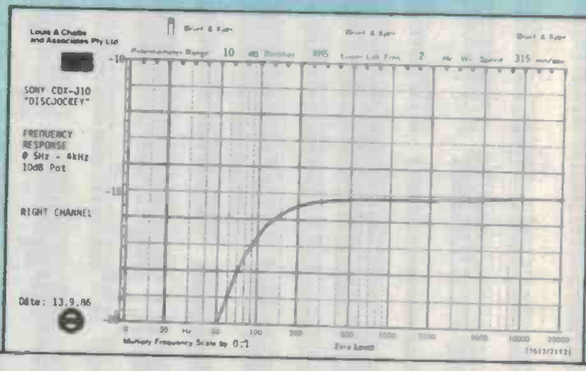
Louis A Challis and Associates Pty Ltd
SONY CDX-J10 "DISCJOCKEY"
10dB Pot @ 20Hz - 20kHz
RIGHT CHANNEL
FREQUENCY RESPONSE
Date: 13.9.86



Louis A Challis and Associates Pty Ltd
SONY CDX-J10 "DISCJOCKEY"
FREQUENCY RESPONSE @ 5Hz - 4kHz 10dB Pot
LEFT CHANNEL



Louis A Challis and Associates Pty Ltd
SONY CDX-J10 "DISCJOCKEY"
10dB Pot @ 20Hz - 20kHz
LEFT CHANNEL
FREQUENCY RESPONSE
Date: 19.9.86

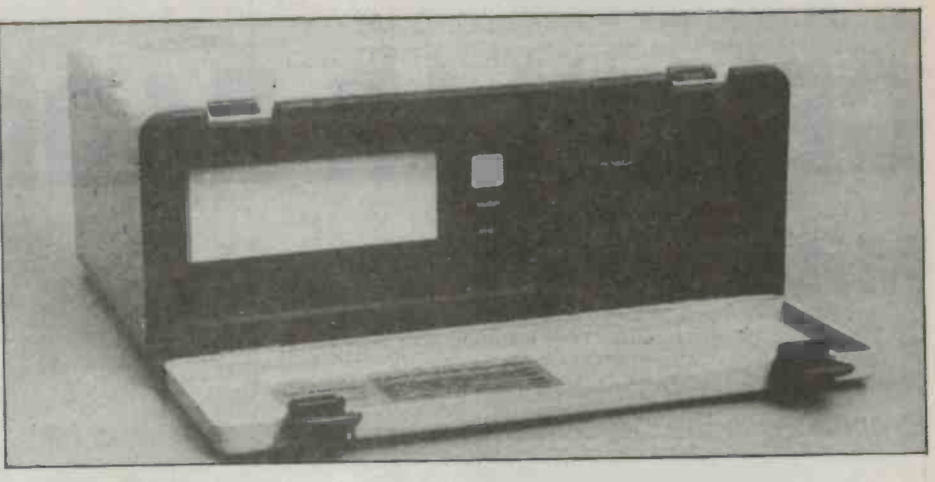


Louis A Challis and Associates Pty Ltd
SONY CDX-J10 "DISCJOCKEY"
FREQUENCY RESPONSE @ 5Hz - 4kHz 10dB Pot
RIGHT CHANNEL
Date: 13.9.86

used by the internal mechanism to slide a given disc from the cartridge into the normal playing position. In the event of any one of five possible malfunctions, error codes 01 to 05 are displayed on the Commander. Code 01 indicates that the disc magazine has not been loaded. Code 02 indicates that no discs are loaded into the magazine. Code 03 indicates that your selection of AMS programming cannot be provided by the disc. Code 04 indicates that the disc is dirty or 'upside down' and Code 05 indicates that the program play has been activated when no program has been selected or entered.

The back of the unit provides four RCA connectors for front and rear speakers; a socket to accept a supplementary tuner unit; a subcode output for future video or audio functions; and a socket for the Commander unit's input plug; and a terminal box for the electrical connections for which all the wiring and fuses are provided.

The unit is provided with a small tri-lingual (English, French, Spanish) book providing installation instructions, a tri-lingual operations handbook and a small quick reference and CD storage folder which I suspect is intended to be stored in your glove box.



Objective testing

The objective testing of the unit presented no problems whatsoever, although I expected some as a result of the differing controls and the absence of some of the normal functions found on residential CD players.

The frequency response of the Disjockey is particularly flat, being within 1 dB from 20 Hz to 20 kHz and still only 5 dB down at 5 Hz. This extended low frequency response could prove to be embarrassing if your automotive speakers are not designed to cope with some of the high level low frequency output, which some of the software now produces. The frequency linearity of the unit when tested in the normal mode is exceptionally good and I was unable to detect any measurable non-linearity until −50 dB. The non-linearity between there and −70 dB is only 0.2 dB; at −80 dB it is only 0.5 dB; and at −90 dB only 2.5 dB. This is extremely good and these linearity figures are just about as good as I have seen to date.

When I selected the DRS1 mode with the Commander, the 0 dB signal immediately drops to −10 dB and the compression results in the 50 dB dynamic range between −20 and −70 being reduced to a 38.7 dB dynamic range. The total dynamic range for a 0 to −90 dB signal is then reduced to a 64.8 dB. When the DRS2 mode is selected, the 0 dB is again attenuated to −10 dB and the compression results in the 50 dB dynamic range between −20 and −70 being reduced to a 28.8 dB dynamic range. The total dynamic range of 90 dB is then reduced to 51.7 dB. This variable dynamic range capability is extremely important, as without it, you can never really appreciate the musical content recorded on your CD software in the automotive environment.

The channel separation provided by the unit is good at 100 Hz and 1 kHz and is somewhat lower than normal at 10 kHz and 20 kHz where it drops to 53 and 39 dB respectively. This limited dynamic range does not really matter in the automotive environment and may well be an intentional design feature. The distortion characteristics of the player are not very good at 0 dB where there is a tendency for markedly increased distortion if the player's output voltage exceeds one volt.

With the voltage held down to one volt, the distortion levels actually decrease from a level of 0.13% down to 0.021% at the −20 dB level after which they rise slowly up to 1.43% at −70 dB; 4.9% at −80 dB; and 19.7% at −90 dB. These figures are still extremely good and certainly much better than is called for by an automotive CD player.

The measured emphasis levels are adequately maintained by the player with the deviation comparable to the better or best residential-type CD players. The signal-to-noise capabilities of the unit in the normal play position are 90.2 dB(A) without emphasis and 9.14 dB(A) with emphasis (which is excellent and much more than you require). The frequency accuracy of the unit is −1 Hz for a 20 Hz test signal, which is also extremely good.

The square wave and impulse responses of the unit confirm that this unit uses the conventional digital filtering technique, which Sony has utilized for the last three years. These tests also showed that the low frequency characteristics of the sound are not quite as flat as displayed by other Sony players which we have recently tested.

The most interesting tests are those associated with the interruptions to the information layer, black dot readout tests, black strip readout test and measured low frequency excitation with the highest levels that would normally be expected in an automotive situation.

The results of these tests were, to say the least, outstanding. The Discjockey passed all the software tests with flying colours and did not miss a beat. More significantly, the vibration levels which I imposed on the unit were the most severe that I have yet applied to any residential or automotive CD player and it passed every single test without fault. The maximum vibration level that I could generate was just over 2 'g' in the 5 Hz to 10 Hz range and the unit accepted this while playing without any sign of complaint. The test vibration was applied in each of the three axes in turn with the same result; grade A performance and unimpaired listening.

The internal mechanism is spring isolated, obviously effectively, and the tests which I imposed on the player would be extremely difficult to duplicate in a car in a real situation excluding off-road vehicles off the beaten track. As a consequence I am very impressed with what the design engineers have achieved in the unit's isolation system.

Subjective testing

The subjective listening tests on this player were of necessity restricted to playing the unit through an amplifier and monitor loudspeakers in my laboratory and the quality of sound was extremely clean, sharp and undistorted (provided the output levels were kept below one volt). They were generally as good as I have yet heard from an automotive CD player.

The Sony CDX-J10 Discjockey is an outstanding piece of equipment. Its main attributes are its convenience and its technical and ergonomic performance which are quite exceptional. Given a situation in which you are likely to be trapped inside a motor vehicle for hours on end, this is unquestionably the system to buy. The only catch is that with a base RRP of $1999 and the obvious need to install at least another $2000 worth of amplifier/s and speakers, you are going to end up with a very pricey system. With the matching performance of the best amplifiers and automotive speakers that are now available, the results should be positively breathtaking. ●

CELLULAR RADIO

Mitsubishi Mobile

Not quite the Dick Tracy model yet, but the shape of things to come. With the Diamond Tel, cellular radio finally kicks off.

Peter Williams

REVIEWING a cellular radio at the moment is a bit like assessing a BMW M1 — you can read the specifications and see the photos, but putting it to a road test is out of the question right now in Australia.

With no cell sites yet operational in Australia we had to content ourselves with reviewing the features and running some lab tests to see how well the specifications demanded by Telecom and DOC have been met.

Features

Mitsubishi Mobile is a dual purpose system that can be mounted in a car or, with the optional battery pack, be used as a personal portable telephone. In this mode it is designed to be carried over the shoulder with a carry strap. And in this case a short whip antenna is used, plugged into the antenna socket.

The handset clips neatly onto the transceiver base unit. It's approximately the same size as a normal phone handset but has a different shape and keypad rather reminiscent of a scientific calculator.

In a car, the transceiver base unit may be mounted on the centre console with the handset clipped on the top. The only wires to connect are the power cord and the coax cable to the antenna. If space is a problem the alternatives are to mount the transceiver unit under the seat or in the boot. The handset can be mounted on a separate cradle in a more accessible position. Of course the mounting

Handset showing keypad. The called telephone number is displayed on the LCD.

methods will be determined by what you have — a Rolls would be easier to fit than a Honda Civic.

Handset

The handset is rather impressive with 22 keys, but it's easily operated once you know what they all do. The photo shows the layout. There is a 16-digit LCD display showing the dialled number and other service functions. These functions, or status indicators as they are called, are lit as follows:

PWR: lights when power is on.
IN USE: lights when a call is in progress.
NO SVC: no service — lights when you are outside service areas.
ROAM: lights when within system range.
MUTE: lights when telephone is muted as when using hands-free microphone for private conversations.
FCN: lights when auxiliary functions are selected.
HORN: lights when the telephone is in the Horn Alert mode. You can have your car wired so that the horn will sound on an incoming call. It's intended for use if you are temporarily absent from the vehicle.

Below the LCD readout are the function keys — a total of 11.

PWR: turns your telephone on and off.
FCN: a function key to select auxiliary functions (see later).
RCL: recalls a number from memory.
STO: stores a number in memory.
MUTE: mutes the handset and hands-free microphone for private conversations.
NITE: selects one of two brightness levels on the keyboard for low ambient light conditions.
CLR: clears the display or clears the last digit.
END: terminates the call.

The two Δ or ∇ keys are depressed to turn the volume up or down in eight discrete steps. The remaining 12 keys are used for dialling the required number or setting up desired special functions when operating.

CELLULAR RADIO

So, what is cellular radio? In an ordinary telephone service the factor limiting the number of telephone channels is the number of wires in the ground. When the radio is used for propagation of the telephone signal the same role is played by the electromagnetic spectrum, ie, the amount of space allocated the service determines how many calls you can have going at one time.

One way around this impasse is to use multiplexing. To cram more channels into one pair of wires we can divide the channels in time, or in frequency, or in some combination of both. The limiting factor in the amount of multiplexing is the bandwidth of the transmission medium. In wire communications this is set by technology, but this is true to a much lesser case in radio communications. Over the air, the limit is set by legislation.

An enormous number of potential users have some legitimate reason to use the radio spectrum. This finite range of frequencies is broken down into small regions and allocated to certain uses on the same basis that political decisions are always made. Whether those are good or bad reasons, the result is that around the world, only a small range of frequencies is available for consideration by telephone companies.

When the facts of scarce spectrum resources meet the needs of intelligible speech transmission for a certain minimum bandwidth, the result is a service like the MTS. It uses a single, or a few widely spaced transmitters. All the mobiles share the frequency space available on a first come first served basis.

Cellular radio goes down a different track, which we might call space multiplexing. The idea is that the same frequency is reused in different places across a large area like a city. The city is divided into zones called clusters, and each cluster into cells. At the centre of each cell is a radio transmitter which broadcasts over a small range of frequencies. It is surrounded by other cells all broadcasting on different frequencies. Together, all the cells in a cluster take up the entire bandwidth available to the service. So, within this cluster, all the frequencies available are separated in a specific special pattern. This pattern is then repeated in another cluster adjacent to it, and in another and another and so on. The result is that no two adjacent cells use the same small range of frequencies.

The number of cells in a cluster must be chosen such that the pattern forms in the way just described. On the assumption that all the cells are the same size and shape, there are only a certain number of cells per cluster that will work, for example: 4, 7, 9, 12, 13, 16, 19 and so on. Telecom has settled on 7 as its standard number.

The number of cells in a cluster is the result of a trade off. The advantage of going to higher numbers is that there is less danger of interference with another cell using the same frequency. In order to find the same frequencies being reused one must cross a greater number of other cells.

On the other hand the more cells there are in a cluster, the fewer channels are available in any given cell. So the trade off is between reception quality and efficient use of the spectrum.

One of the beauties of the system is that it is expandable in a way no other form of multiplexing is. Simply by making the size of the cells smaller, you can increase the number of subscribers ad infinitum. The primary check on this process is an economic one. The more cells, and thus transmitters there are the more the system costs.

Handoff

Perhaps the most fundamental technical problem that needed to be solved before cellular radio could become a reality was 'handoff'. Cellular radio is intended as a mobile service. Thus it has to be accepted right from the start that during the course of a call the mobile transceiver might traverse a number of different cells. At each cell boundary the mobile must change base station and thus frequency. The smaller the cells the faster and more often this process must be done. It has only been made possible by the availability of large amounts of computing power, both in the radio and the base station.

While the unit is on the air the level of its signal is constantly monitored. When the signal reaches a certain low level the system commences to find a new frequency in a new cell that will achieve a significantly higher signal level.

To do this the system tries out a number of different adjacent cells, searching for one on which the signal is better. When it finds one it assigns a new route through the switching centres for the call, and then orders the mobile to switch frequency. The whole process takes a few hundred microseconds to complete, so that users are completely unaware of what is happening.

This system, impressive though it may be, would be of little use without a rather complex interface into the conventional telephone network. Under normal conditions the mobile communicates with a base station, which turns the FM signal from the mobile into a two megabit pulse code modulated data stream. Each base station has associated with it a Mobile Services Switching Centre (MSC) which checks the level of the signals, initiates the handoff routine if necessary and passes the signal on to the exchange.

The MSC is also able to communicate directly with all the other adjacent MCS's so that during the handoff operation, proper switching can be achieved. The control sequence originates in the MSC which first accepts the call and which continues to control the fate of the call as long as the connection is maintained, even though it may no longer be directly involved.

When the MSC has determined the proper handoff sequence a parallel operation takes place between the exchanges. An exchange has to be one of the new generation of digitally controlled Ericsson AXE exchanges; they connect the mobile to the rest of the Telecom switched network, and re-route the signal path under the control of the MSC.

Operation

To find out how difficult it would be to use the telephone in real life, we had to simulate a cell site, which meant the use of a special test set. A cellular radio tester provides the necessary calling information to a radio and responds with a display of system information and transmitter parameters such as power output, frequency error, and other important characteristics. It also provides the necessary paging channels. ▶

In this simulated system, we were able to put the Mobile through a typical "be called" and "calling up" process. At the same time we could see the various technical parameters that are demanded by the specifications.

The rf connection was simply made by connecting the antenna socket of the Mobile directly to the input socket of the tester. The dialling sequence is extremely simple. Turn the phone on by pressing the PWR key on the handset and you see a momentary display of all digits. An alert tone also sounds. You don't have to remove the phone from the console for any part of this sequence.

If you have locked the phone the LOCKED message shows on the display. To remove it, you must dial in your special unlock code or PIN number. All you do then, is to key in the desired telephone number and watch each digit come up on the display. To transmit you just press the SEND key.

When the connection is established, all you do is pick up the handset, press SEND and start talking.

A hands free capability exists too, with a separate microphone that can be mounted on the sun visor. A speaker in the control unit allows you to hear your called party without lifting the handset at all. Using the handset like an ordinary telephone automatically inhibits the hands free function.

To terminate or "hang up", all that is required is to press the END key.

If you want to know how long you spent on an STD call, the cumulative talk time can be displayed by pressing the FCN (function) key first and the "8" key.

The Mitsubishi Mobile with handset detached and with portable antenna attached to transceiver.

Built-in options

One of the beauties of these telephones is the memory capacity. You can store up to 100 phone numbers, and recall them by simply pressing the RCL (recall) key and entering the number of the address from 0 to 99. The desired number appears on the display and pressing the SEND key makes the call. Of course, this presumes you have a good memory so you can remember what number is in what memory location.

Technical

We have said that all cellular radios have to meet Telecom and international standards. If radios meet that specification then one can expect them to perform as intended, so the user will not be compromised on performance.

Many of the specifications are peculiar to cellular radio control functions. For instance, peak frequency deviation of ± 12 kHz maximum for voice and ± 8 kHz for the signalling tones are required. Compare this with the deviation in the mobile two-way service of ± 5 kHz and it will be obvious that there needs to be a close look at satisfying system parameters where receivers are concerned. For example, the received digital control information must have negligible error rates if calling/control functions are to be effective.

Exacerbating the problem, receiver manufacturers must allow for less than optimum conditions. These unfavourable effects occur as a result of vehicle speeds which accentuate phase reversals and cause frequency shifts. Reflections of the radio signals from buildings in urban areas also cause problems. There are also localized poor reception areas which have to be accounted for.

To handle these problems, the transmitter and receiver must change power and retune to new channels with a minimum of delay. Switching times are specified for this within the standard.

We have compiled a list of the more relevant specifications. Our laboratory results are shown in the table for comparison, so you can see the variation from the specification.

Physical construction

A radio must be robust, well engineered, and ergonomically acceptable to perform in this environment. It has to withstand extremes of temperature, shocks and vibration almost as rigorous as that in military service. The hand set must be conveniently located, and it should not obstruct the normal operation and appearance of the car.

We found this unit had been ruggedly built. In addition it is shielded from rf fields, which are an immense problem in cars. The separate parts of the box are sealed with an O ring to keep out dust and moisture.

The mobile cradle can be locked with a key but there is no means of preventing the removal of the hand set. This could be a problem if you forget to program the security code into the unit.

In summary we can only say that if the Mobile is a representative example of what is to be offered to mobile phone users then they should be well satisfied.

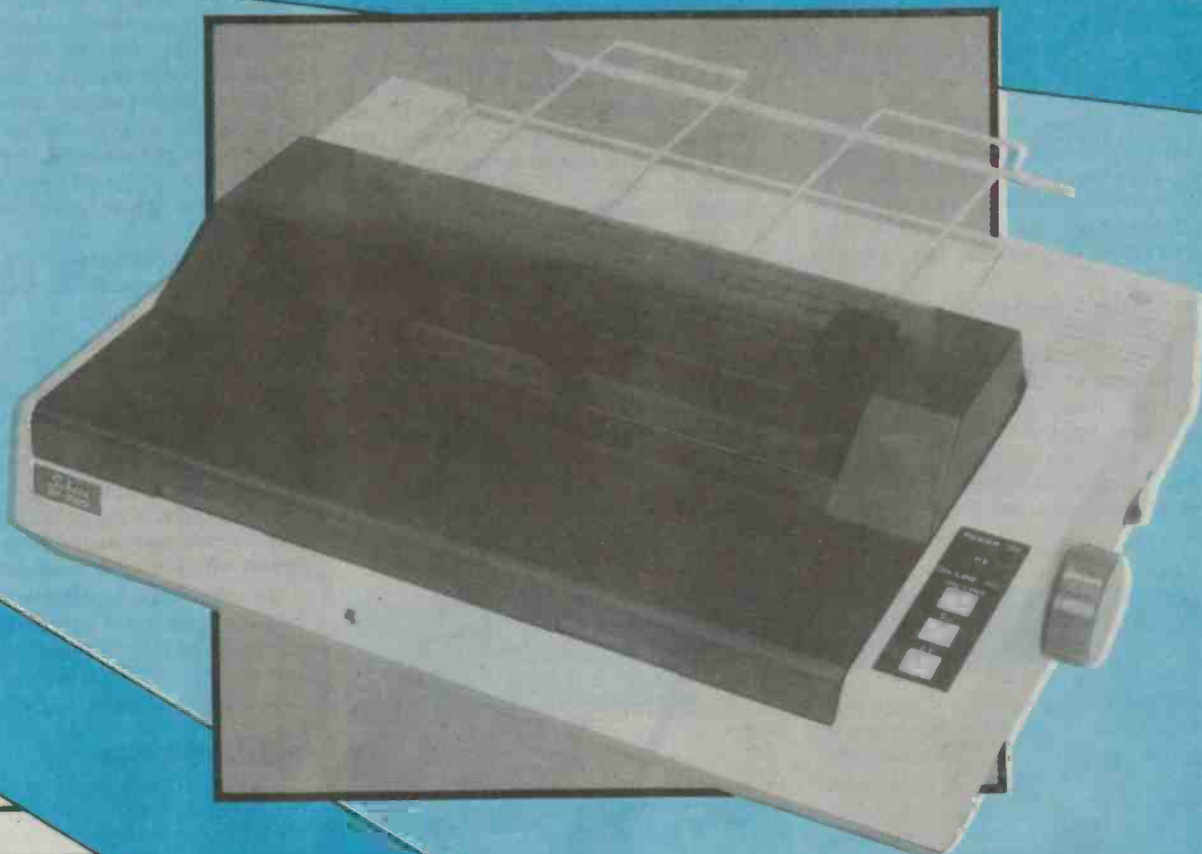
Service

For the most part, all circuits in the radio will remain in adjustment for long periods of time, although it may be advisable to have a check done every year. Automatic test sets such as the one used in this review can do the whole test routine in minutes, including antenna, without removing the radio from the car.

We understand that Telecom will require manufacturers to provide adequate service facilities before they are authorized to supply radios, so there should be no problem in this area.

In use, there are no more precautions that should be taken than if you use any other radio system and the user's manual, although written for the USA market, is just as appropriate here. For example, it warns that some control functions in your car may be subject to rf interference such as anti-skid and electronic fuel injection systems. The obvious thing to do is to have these things checked out on installation. ●

BUYING GUIDE TO PRINTERS



PRINTERS

This month, we cover the multitudinous types of printer that have been developed over the past few years to meet the growing computer industry demand.

Phil Cohen

PERHAPS BECAUSE ITS history is such a short one, the computer industry is still evolving its vocabulary. In the BASIC language, for example, the command that causes an output to the screen of the computer is named **PRINT**. This is due to the fact that when BASIC was developed, a couple of decades ago, the only output device you could afford to connect to a computer in any numbers was a teletype.

This was a cross between a mechanical typewriter, a telex machine and a Volkswagen, a glorious combination of solenoids, bits of bent wire and inked ribbon that effectively limited both your typing speed and the speed of output to something around that of Morse code.

The teletype worked on the now familiar golfball principle, in which a whirling piece of metal with all of the letters of the alphabet embossed on it was hurled at a piece of paper with an inky ribbon in between.

These days, printers have come some way past that. There are at present a number of different printer technologies around, a couple of which you are probably able to afford.

Thermal and discharge

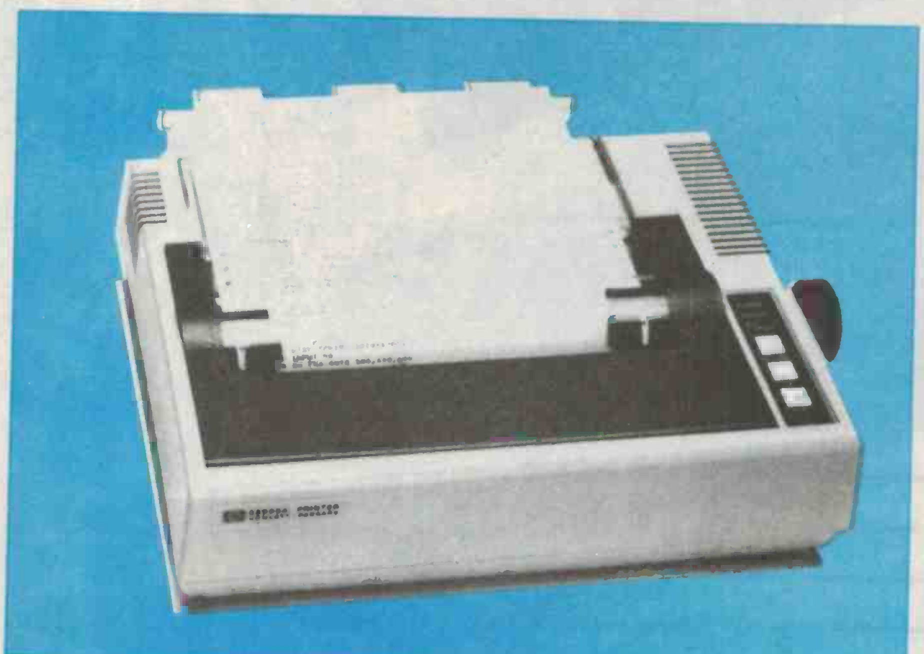
Starting at the bottom end of the price scale, the discharge and thermal printers are normally used in applications where small size, small power consumption, and above all low price are important. Both work with special paper, which is usually sold in rolls.

In the thermal printer, a number of very small heating elements are dragged across the surface of the paper in a printing head, only a few millimeters across. As they move, they can be heated up instantaneously by passing current through them, and will cool almost as quickly when the current is not there. When an element is hot, the paper underneath (which, remember, is specially treated) will change colour.

The elements are arranged in a vertical row, and by turning them on and off at appropriate times, a pattern of dots can be formed on the paper in the shape of letters and numbers.

The discharge printer works on a similar principle, the difference being that instead of heating the paper, the discharge printer passes a high voltage spark into it to change its colour permanently by burning the paper.

In quantity, small thermal and discharge printers can cost as little as a few dollars, and are sometimes built into calculators.



Dot matrix

Dot matrix printers are probably the most common type used with personal computers. Basically, they work on similar principles to the thermal and discharge types, except with the more traditional ink and normal paper.

A number of solenoids are built into the print head, and each is attached to a 'print wire' which pokes through the head and touches the paper when the solenoid is energized.

An ink ribbon between the head and the paper causes a dot of ink to be deposited at the appropriate spot.

Although in the past dot matrix printers were generally thought of as low quality, high speed output devices, recent advances such as the ability to move the print head and the paper by less than the thickness of a single dot have allowed dot matrix printers to produce high quality output with properly shaped typefaces (ie, ones that do not look like they are composed of dots) and even diagrams with lines that look continuous.

By using a multi-coloured ribbon, a dot matrix printer can be coaxed into printing in colour, although this turns out to be expensive and not as impressive as it sounds.

Dot matrix printers cost $100 upwards.

Printer/Plotters

A plotter is traditionally a very expensive device indeed, which uses a special pen driven by computer-controlled motors to actually draw on the surface of a piece of paper.

Recently, a number of cheap printers have appeared which use the same principle as an expensive plotter, but in a very much smaller size, and using ballpoint pens.

The use of these printer/plotters has not really taken off in the home computer area, but they are likely to become more popular since they can normally print in four colours.

Printer/plotter mechanisms are usually found in small portable electronic typewriters and some cheap computer printers (like the Mattel/Radofin Aquarius printers). A mechanism might cost somewhere in the region of $50 in quantity (at an educated guess).

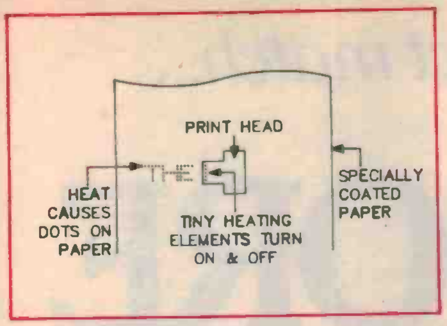


Figure 1. Thermal printer.

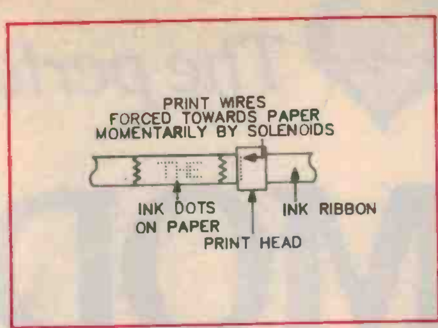


Figure 2. Dot matrix printer.

Daisywheel

At one stage, a daisywheel printer was every computer enthusiast's dream. The output from a daisywheel looks just like the output from a high quality electronic typewriter, which is not surprising since high quality electronic typewriters use the same mechanisms as daisywheel printers!

The daisywheel in question is a round flat piece of plastic with about a hundred petals sticking out of it. Each petal has a letter or number embossed on it. The print head turns the daisywheel until the appropriate letter is in the right spot, and then a hammer in the print head forces the petal into contact with the paper, with the usual inky ribbon in between.

Daisywheel printers generally cost from $1000 upwards.

Laser printers

My dream (I already have a daisywheel printer) is to own a laser printer. This is actually a cross between an electronic typesetting machine and a photocopier. A laser beam is generated inside the printer and scanned across the paper, turning on and off to form the appropriate pattern of black dots on the paper. The paper is not actually burned, but a photocopier-like process is used to form the dots (electrostatic attraction of carbon dust, followed by heat to fuse it into place).

A laser printer can produce print of such a high quality that it is impossible to tell it from typeset material, such as the text that is used to print this article. Laser printers can produce text in almost any size, and can also print diagrams, lines, and are generally just what you need for a small publishing business. Santa take note.

Laser printers cost anything from thousands of dollars upwards.

Ink jet

The big news a few years ago was the advent of the ink jet printer — a device which actually spat little ink droplets at the paper and guided them to their targets by electrical fields.

The great thing about an ink jet printer is that it doesn't matter what the material is you are printing on. Ink jets are currently used for printing onto things like bottles (because they are round) and they have been demonstrated printing onto uncooked egg yolks without breaking the skin!

Ink jet printers are much quieter than dot matrix or daisywheel types.

Appropriate printers

Each of these types of printer has its advantages and disadvantages. The thermal and discharge types are usually used as part of a larger piece of equipment, such as a printing calculator, data logging device, etc.

The printer/plotters have yet to find their full potential, I believe, and are presently used for cheap typewriters.

Dot matrix printers are very widely used, and are capable of fairly high speeds (a couple of hundred characters per second). Daisywheel printers will be pushed out of the market when laser printers become cheap enough, mainly due to the daisywheel's relatively slow speed (a few dozen characters per second).

The speed of a laser printer is usually measured in pages per minute, which gives some indication of how much faster than other printers they are!

Ink jet printers have not really taken off in the way they might, probably due to technical problems like the clogging of ink jets. When they were first released they seemed ideal for an office environment due to their very low noise — but laser printers are even quieter.

As things like facsimile, telex, printers, photocopiers and so on converge over the next few years, we are probably going to see a good general purpose printer built around a laser, which is in the price bracket now occupied by daisywheel printers.

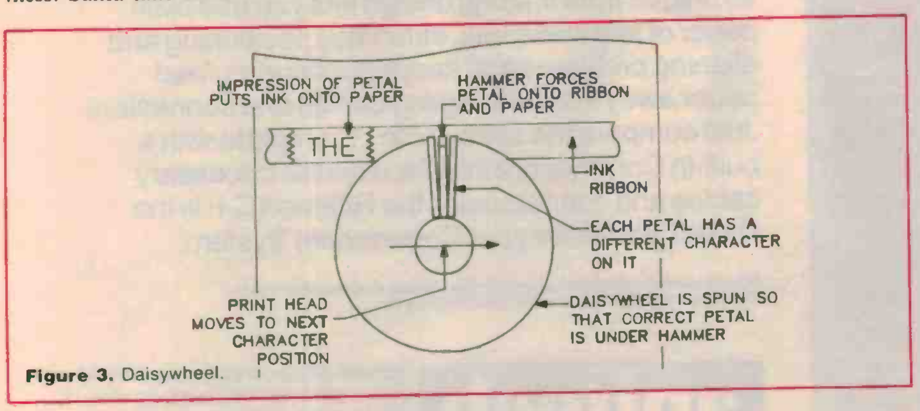


Figure 3. Daisywheel.

Glossary

Daisywheel: a flat round piece of plastic with the letters of the alphabet, numbers, symbols, etc, embossed on each of a number of petals protruding from it. The daisywheel is turned by a printer until the appropriate petal is in the right position, and then a hammer forces that petal into contact with the paper (with a ribbon in between), forming the image of that character on the paper.

Discharge printer: a printer that uses high voltage sparks to make marks on specially treated paper.

Dot matrix: a type of printer that uses a number of print wires attached to solenoids to hit appropriate points on the paper (with a ribbon in between).

Golfball: a round device with all of the letters on the alphabet, numbers, symbols, etc, embossed on it. The golfball is turned by the printer until the appropriate character is opposite the hammer, then the hammer hits the back of the golfball, forcing it onto the paper, with a ribbon in between to make the impression of the character on the paper in ink.

Hammer: see 'golfball' and 'daisywheel'.

Head: that part of the printer that moves back and forth across the paper.

Laser printer: a printer that uses light from a laser to form an image on the paper that is fixed there by a process similar to photocopying.

Print: a BASIC command to put something onto the screen.

Petal: see 'daisywheel'.

Plotter: a device that uses a special pen dragged by a motor arrangement across paper to draw diagrams.

Print wire: see 'dot matrix'.

Printer/plotter: a very cheap plotter which can be used as a printer by drawing characters as well as diagrams.

Ribbon: a strip of inked cloth.

Solenoid: an electromagnet used to move a piece of metal a short distance.

Teletype: an old form of combined printer and keyboard.

Thermal printer: a printer which uses rapid heating and cooling as part of its head to form a pattern on specially treated paper.

Typeface: the shapes of the set of characters being used by a printer. ●

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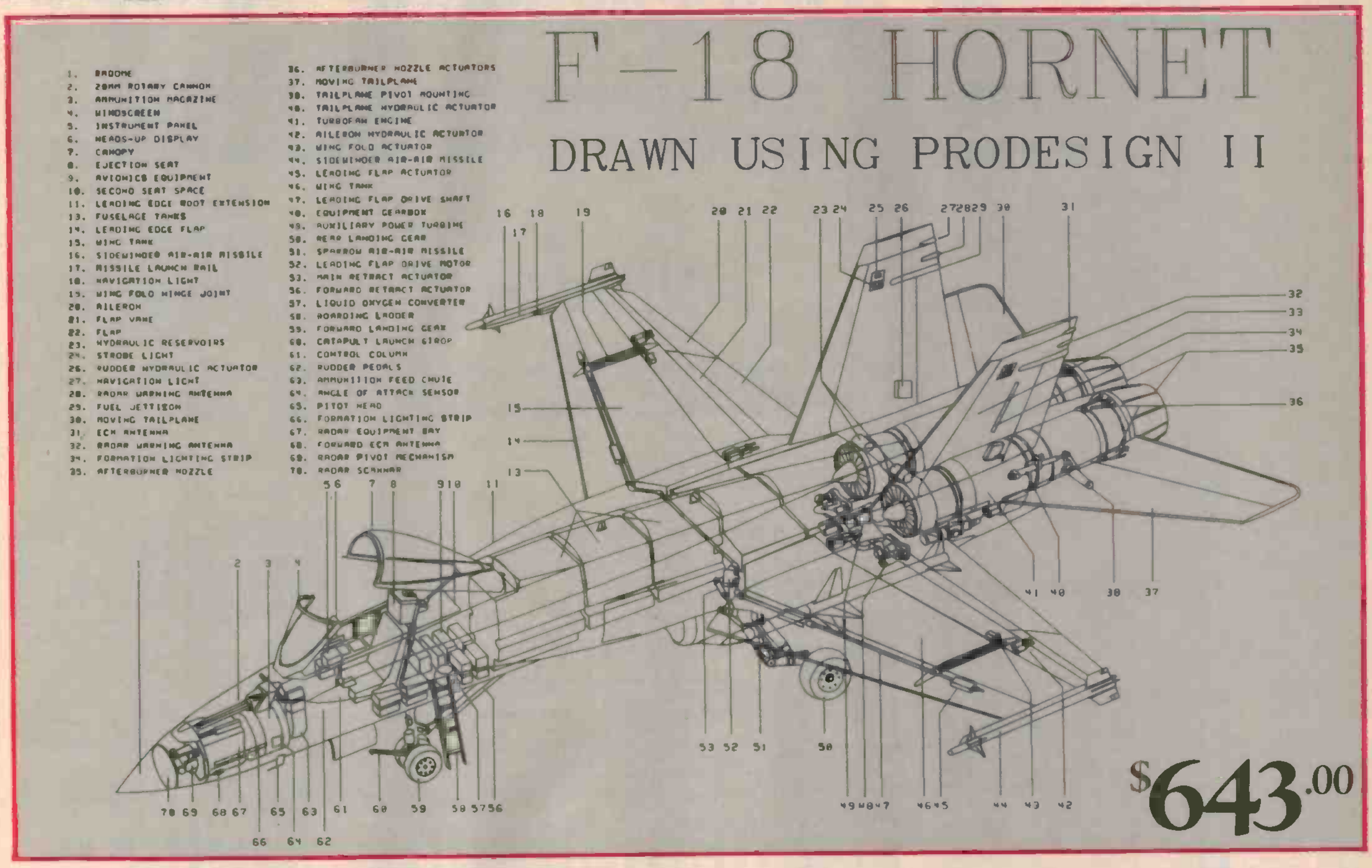

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1986 PRINTERS BUYERS' GUIDE

This table lists only the standard printer features. Many printers have a wide range of add-on options available, particularly in the areas of feed type and founts and enhancements. All the prices quoted are approximate and vary between dealers.

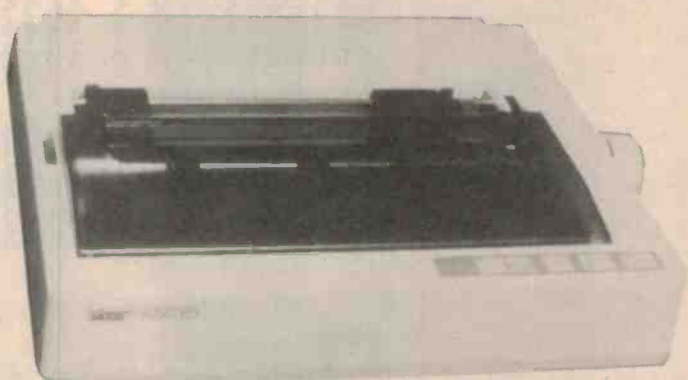
CSF — cut sheet feed
DQ — draft quality
(N)LQ — (near) letter quality
cps — characters per second
ppm — pages per minute
lpm — lines per minute

DOT MATRIX

Make	Model	Size (mm)	Feed Type	No of Founts	Italic	Compressed	Enhanced	Graphics	Colour	Standard Interface	Interface Options	Emulation Modes	Paper Width (mm)	Speed (cps) DQ/(N)LQ	RRPs (approx)	Distributor
Apple	Imagewriter 2	431x304x127	friction/sprocket	2	y	y	y	y	y	serial			254	250	1395	Apple
Apple	15"Imagewriter	498x285x125	friction/sprocket	2	y	y	y	y	n	serial			254	120	1395	Apple
Admate	DP100	420x320x125	tractor	7	n	y	y	y	n	parallel	RS232		254	100	449	Microbee
BMC	BX1000	384x315x125	friction/tractor	1	n	y	y	y	n	parallel	RS232		254	100	464	Rita
BMC	BX130	384x315x125	friction/tractor	1	y	y	y	y	n	parallel	RS232	IBM	254	130	489	Rita
BMC	BX130W	586x358x130	friction/tractor	1	y	y	y	y	n	parallel	RS232	IBM	381	130	618	Rita
C-Itoh	CI-1550CEP	550x300x133	friction/tractor	6	n	y	y	y	y	parallel	serial	Epson	381	180	1949	Anitech
C-Itoh	CI-1550SEP	550x300x133	friction/tractor	6	n	y	y	y	n	parallel	serial	Epson	381	180	1749	Anitech
C-Itoh	CI-8510SCEP	550x300x133	friction/tractor	6	n	y	y	y	y	parallel	serial	Epson	241	180	1649	Anitech
C-Itoh	CI-8510SEP	420x297x137	friction/tractor	6	n	y	y	y	n	parallel	serial	Epson	241	180	1399	Anitech
C-Itoh	CI-310CP	420x297x137	friction/tractor	3	y	y	y	y	y	parallel	serial	Epson	241	300	2075	Anitech
C-Itoh	CI-310CEP	442x346x128	friction/tractor	3	n	y	y	y	y	parallel	serial	IBM	241	300	1975	Anitech
C-Itoh	CI-310CXP	442x346x128	friction/tractor	3	y	y	y	y	y	parallel	serial	IBM,Epson	254	300	2075	Anitech
C-Itoh	CI-310EP	442x346x128	friction/tractor	3	y	y	y	y	n	parallel	serial	IBM	254	300	1895	Anitech
C-Itoh	CI-310P	442x346x128	friction/tractor	3	y	y	y	y	n	parallel	serial	Epson	254	300	1975	Anitech
C-Itoh	CI-310XP	442x346x128	friction/tractor	3	y	y	y	y	n	parallel	serial	Epson, IBM	254	300	1975	Anitech
C-Itoh	CI-315CP	568x346x143	friction/tractor	3	y	y	y	y	n	parallel	serial		381	300	2499	Anitech
C-Itoh	CI-315CXP	568x346x143	friction/tractor	3	y	y	y	y	y	parallel	serial	Epson, IBM	381	300	2499	Anitech
C-Itoh	CI-315XP	568x346x143	friction/tractor	4	y	y	y	y	n	parallel	serial	Epson, IBM	381	300	2399	Anitech
C-Itoh	CI-3510	570x420x120	friction/tractor	4	y	y	y	y	n	serial		LA100,DEC	381	350	4345	Anitech
C-Itoh	CI-3520	570x420x120	friction/tractor	8	y	y	y	y	n	parallel		IBM	381	350	4345	Anitech
Centronics	HPC808		friction/CSF	8	y	y	y	y	n	parallel	RS232		254	180/34		STC
Centronics	HPC1368		friction/CSF	8	y	y	y	y	n	parallel	RS232		431	180/34		STC
Centronics	351		friction/CSF	2		y	y	y	n	parallel	RS232		381	200/50		STC
Centronics	353		friction/CSF	2		y	y	y	n	parallel	RS232		381	200/50		STC
Centronics	358		friction/CSF	4		y	y	y	y	parallel	RS232		381	400/100		STC
Chinon	K-108	412x300x115	friction/sprocket	8	y	y	y	y	n	parallel		IBM,Epson	280	210/75	1049	Microbee
Citizen	MSP10	403x344x90	friction/tractor	4	y	y	y	y	n	parallel	serial	IBM,Epson	254	160/40	908	Datronics
Citizen	MSP15	575x354x90	friction/tractor	4	y	y	y	y	n	parallel	serial	IBM,Epson	406	200/50	1092	Datronics
Citizen	MSP20	403x344x90	friction/tractor	4	y	y	y	y	n	parallel	serial	IBM,Epson	254	200/50	1437	Datronics
Citizen	MSP25	403x334x90	friction/tractor	4	y	y	y	y	n	parallel	serial	IBM,Epson	381	120/24	586	Datronics
Citizen	ISP1200	373x240x90.5	friction/tractor	4	y	y	y	y	n	parallel	serial	IBM,Epson	254	35	1550	Datronics
Commodore	MPS1000	315x422x84	friction/tractor	6	n	y	y	y	n	serial		IBM	254	100	559	Commodore
Commodore	MPS803	330x140x70	friction	1	n	n	y	y	n	serial			254	60	349	Commodore
Datamate	DSE130	385x315x125	friction/tractor	1	n	y	n	y	n	parallel		IBM	254	30	499	DSE
Dataproducts	8012	425x345x125	friction/tractor	3	n	y	y	n	n	parallel			254	180	995	DSE
Dataproducts	8022	425x345x125	friction/tractor	3	n	y	y	n	n	parallel			381	180	995	DSE
Digital	LA210	546x343x127	CSF	11	y	y	y	y	n	serial	parallel	Epson	330	240	3545	Mitsui
Digital	LA210D	851x699x61	CSF	8	n	y	n	n	n	serial			381	180	6280	Mitsui
Digital	LA50	400x295x142	CSF	4	n	y	y	y	n	serial			254	100	1261	Mitsui

Epson	EX80	447x378x119	friction/tractor	3	y	y	y	y		serial/parallel		Diablo,IBM	203	300/60	1050*	Epson
Epson	EX1000	618x388x121	friction/tractor	3	y	y	y	y		serial/parallel		Diablo,IBM	345	300/60	1320*	Epson
Epson	FX85	420x347x100	friction/tractor	2	y	y	y	y	n	parallel		IBM	203	160/30	840*	Epson
Epson	FX105	594x354x106	friction/tractor	2	y	y	y	y	n	parallel		IBM	335	160/30	1070*	Epson
Epson	GX80	421x314x84	friction	2	y	y	y	y	n		many		203	100/25	430*	Epson
Epson	LQ800	406x335x93	friction/tractor	2	y	y	y	y	n	serial/parallel	many		203	216/72	1195*	Epson
Epson	LQ1000	581x335x93	friction/tractor	2	y	y	y	y	n	serial/parallel	many		335	216/72	1490*	Epson
Epson	LX86	421x314x84	friction	3	y	y	y	y	n	parallel			203	120/25	530*	Epson
Epson	RX100+		friction/tractor		y	y	y	y	n	parallel			345	100/25	700*	Epson
Epson	LQ2500		friction/tractor		y	y	y	y	n	serial/parallel			345	270/90	2150*	Epson
Facit	4513	420x340x125	friction/tractor	2	y	y	y	y	n	serial/parallel		Epson	250	158	1824	ElectronEIA
Facit	4514	630x340x150	friction/tractor	2	y	y	y	y	n	serial/parallel		Epson	380	158	2448	ElectronEIA
Facit	C5500	584x458x196	friction/tractor	2	y	y	y	y	y	serial/parallel		Epson	380	250	4320	ElectronEIA
Facit	C7500	584x458x196	friction/tractor	2	y	y	y	y	y	serial/parallel		Epson	380	400	5748	ElectronEIA
Facit	4542	640x460x250	friction/tractor	1	n	n	n	y	y	serial/parallel			450	250/400	8268	ElectronEIA
Fujitsu	DL2400	570x390x195	friction/tractor	2			y		n	serial/parallel		IBM/Diablo	345	360/120		Microhelp
Fujitsu	DPL24D	550x380x160	friction/tractor	3			y		n	serial/parallel		Diablo	345	192		Microhelp
Fujitsu	DPL241	550x380x160	friction/tractor	2			y		n	serial/parallel		IBM	345	288		Microhelp
Fujitsu	DX2100	438x345x120	friction/tractor	2			y			serial/parallel		Epson	203	220/40		Microhelp
Fujitsu	DX2200	580x345x120	friction/tractor	2			y		n	serial/parallel		Epson	345	220/40		Microhelp
Hermes	M400		friction/tractor	2	n	y	y	y	y	serial/parallel	many	Diablo/Epson	430	600/100	4500*	Impact Systems
Hewlett Packard	HP2932A	185x600x365	tractor	3	y	y		y	n	serial	parallel		381	200	5864	HP
Hewlett Packard	HP2934A	185x600x365	tractor	16	y	y		y	n	serial	parallel		381	200	6780	HP
IBM	4201	421x342x147	friction/sprocket		y	y	y	y	n	serial/parallel	serial		279	200	1106	IBM dealers
Interface Systems	468	580x560x220	tractor	2	-	y	n	y	y	3274/3276		3287	381	400/100		STC
Interface Systems	487	570x470x200	tractor	2	-	y	n	y	n	3274/3276		3287	381	200/50		STC
Interface Systems	424	570x470x200	tractor	2	n	y	n	y	n	S/3x twin ax		IBM	381	200/50		STC
ITT courier	9303	580x570x220	tractor	1	-	y	y	y	n	serial/parallel		IBM	381	220/55		STC
ITT courier	9306	580x570x220	tractor	1	y	y	y	y	n	serial/parallel		IBM	381	400/100		STC
NEC	P6	410x335x125	friction	7	y	y	y	y	y	parallel	serial	Epson	254	216	1114	Rita
NEC	P7	570x335x125	friction	7	y	y	y	y	y	parallel	serial	Epson	406	216	1362	Rita
NEC	P5	580x375x155	friction	7	y	y	y	y	y	parallel	serial	Epson/Diablo	406	264	2118	Rita
NEC	P5XL	580x375x155	friction	7	y	y	y	y	y	parallel	serial	Epson	406	264	2688	Rita
NEC	CP6	580x375x155	friction	7	y	y	y	y	y	parallel	serial	Epson	254	216	1372	Rita
NEC	CP7	580x375x155	friction	7	y	y	y	y	y	parallel	serial	Epson	406	216	1736	Rita
Newbury Data	NDC8850	580x375x155	tractor	7	y	y	y	y	y	serial	serial	Epson	351	480/320	6500	Ampec
Newbury Data	OSP2	553x491x188	CSF	13	y	y	y	y	y	parallel	parallel	Epson/IBM	A4	200/100		Ampec
Newbury Data	OSP3	533x559x227	CSF	13	y	y	y	y	y	serial	serial	Epson/IBM	A4	200/100		Ampec
OKI	Microline 182	355x270x75	friction/sprocket	9	n	y	y	y	n	serial/parallel	RS422	IBM/Epson	254	120	599	DSE/IPL Datron
OKI	Microline 183	524x279x128	friction/tractor	9	n	y	y	y	n	serial/parallel	RS422	IBM/Epson	381	120/60	849	IPL Datron
OKI	Microline 192	372x275x80	friction/sprocket	46	y	y	y	y	n	serial/parallel	RS422	IBM/Epson	254	120/60	899	IPL Datron
OKI	Microline 193	524x279x128	friction/tractor	46	y	y	y	y	n	serial/parallel	RS422	IBM/Epson	381	200/40	1180	IPL Datron
OKI	Microline 292	367x305x97	friction/sprocket	46	y	y	y	y	y	serial/parallel	RS422	IBM/Epson	254	200/40	1360	IPL Datron
OKI	Microline 293	521x305x97	friction/tractor	46	y	y	y	y	y	serial/parallel	RS422	IBM/Epson	381	200/100	1699	IPL Datron
OKI	Microline 294	521x305x105	friction/tractor	46	y	y	y	y	y	serial/parallel	RS422	IBM/Epson	381	400/100	2599	IPL Datron
OKI	Microline 84	512x328x133	friction/tractor	9	n	y	y	y	n	serial/parallel	RS422	IBM/Epson	381	200/50	1587	IPL Datron
Olympia	NP165	405x300x120	friction/tractor	30	y	y	y	y	n	parallel	RS232	Epson	254	165	720	Olympia
Olympia	N136	612x350x110	friction/tractor	30	y	y	y	y	n	parallel			254	200	1420	Olympia
Riteman	15	596x530x127	friction/tractor	9	y	y	y	y	n	parallel	RS232	Epson	381	160		Anitech
Riteman	C+	381x292x76	friction/tractor	10	y	y	y	y	n	serial		Epson	241	120		Anitech
Riteman	F+	596x330x127	friction/tractor	11	y	y	y	y	n	parallel	serial	Epson/IBM	241	120		Anitech
Seikosha	BP5420AI	595x580x194	friction/tractor	3	y	y	y	y	n	serial/parallel	many	Epson/IBM	381	420/104	3800	AWA/Mitsui
Seikosha	BP5420TX	595x580x194	friction/tractor	3	y	y	y	y	n	IBM twin ax		many	381	420/104	6300	AWA
Seikosha	BP5420U20	595x580x194	friction/tractor	3	y	y	y	y	n	Univac			381	420/104	4500	AWA
Seikosha	BP5420DEC	595x580x194	friction/tractor	3	y	y	y	y	n	serial/parallel		DEC	381	420/104	3900	AWA
Seikosha	BP5200AI	595x580x194	friction/tractor	3	y	y	y	y	n	serial/parallel	IBM/Wang	Epson	381	200/103	2450	AWA
Seikosha	BP5200TX	595x580x194	friction/tractor	3	y	y	y	y	n	IBM twin ax	IBM/Wang	many	381	200/103	5245	AWA
Seikosha	MP5300AI	590x372x157	friction/tractor	2	y	y	y	y	n	serial/parallel	IBM/Wang	Epson/IBM	381	300/50	2450	AWA
Seikosha	MP1300AI	470x360x137	friction/tractor	2	y	y	y	y	y	serial/parallel	IBM/Wang	Epson/IBM	254	300/50	1448	AWA

WIN THIS FINE STAR NX-10 NEAR LETTER QUALITY PRINTER VALUED AT NEARLY $600 FROM GENESIS SYSTEMS PTY LTD!



It's easy — just answer the questions below and send your answer to:

ETI-STAR PRINTER COMPETITION
PO BOX 227
WATERLOO, NSW 2017

Entries should be with us by 25 December 1986.

1. What type of printer is the NX-10?
2. What feed type is standard on the NX-10?
3. Will the NX-10 print graphics?
4. What type is the standard interface on the NX-10?
5. At what speed in draft mode will the NX-10 print?

All the answers can be found in our buyers' guide to printers on page 100.

Make	Model	Size (mm)	Feed Type	No of Founts	Italic	Compressed	Enhanced	Graphics	Colour	Standard Interface	Interface Options	Emulation Modes	Paper Width (mm)	Speed (cps) DQ/(N)LQ	RRP$ (approx)	Distributor
Seikosha	SP1000A	390x266x119	friction/tractor	2	y	y	y	y	n	serial/parallel		Epson	254	100/20	735	AWA
Seikosha	SP100VC	390x266x119	friction/tractor	2	y	y	y	y	n	Commodore			254	100/20	735	AWA
Seikosha	SP1000AP	390x266x119	friction/tractor	2	y	y	y	y	n	Apple			254	100/20	685	AWA
Seikosha	SP1000J	390x266x119	friction/tractor	2	y	y	y	y	n	IBM			254	100/20	735	AWA
Seikosha	SP180VC	407x274x86	friction/tractor	2	y	y	y	y	n	Commodore			254	100/16	685	AWA
Seikosha	GP700A	450x320x113	friction/tractor	1	n	y	n	n	y	parallel	many		254	50/38	695	AWA
Seikosha	SP1200Plus	401x337x104	friction/sprocket	2		y	y	y	n	parallel	serial	IBM	254	120		Emona
Sakata	SP1500	408x314x116	friction/tractor	2		y	y	y	n	parallel	serial		254	180		Emona
Sakata	SP5500	561x314x103	friction/tractor	2		y		y	n	parallel	serial	IBM	406	180		Emona
Star	NL10	400x336x104	friction/tractor	3	y	y			n	serial/parallel	many	IBM/Epsom	254	120/30	660	Triumph Adler/ Genesis Systems
Star	NX10	400x336x104	friction/tractor	2	y	y			n	parallel		IBM/Epson	254	120/30	599	Triumph Adler/ Genesis Systems
Star	SG10	392x315x145	friction/tractor	4	y	y	y	y	n	parallel	serial		254	120		Triumph Adler
Star	SG15	542x315x145	friction/tractor	4	y	y	y	y	n	parallel	serial		393	120		Triumph Adler
Star	NX15	542x360x105	friction/tractor	3	y	y	y	y	n	parallel	many	IBM/Epson	381	120/30	950	Genesis
Star	ND15	542x360x105	friction/tractor	3	y	y	y	y	n	parallel	RS232	IBM/Epson	381	180/45	1299	Genesis
Star	NR15	542x360x105	friction/tractor	3	y	y	y	y	n	parallel	RS232	IBM/Epson	381	240/60	1495	Genesis
Star	NB24	580x383x121	friction/tractor	3	y	y	y	y	n	parallel	RS232	IBM/Epson	381	200/70	1760	Genesis
Star	NB15	580x382x121	friction/tractor	3	y	y	y	y	n	parallel	RS232	IBM/Epson	381	300/100	2050	Genesis
Taxan	KP3500		friction/tractor		y	y	y	y	n	serial		many	367	350	2712	Megavision
Tektronix	4644	598x350x130	friction/tractor	3	y	y	y	y	n	serial/parallel		Epson	431	160		Tektronix
Texas Instruments	TI850XL		friction/tractor	2	y	y	y	y	n	serial/parallel		Epson	254	150/35		TI
Texas Instruments	TI850		friction/tractor	15	y	y	y	y	n	serial/parallel		Epson	254	150/35		TI
Texas Instruments	TI860XL		friction/tractor	2	y	y	y	y	n	serial/parallel		Epson	381	150/35		TI
Texas Instruments	TI865		friction/tractor	15	y	y	y	y	n	serial/parallel		Epson	381	150/35		TI
Texas Instruments	TI810		friction/tractor	5	y	y	y	y	n	serial/parallel	RS422	Qume	381	225/20		TI
Texas Instruments	TI880		friction/tractor	5	y	y	y	y	n	serial/parallel	RS422	Qume	381	300/75		TI
Toshiba	P351	560x360x150	friction	3	y	y	y	y	n	serial/parallel		Qume/IBM	381	288/100	2195	Toshiba
Toshiba	P351C	560x360x150	friction	3	y	y	y	y	y	serial/parallel		Qume/IBM	381	288/100	2495	Toshiba
Toshiba	P351E	560x360x150	friction	3	y	y	y	y	n	serial/parallel		Qume/IBM	381	216/72	1495	Toshiba
Toshiba	P321	417x325x150	friction	2	y	y	y	y	n	serial/parallel		Qume/IBM	279	216/72	1195	Toshiba

THERMAL

IBM	Quietwriter 1	541x365x854	friction	2	n	y	y	n	n	parallel			381	60	2663	IBM dealers
IBM	Quietwriter 2	541x365x854	friction	2	y	y	y	n	n	parallel			381	60	3038	IBM dealers
OKI	Okimate 20	330x190x60	friction	10	y	y	y	y	y	serial/parallel		many	254	80/4	699	IPL Datron

DAISYWHEEL

AWA	TP760	517x406x152	friction		y		n	parallel	serial		381	57	3195	AWA
AWA	TP790	517x406x152	friction		y		n	parallel	serial		381	90	3995	AWA
Citizen	Premier 35	636x382x157	friction	y	y	y	n	parallel	serial	many	419	35	1550	Datronics
Commodore	DPS1101	607x343x173	friction	y	y	n	n	serial			330	17	509	Commodore
Datamate	DWP2500	355x270x75	friction	n	n	n	n	parallel		Diablo	279	20	699	DSE
Diablo	D630	569x436x209	sprocket	n	n			serial/parallel			330	40	4800	Mitsui
Digital	LQP02	635x406x178	CSF		n			serial			330	25	4966	Mitsui
Digital	LQP03	527x387x197	CSF		n			serial			330	34	1916	Mitsui
Facit	D2000	450x305x145	friction	n	n	n	n	serial/parallel		Diablo	290	20	1512	Electron-EAI
Hewlett Packard	HP2603A	142x550x330	CSF	y	y	n	n	serial		Diablo	406	48	3926	HP
IBM	Wheelprinter	581x408x223	friction	y	y	y	n	parallel	serial		298	50/25	3456	IBM
Olympia	ESW1000	575x500x182	tractor	y	y	y	y	serial/parallel		Diablo	381	15	1200	Olympia
Olympia	ESW2000	604x310x190	tractor	y	y	y	y	serial/parallel		Diablo	431	25	2150	Olympia
Olympia	ESW3000	520x400x156	tractor	y	y	y	y	serial/parallel		Qume	431	35	2250	Olympia
Qume	Letterpro 20	520x360x190	tractor/CSF				n	serial/parallel	many		330	22		STC
Qume	Letterpro Plus	520x360x190	tractor/CSF				n	serial/parallel			330	45		STC
Qume	Sprint 11-40	620x377x181	tractor/CSF				n	parallel	many		381	40		STC
Qume	Sprint 11-55	620x377x181	tractor/CSF				n	parallel	many		381	55	3758	STC/Triumph Adler
Qume	Sprint 11-90	620x377x181	tractor/CSF				n	parallel	many	many	381	90	4737	STC/Triumph Adler
Qume	Sprint 11-130	610x178x371	tractor/CSF			y	n	parallel	many		381	40		STC/Triumph Adler
Qume	11 Widetrack		tractor/CSF				n	parallel	many		558	50		STC/Triumph Adler
Ricoh	RP3400Q	624x347x170	friction/CSF		o	n	n	serial	parallel	Diablo	421	52	3080	Mitsui
Uchida	DWX335	385x315x125	friction	n	n	n	n	serial		Qume	330	18	339	DSE

FULLY FORMED

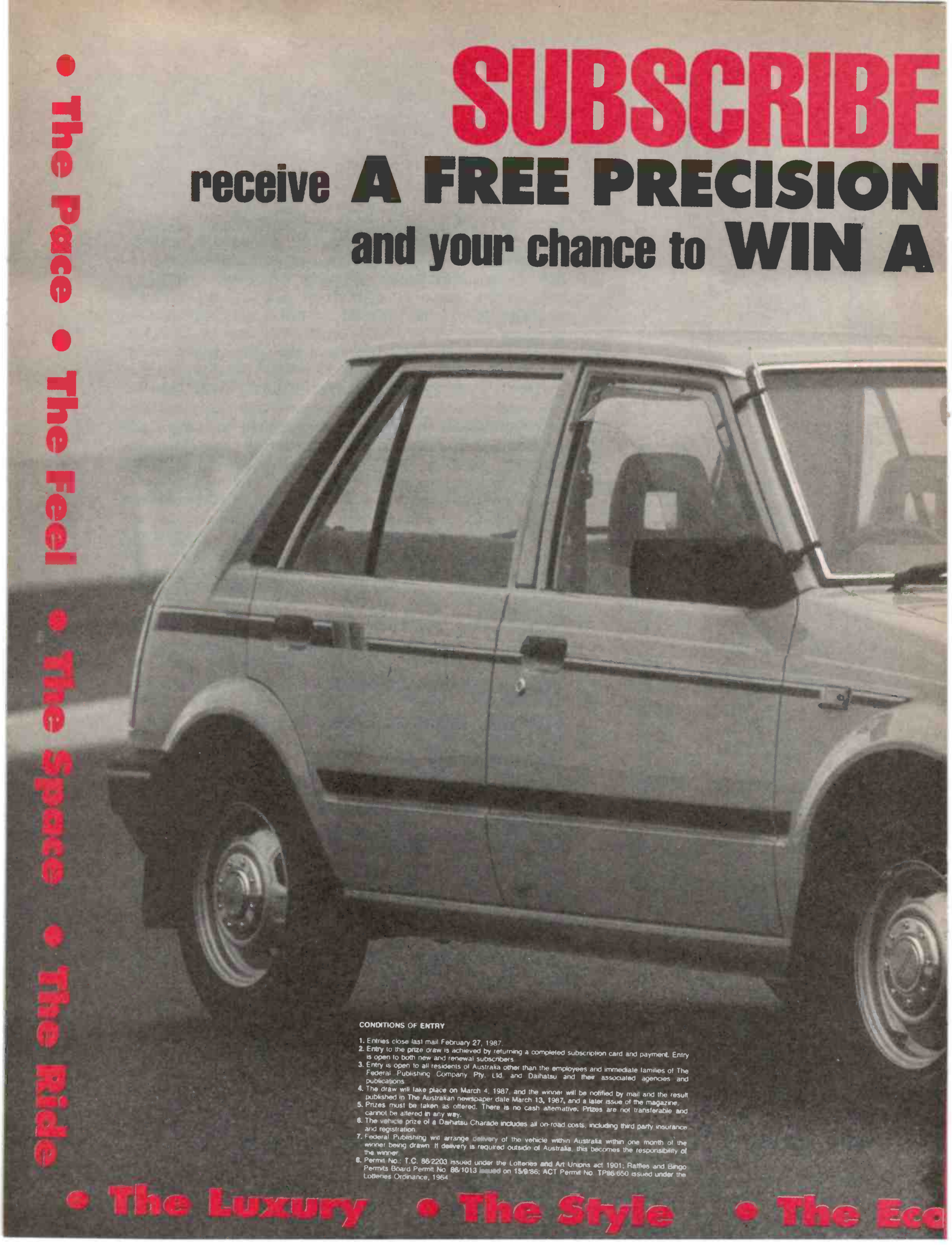
												lpm		
Centronics	LW400/455	910x740x690	friction					parallel	many	IBM/Epson	457	480		STC
Centronics	LW800/855	910x740x690	friction					parallel	many	IBM/Epson	457	480		STC
Decision Data	6708-38	1059x863x724	friction					twinax		many	444	300		STC
Decision Data	6811-38	1059x863x724	friction					twinax		many	444	700		STC
Decision Data	6814-30	1059x863x724	friction					twinax		many	444	1400		STC
Interface Systems	462	930x730x700	tractor	n	y	n		3274/76		IBM	381	300		STC
Interface Systems	463	930x730x700	tractor	n	y	n		3274/76		IBM	381	800		STC
Interface Systems	736	610x430x250	friction/CSF	n	n	n		3274/76		IBM	406	55cps		STC
NEC	Elf	490x330x147	friction	y	y	y		serial/parallel		many	330	20cps		Rifa
NEC	3500	570x395x208	friction	y	y	y		parallel	serial	many	406	55cps		Rifa
NEC	8800	570x409x172	friction	y	y	y		parallel	serial	many	406	35cps		Rifa
Printronix	DP600	1059x864x724	tractor	n	n	n		dataproducts	many	Diablo	444	600		Bell & Howell
Printronix	DP750	1059x864x724	tractor	n	n	n		dataproducts	many	Diablo	444	750		Bell & Howell
Printronix	DP1000	1059x864x724	tractor	n	n	n		dataproducts	many	Diablo	444	1000		Bell & Howell
Printronix	DP1200	1059x864x724	tractor	n	n	n		dataproducts	many	Diablo	444	1200		Bell & Howell
Printronix	B2012	1062x864x732	tractor	h	n	n		dataproducts	many	Diablo	444	1200		Bell & Howell
Printronix	B2015	1062x864x732	tractor	n	n	n		dataproducts	many	Diablo	444	1500		Bell & Howell
Printronix	B2020	1062x864x732	tractor	n	n	n		dataproducts	many	Diablo	444	1650		Bell & Howell

Make	Model	Size (mm)	Feed Type	No of Founts	Italic	Compressed	Enhanced	Graphics	Colour	Standard Interface	Interface Options	Emulation Modes	Paper Width (mm)	Speed (cps) DQ/(N)LQ	RRP$ (approx)	Distributor
LASER														ppm		
Apple	Laserwriter	974x415x295	CSF	4	y	y	y	y		serial		Diablo	355	8		Apple
Apple	Laserwriter Plus	974x415x295	CSF	11	y	y	y	y		serial		Diablo	355	8		Apple
C-Itoh	LIPS 10	490x520x285	CSF	6	y	y	y	y		serial/parallel		many	348	10		Anitech
Facit	P7000	530x420x329	CSF	4	y	y	y	y		serial/parallel		Diablo	A4	8		ElectronEIA
Hewlett Packard	Laserjet	293x475x415	CSF	26	n	n	n	n		serial			216	8	6535	HP
Hewlett Packard	Laserjet Plus	293x475x415	CSF	26	n	n	n	y		serial/parallel			216	8	8633	HP
Hewlett Packard	Laserjet 500+	460x475x495	CSF	26	n	n	n	y		serial/parallel			216	8	11716	HP
IBM	3812	680x480x280	CSF	62	y	y	y	y		serial/parallel	parallel		A4	12	15635	IBM
Impact	L800 I	475x915	CSF	4	y	y	y	y		serial/parallel		many	A4	8	5895*	Impact Systems
Impact	L800 11	475x915	CSF	6	y	y	y	y		serial/parallel	parallel	many	A4	8	6460*	Impact Systems
Impact	L800 P	475x915	CSF	6	y	y	y	y		serial/parallel		many	A4	8	7455*	Impact Systems
Impact	L800 111	475x915	CSF	10	y	y	y	y		serial/parallel		HP	A4	8	8950*	Impact Systems
Impact	L800 T	475x915	CSF	4	y	y	y	y		serial/parallel	many		A4	8	8900*	Impact Systems
Impact	L800 C	475x915	CSF	6	y	y	y	y		serial/parallel	many	many	A4	8	8900*	Impact Systems
Printronix	L1012	477x439x318	CSF	6	y	y	y	y		serial/parallel		many	A4	12		Bell & Howell
Printronix	L2120	730x600x570	CSF		n	y	y	y		serial/parallel	many	Diablo	A4	20		Bell & Howell
QMS	K8	474x414x289	CSF	8	y	y	y	y		parallel	RS232	many	A4	8		Bell & Howell
QMS	Smartwriter	474x414x289	CSF	7	y	y	y	y		parallel	RS232	many	A4	8		Bell & Howell
QMS	PS800	474x414x289	CSF	13	y	y	y	y		serial		many	A4	8		Bell & Howell
QMS	LGX800	474x414x289	CSF	12	y	y	y	y		parallel	RS232	many	A4	8		Bell & Howell
QMS	LGX120	914x660x660	CSF	12	y	y	y	y		parallel	RS232	many	A4	12		Bell & Howell
QMS	LGX2400	914x576x660	CSF	12	y	y	y	y		parallel	RS232	many	A4	24		Bell & Howell
Qume	Laserten	508x431x381	CSF	1	y	y	y	y		serial/parallel		many	A4	10	7244	STC/Triumph Adler
Ricoh	LP408R	530x420x329	CSF	4	y	y	y	y		serial/parallel		Diablo	A4	8	6995	Mitsui
Ricoh	LP4080M	530x420x329	CSF	9	y	y	y	y		serial/parallel		many	A4	8	6995	Mitsui
Texas Instruments	2015	723x546x444	CSF		y	y	y	y		serial/parallel		many	A4		11500	TI
Texas Instruments	2018	596x546x393	CSF		y	y	y	y		serial/parallel		many	A4			TI
Texas Instruments	2115	723x546x444	CSF		y	y	y	y		serial/parallel		many	A4			TI
Xerox	4045		CSF	1000	y	y	y	y		serial/parallel		many	A4	10	10000	Rank Xerox
LINE MATRIX														lpm		
C-Itoh	CI-3000P	656x610x330	tractor	4	y	y	y	y	n	serial/parallel	Dataproducts	Printronix	381	350	13767	Anitech
C-Itoh	CI-6000P	656x610x330	tractor	4	y	y	y	y	n	serial/parallel	Dataproducts	Printronix	381	350	15609	Anitech
Decision Data	6703	685x558x279	friction			y	y	y	n	S/3x twin ax			406	300	1280	STC
Printronix	S7024	706x416x195	friction/tractor	1	n	y	y	y	n	serial/parallel	many	IBM	406	60/240		Bell & Howell
Printronix	P1013	412x300x114	friction/tractor	2	n	y	y	y	n	parallel		many	279	47/134		Bell & Howell
Printronix	MVP	625x326x267	tractor	1	n	y	y	y	n	serial/parallel	many	Diablo	279	80/200		Bell & Howell
Printronix	MVP102	625x326x267	tractor	1	n	y	y	y	n	parallel	RS232	Epson	279	80/200		Bell & Howell
Printronix	P300	762x617x419	tractor	1	n	y	y	y	n	parallel	many	Diablo	279	300		Bell & Howell
Printronix	P600	762x617x419	tractor	1	n	y	y	y	n	parallel	many	Diablo	279	600		Bell & Howell
Printronix	P300XQ	1059x864x724	tractor	1	n	y	y	y	n	parallel	many	Diablo	279	300		Bell & Howell
Printronix	P600XQ	1059x864x724	tractor	1	n	y	y	y	n	parallel	many	Diablo	279	600		Bell & Howell
Printronix	4160	619x495x274	tractor	1	n	y	y	y	n	parallel	RS232	Diablo	279	130		Bell & Howell
Printronix	L150	625x526x267	tractor	1	n	y	y	y	n	parallel	IBM	Diablo	279	150		Bell & Howell
Printronix	L300	762x617x419	tractor	1	n	y	y	y	n	parallel	IBM	Diablo	406	300		Bell & Howell
Printronix	L600	762x617x419	tractor	1	n	y	y	y	n	parallel	IBM	Diablo	406	600		Bell & Howell
Printronix	L600XQ	1059x864x724	tractor	1	n	y	y	y	n	parallel	IBM	Diablo	406	600		Bell & Howell

INKJET

Epson	SQ2000	595x383x165	friction/tractor	2	y	y	y	y	n	serial/parallel			345	176/105	2000*	Epson
Hewlett Packard	Thinkjet	292x206x89	friction/tractor	4	n	y	n	y	n	parallel	many	Epson	216	150	1118	HP
Hewlett Packard	Quietjet Plus	527x118x214	friction/tractor	6	n	y	n	y	n	serial/parallel		Epson	381	160	1798	HP
IBM	3852	400x295x114	friction/tractor		y	y	y	y	y	parallel			215	20	1403	IBM
Tektronix	4696	506x343x153	friction	1	n	n	n	y	y	parallel			279	35		Tektronix

* — not including sales tax.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2. Entry to the prize draw is achieved by returning a completed subscription card and payment. Entry is open to both new and renewal subscribers.
3. Entry is open to all residents of Australia other than the employees and immediate families of The Federal Publishing Company Pty. Ltd. and Daihatsu and their associated agencies and publications.
4. The draw will take place on March 4, 1987, and the winner will be notified by mail and the result published in The Australian newspaper date March 13, 1987, and a later issue of the magazine.
5. Prizes must be taken as offered. There is no cash alternative. Prizes are not transferable and cannot be altered in any way.
6. The vehicle prize of a Daihatsu Charade includes all on-road costs, including third party insurance and registration.
7. Federal Publishing will arrange delivery of the vehicle within Australia within one month of the winner being drawn. If delivery is required outside of Australia, this becomes the responsibility of the winner.
8. Permit No.: T.C. 86/2203 issued under the Lotteries and Art Unions act 1901; Raffles and Bingo Permits Board Permit No 86/1013 issued on 15/9/86; ACT Permit No. TP86/650 issued under the Lotteries Ordinance, 1964.
• The Luxury • The Style • The Eco


NOW!
SCREWDRIVER SET
"CHARADE" from "DAIHATSU"
FREE SCREWDRIVER SET
with all new or renewed subscriptions
★ Chrome plated and presented in plastic storage case.
★ Free running top on each driver gives operator ease of use.
★ Consists of 4 blade drivers from 1.4 mm to 2.9 mm and 2 Phillips screwdrivers, No. 0 and No. 1.
LIMITED OFFER, SO POST SUBSCRIPTION CARD TODAY!!
(If card missing, please phone (02) 693-6666 and ask for the Subscriptions Department).
DAIHATSU
DAIHATSU
"Daihatsu. That's who."
See Subscription Coupon
nomy • The Options • The Safety
• The Ride • The Space • The Feel • The Pace

Kits! Kits! Kits! Kits! Kits! Kits!

SOLDERING IRON TEMPERATURE CONTROL KIT

An important factor in good soldering technique is the correct choice of soldering temperature. If you have put off buying a temperature controlled soldering iron because they are so expensive, your problems are solved with this low cost soldering iron temperature conroller kit. It provides fully regulated, adjustable temperature control over a reasonably wide range and will work with just about any conventional 240V soldering iron rated from 20W to 75W.
(ETI 1532, ETI Sept. '86)
Cat. K55320 .... **$24.95**

TELEPHONE APPLIANCE CONTROLLER

This clever project lets you dial your home number and switch a mains appliance on or off, without paying for the phone call. You can use it to turn on outside lights, a spa or an electric blanket.
(86ts6, EA June '86)
Cat. K86061 .... **$54.95**

DIGITAL SAMPLER KIT

Digital sampling is at the core of many of the special sound effects used by modern musicians. A trigger input (usually a contsruction drum pad) triggers a prerecorded sound from the digital sampler. This sound has been recorded into the 4K of onboard memory and can be digitally manipulated so that it sounds completely different on playback. The unit has controls for gain, regeneration and mixing. It also gives a choice of a number of different triggering methods.
(ETI 1402, May-July '86)
Cat. K41420 .... **$119**

BIT PATTERN GENERATOR KIT

In applications where you are required to look for a particular byte of information in a serial or parallel data path, short of a logic analyser or a storage oscilloscope, there is not a lot to help you. However, this Bit Pattern Generator gives you a simple and economical way to detect and display specific bytes of data. It may be used on both parallel and serial data paths.
(ETI 172, May '86)
Cat. K41720 .... **$54.95**
(Serial/Parallel Kit)

FOUR CHANNEL MIXER

This four channel mixer project gives professional quality with impressive specifications.
SPECIFICATIONS:
Max. input sensitivity —50dB (2.5mV)
Signal to noise ratio: —78dB relative to +4dB
Distortion: 0.03% at +4dB, 2kHz
Input Impedance: 3k ohm nominal
Output impedance: 100 ohms
Frequency Response: 10Hz to 30kHz (— +1dB)
(ETI1404, ETI July '85)
Cat. K54040 .... **$99**

PARAMETRIC EQUALISER

Does your music system want a new frequency response? Does your guitar or keyboard need some equalisation to brighten the sound? Well, here is a module which can be used by itself on individual instruments or ganged to equalise your music system.
(ETI 1406, ETI August '86)
Cat. K54060 .... **$16.50**

RS232 FOR COMMODORE

A simple project to give your Commodore RS232 compatibility.
(ETI 1601, ETI July '86)
Cat. K56010 .... **$14.95**

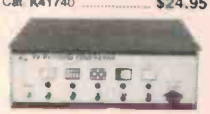
MULTI SECTOR ALARM STATION

Protect your home and possessions from burglars with this up to the minute burglar alarm system. It's easy to build, costs less than equivalent commercial units, and features eight seperate inputs, individual sector control, battery back up and self-test facility.
Specifications:
- Eight sectors with LED status indication.
- Two delayed entry sectors.
- Variable exit, entry and alarm time settings: entry delay variable between 10 and 75 seconds, exit delay variable between 5 and 45 seconds; alarm time variable between 1 and 15 minutes.
- Resistive loop sensing: suits both normally open and normally closed alarm sensors.
- Battery back-up with in-built charger circuit.
- Built-in siren driver.

The RIE kit includes a superb printed and prepunched metal case and inside metal work, plus a gell battery! Unbeatable VALUE!
Cat. K85900 .... Normally $129
SPECIAL, $119

FREQUENCY STANDARD

Get the equivelent of a rubidium frequency standard by draping a piece of wire over the back of your TV set!! Believe it or not your humble television can provide an extremely stable and accurate reference frequency. The wire acts as a transducer to pick up electromagnetic radiaton from the back of the set. Normally you would need to spend thousands of dollars to achieve accuracy beyond the "parts per thousand" you expect from ordinary meters. With this simple project, an extremely accurate 1MHz signal can be derived for very little outlay.
(ETI 174, July '86)
Cat. K41740 .... **$24.95**



CRYSTAL CONTROLLED TV PATTERN GENERATOR

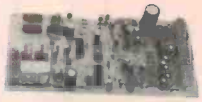
Anyone wishing to obtain the maximum performance from a colour TV reciever needs a pattern generator. Why not build this superb unit which provides five separate patterns; dot, crosshatch, checker board, grey scale and white raster?
Note: The RIE kit includes a large ABS type case!
(80pg6, EA June '80)
Cat. K80033 .... Normally $67.50
SPECIAL, $62.50

DIGITAL CAPACITANCE METER Mk.2

Updated from the EA March '80 issue, this Digital Capacitance Meter checks capacitor values from 1pF to 99.99uF over three ranges. Its main features include a nulling circuit and a bright 4 digit LED display.
***Note:** The RIE kit contains quality silk screen printed and prepunched front panel AND an exclusive High Intensity Display!
(80cm3a, EA August '85)
Cat. K80030 .... **$69.50**

TRANSISTOR TESTER

Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept.'83) 83TT8
Cat. K83080 .... Normally $18.95
SPECIAL, ONLY $14.95



DELUXE CAR BURGLAR ALARM

Stop your car from being one of the 70,000+ stolen cars stolen each year with this "state of the art" car burglar alarm. Features include key switch operation, delayed entry and exit, automatic reset, and provision for an auxiliary battery. Further more, of the 10 most important features listed by NRMA, this EA Deluxe Car Alrm has 9 of them!
(84ba5, EA May '84)
Cat. K84050 .... **$79.50**

MICROBEE SERIAL-TO-PARALLEL INTERFACE

Most microcomputers worth owning have an 'RS232' connector, or port, through which serial communications (input/output) is conducted. It is a convention that, for listing on a printer, the BASIC LLIST or LPRINT command assumes a printer is connected to the RS232 port. Problem is, serial interface printers are more expensive than parallel 'Centronics' interface printers. Save money by building this interface. (ETI Jan. '84) ETI 675
Cat. K46750 .... **$59.50**

PLAYMASTER 300 WATT AMPLIFIER

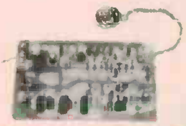
This module will deliver up to 200 watts into an 8 ohm load and up to 300 watts into a 4 ohm load. Comprehensive protection is included and a printer circuit board brings it all together in a rugged easy-to-build module. It can be built in either fully-complemetary or quasi-complementary versions, so output transistor shortages should be no problem at all.
(80PA6) (EA July '80)
Cat. K80060 .... Normally $109
SPECIAL, ONLY $99
(Heatsink not included)

HUMIDITY METER

This project can be built to give a readout of relative humidity either on a LED dot-mode display or a conventional meter. In addition it can be used with another project as a controller to turn on and off a water mist spray in a hothouse, for example. (ETI May '81) ETI-256 (Includes humidity sensor $19.50)
Cat. K42560 .... **$39.50**

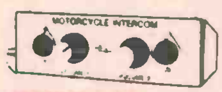
MUSICOLOR IV

Add excitement to parties, card nights and discos with EAs Musicolor IV light show. This is the latest in the famous line of musicolors and it offers features such as four channel "color organ" plus four channel light chaser, front panel LED display, internal microphone, single sensitivity control plus opto-coupled switching for increased safety.
(EA Aug '81) 81MC8
Cat. K81080 .... **$99**



VIDEO FADER CIRCUIT

Add a touch of professionalism to your video movies with this simple Video Fader Circuit. It enables you to fade a scene to black (and back again) without loss of picture lock (sync) or colour.
(EA Jan '86, 85tf10)
Cat. K86010 .... **$19.95**



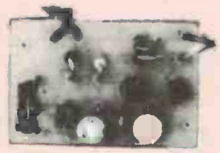
MOTORCYCLE INTERCOM

OVER 300 SOLD!

Motorcycling is fun, but the conversation between rider and passenger is usually just not possible. But build this intercom and you can converse with your passenger at any time while you are on the move. There are no "push-to-talk" buttons, adjustable volume and it's easy to build!
(EA Feb. '84) 84MC2
Cat. K84020 .... **$45.00**

LOW-COST BIPOLAR MODEL TRAIN CONTROLLER

Here is a simple model train control for those enthusiasts who desire something better than the usual rheostat control. It provides much improved low speed performance and is fully overload protected, yet contains relatively few components. Best of all, you don't need to be an electronic genius to construct it. (80TC12) (EA Dec '80)
Cat. K80120 .... **$39.95**



LOW BATTERY VOLTAGE INDICATOR

Knowing your batteries are about to give up on you could save many an embarrassing situation. This simple low cost project will give your early warning of power failure, and makes a handy beginner's project.
(ETI 280, March '85)
Cat. K42800 .... **$7.95**

ELECTRIC FENCE

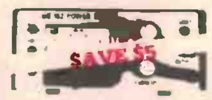
Mains or battery powered, this electric fence controller is both inexpensive and versatile. Based on an automative ignition coil, it should prove an adequeate deterrent to all manner of livestock. Additionally, its operation comforms to the relevant clauses of Australian Stnd 3129. (EA Sept.'82) 82EF9
Cat. K82092 .... Normally $19.95
SPECIAL, ONLY $14.95

AUDIO TEST UNIT

Just about everyone these days who has a stereo system also has a good cassette deck, but not many people are able to get the best performance from it. Our Audio Test Unit allows you to set your cassette recorder's bias for optimum frequency response for a given tape or alternatively, it allows you to find out which tape is best for your recorder. (81AO10) (EA Oct '81)
Cat. K81101 .... **$59.50**

15V DUAL POWER SUPPLY

This simple project is suitable for most projects requiring a dual voltage. Includes transformer.
(ETI 581, June '76)
Cat. K45810 .... **$34.95**



30 V/1 A FULLY PROTECTED POWER SUPPLY

The last power supply we did was the phenomenally popular ETI-131. This low cost supply features full protection, output variation from 0V to 30V and selectable current limit. Both volatage and current metering is provided. (ETI Dec '83) ETI 162
Cat. K41620 .... Normally $59.50
SPECIAL, $44.50

AEM DUAL SPEED MODEM KIT

The ultimate kit modem featuring 1200/300 baud, case and prepunched front panel.
Exceptional value for money!
(AEM 4600 Dec '85)
Normally $169
SPECIAL, ONLY $149

PHONE MINDER

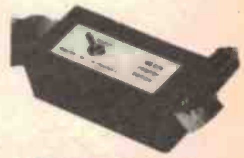
Dubbed the Phone Minder, this handy gadget functions as both a bell extender and paging unit, or it can perform either function separately. (EA Feb. '84) 84TP2
Cat. K84021 .... **$27.50**

FUNCTION GENERATOR

This Function Generator with digital readout produces Sine, Triangle and Square waves over a frequency range from below 20Hz to above 160Hz with low distortion and good envelope stability. It has an inbuilt four-digit frequency counter for ease and accuracy of frequency setting.
(EA April '82, 82AO3A/B)
Note: The RIE Function Generator has a high quality screen printed and prepunched front panel!
Cat. K82040
Cat. K82041 .... **$109**

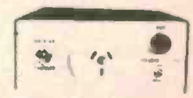
ELECTRONIC MOUSETRAP

This clever electronic mousetrap disposes of mice instantly and mercifully, without fail, and resets itself automatically. They'll never get away with the cheese again!
(ETI Aug '84) ETI 1524
Cat. K55240 .... **$34.95**



PARALLEL PRINTER SWITCH KIT

Tired of plug swapping when ever you want to change from one printer to another? This low-cost project should suit you down to the ground. It lets you have two Centronics-type printers connected up permanently, so that you can select one or the other at the flick of a switch.
(ETI 666, Feb. '85)
Cat. K46660 .... **$79.95**



12/240V 40W INVERTER

This 12 240V inverter can be used to power up mains appliances rated up to 40W, or to vary the speed of a turntable. As a bonus, it will also work backwards as a trickle charger to top up the battery when the power is on. (EA May'82) 82IV5
Cat. K82050 .... **$69.95**

12-240V DC-AC INVERTER INLCLUDING 300 WATTS TRANSFORMER

This EA inverter is capable of driving mains appliances rated up to 300VA and features voltage regulation and full over load protection
(EA June '82) 82IV6
Nominal Supply: Voltage 12V DC
Output: Voltage see table
Frequency: 50Hz+ —005%
Regulation: see table
Maximum Load: 300VA
Current Limiting: 30A (primary)
Efficiency: see table

Resistive Load Watts	Output Voltage (RMS)	Input Current (A)	Efficiency (%)	Battery life 40Ah/20h Rate (minutes)
0	210	1.2	0	-
40	235	4.5	60	240
100	240	11.3	62	80
140	240	15.0	69	60
200	240	20.1	78	50
240	240	24.0	79	32
300	235	29.6	82	28

P&P $10.00 Anywhere in Australia
Cat. K82062 .... **$219**

1W AUDIO AMPLIFIER

A low-cost general-purpose, 1 watt audio amplifier, suitable for increasing your computers audio level, etc. (EA Nov. '84)
Cat. K84111 .... **$9.95**

We try to have Australia's cheapest prices, widest range and excellent in-stock availability of computer accesories and compatibles.

RITRON 2 MONITORS
Stylish, swivel base monitor, available in amber or green.
Green Cat. X14506 Normally $235
Amber Cat. X14508 Normally $239
SPECIAL, ONLY $199

TTL MONITORS
Fantastic resolution! Enjoy a crisp, sharp image with the latest Ritron TTL monitor! IBM* compatible, green display, swivel and tilt base.
Green Cat. X14510 Normally $289
Amber Cat. X14512 Normally $289
SPECIAL, ONLY $269

NEW INTRA HIGH RESOLUTION RGB COLOUR MONITOR!
Size: 14 inch
Sync. Horiz. Scan Freq: 15.75 KHz
Sync. Vert. Scan Freq: 50 Hz
Band width: 18 MHz
Dot Pitch: .31mm
Resolution: 640 x 400 dots
Display Format: 80 x 25 Characters
Display Colours: 16 colours.
Input Connector: 9 pin D type
Cat. X14520 .... **only $695**

ANTI GLARE SCREEN
Half the price of other brands!!
Relieve eye strain and headaches and increase productivity with these Anti Glare Screens. Suitable for 12" monochrome and colour monitors.
Cat. X99995 .... **$24.95**

RITRON MULTI PURPOSE MODEM
The RITRON Multi Purpose Modem has all the features you require.
- CCITT V21 300 Baud Full duplex
- CCITT V23 1200/75
- Bell 103 300 Full duplex
- Bell 202 1200 Half duplex
- Auto answer, auto disconnect.

Telecom Approval No. C84/37/1134
Cat. X19103 Normally $399
SPECIAL $299

1200/75 BAUD RATE/BIT CONVERTER
For computers not capable of split baud rates. Buffers characters at 1200 and converts to 75 baud.
Cat. X19105 **$99**

IBM* COMPATIBLE DISK DRIVES
Tired of paying up to 100% more for Japanese Disk Drives? We now have "direct import" Taiwanese disk drives at much lower prices!

Cat.No.	Description	Price
C11801	500K	$199
C11803	1 M/Byte	$219
C11805	1.6 M/Byte	$239

APPLE* COMPATIBLE SLIMLINE DISK DRIVES
Japanese Chinon mechanism.
Cat. X19901 Normally $225
NOW $195
(*Apple is a registered trade mark.)

20 M/BYTE HARD DISK DRIVE FOR IBM* AND COMPATIBLES
Includes hard disk controller card
Cat. X20010 WAS $1,250
SPECIAL, ONLY $995
*IBM is a registered trade mark.

MITSUBISHI DISK DRIVES

MF353 (3½" DRIVE)
Double sided, double density, 1 M/Byte unformatted, 80 track per side.
Cat. C11953 **$280**

M2896-63
Slimline 8" Disk Drive, Double sided Density No AC power required, 3ms track to track, 1.6 Mbytes unformatted, 77 track side 10s/su10 bit soft error rate.
Cat. C11916 **$895**
Case & Power Supply to suit
Cat. X11022 **$159**

M4854
Slimline 5¼" disk drive. Double sided, double density, 96 track/inch, 9621 bit/inch, 1.6Mbyte unformatted 3ms track to track access, 77 track/side.
Cat. C11904 **$375**
Case & Power Supply to suit
Cat. X11011 **$109**

M4853
Slimline 5¼" disk drive, Double sided, double density, 1 Mbyte unformatted, 3ms track to track, 80 track/side, 5922 bits/inch.
Cat. C11903 **$295**

M4851
Slimline 5¼" disk drive. Double sided, double density 500K unformatted, 40 track/side. Steel band drive system.
Cat. C11901 **$249**
Case & Power Supply to suit
Cat. X11011 **$109**

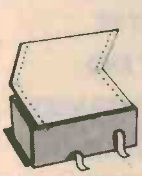
M4855
Slimline 5¼" disk drive, double sided, double density, 96 track/inch 2.0 Mbytes unformatted
Cat. C11905 **$385**

CANON A-40 PRINTER
- Serial Impact Dot Matrix
- 140 C.P.S.
- Near Letter Quality Mode
- 1.4K Buffer

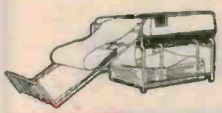
Cat. C20040 .... **$525**

PRINTER LEAD FOR IBM*
- To suit IBM* PC XT and clones.
- 25 pin "D" plug on computer end to Centronics 36 pin plug
- Length 2 metres

Cat. P19029 .... R.R.P. $44.95
SPECIAL, ONLY $19.95



COMPUTER PAPER
Quality paper at a low price! 2,500 sheets of 11 x 9½", 60 gsm bond paper.
Cat. C21001 Normally $44.95
SPECIAL, ONLY $37.95



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

.... **$44.95**
(Printer and paper not included)

MAIL ORDER HOTLINE (03) 543 7877 (2 lines)

RS232 DATA SWITCH WITH TESTER
- 25 pin RS232 "D" connectors 2 in, 1 out or 1 in, 2 out.
- Ideal for 2 computers to one peripheral or 1 computer to 2 peripherals.
- No power required
- Six dual coloured LED indicators showing certain flow status
  - T.D. Transmit Data
  - R.D. Recieve Data
  - R.T.S. Request To Send
  - C.T.S. Clear To Send
  - D.S.R. Data Set Ready
  - D.T.R. Data Terminal Ready
- Housed in heavy duty metal cabinet.
- Size: 200(W)x68(H)x150(D)mm

Cat. X19110 .... Normally $149
SPECIAL, ONLY $119

CENTRONICS DATA SWITCH
- 36 pin gold plated female Centronics connectors.
- All other specs as for RS232 Data Switch with Tester.

Cat. X19115 .... Normally $169
SPECIAL, ONLY $129

5¼" DISK SPECIALS!
All prices 10 disk boxes!

	1-9	10+
XIDEX		
S/S D/D	$29.95	$29.95
D/S D/D	$38.95	$36.95
High Density	$99	$90
VERBATIM DATALIFE		
S/S D/D	$27.95	$26.95
D/S D/D	$34.95	$32.95

3½" DISK SPECIALS!
STOP PRESS! PRICES SLASHED ON 3½" DISKS! SAVE $10 PER BOX!!

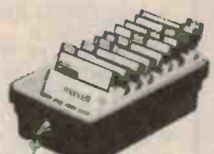
Verbatim S/S	$54.95
Verbatim D/S	$59.95
Xidex S/S	$55.95
Xidex D/S	$79.95

MICRODOT 5¼" DISKS
100% certified and error free guaranteed! Over 300,000 now sold and not one complaint. Where else can you get 100% guaranteed quality disks at these prices?!

	1-9	10+
S/S Cat.C12440	$17.95	$16.95
D/S Cat.C12445	$19.95	$17.95

SPECIAL OFFER!
During November, Double Sided Microdot Disks 20 boxes or more, $16.50 each!!! UNBEATABLE VALUE!!!

Bulk and Dealer inquiries welcome please phone (03) 543 2166

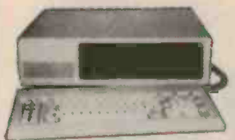


JUMBO 5¼" DISK STORAGE
If you've got lots disks, you'll appreciate the extra capacity of this disk storage unit when it comes to locating "that" disk!
Features...
- 100 disk capacity
- Smoked plastic cover
- Lockable (2 keys supplied)
- 9 Dividers/spacers

Cat. C16027 .... **only $24.95**

3½" DISK STORAGE UNIT
- Holds up to 40 x 3½" diskettes
- Lockable (2 keys supplied)
- High impact plastic lid and base

Cat. C16035 .... **only $19.95**



IBM* COMPATIBLES from $895*

Assembled & Tested in Australia!

Incredible deals to suit everyone including special package deals!
*256K RAM, single drive, graphics, and disk controller cards $895

256K RAM: Colour Graphics, Disk Controller Card, 1 parallel port, 2 disk drives and 3 months warranty. only $1,195

640K RAM: Colour graphics, Multifunction Card, Disk Controller Card, 2 serial and 1 parallel ports, 2 disk drives and 3 months warranty only $1,295

256K PACKAGE DEAL: Includes Colour Graphics Card, Multifunction Card, Disk Controller Card, 2 serial and 1 parallel ports. A 120 C.P.S. printer and a monochrome monitor and 3 months warranty! only $1,995

640K PACKAGE DEAL: Includes Colour Graphics Card, Multifunction Card, Disk Controller Card, 2 serial and 1 parallel ports. A 120 C.P.S. printer, a monochrome monitor and 3 months warranty! only $2,095
*IBM is a registered trademark

STOP PRESS!
TURBO-286K CARD!
Make your XT work as fast as an AT! ie: up to 9 times faster!
$995

IBM* XT COMPATIBLE CARDS

NEW TURBO CARD!
Make your XT work as fast as an AT! (Up to 9 times faster)
Cat. X $995

High Resolution Colour/Graphic/Mono/Printer
Cat. X $395

640K Main Board
Cat. X18020 .... $249

Turbo Mainboard
Cat. X18030 .... $295

Mono Graphic Printer Card
Cat. X $175

Colour Graphic Display Card
Cat. X $129

384K Multifunction Card
(Includes cable, but not RAM)
Cat. X $199

Multi I/O and Disk Controller Card
(Includes cable)
Cat. X $199

Floppy Disk Controller Card
(2 drive capability)
Cat. X18005 .... $79

Floppy Disk Controller Card
(4 drive capability)
Cat. X $99

Parallel Printer Card
Cat. X18017 .... $37.50

RS232 Card
Cat. X18026 .... $59.50

Clock Card
Cat. X $59.50

Games Adaptor Card
(2 joystick ports.)
Cat. X $39.50

Hard Disk Drive Card
Cat. X $299

APPLE* COMPATIBLE CARDS

Printer Card Cat. X17029	$89
Drive Card Cat. X17019	$79
80 Column Card Cat. X17025	$85
Speech Card Cat. X17009	$69
Music Card Cat. X17011	$99
Super Serial Cat. X17035	$129
RGB Card Cat. X17039	$79
Z80 CP/M Card Cat. X17041	$59

APPLE IIe COMPATIBLE CARDS
80 Column/64K Card X17061 **$89**

IBM* AT COMPATIBLE!

Assembled & Tested in Australia!
- 6 MHz
- 80286 CPU
- 8 slots
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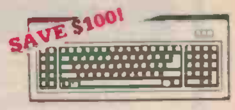

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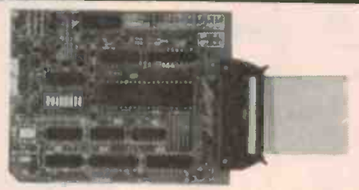

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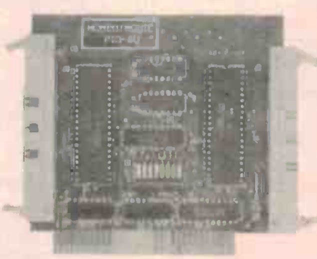

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FASTPLA

SLEEPING GIANT

Video, or laser, disc was launched in December 1978 in Atlanta in the US. It was the product of a joint development project between Philips and MCA, and while its close relative, the audio compact disc, has gone from strength to strength, the video disc has languished in apparent inactivity. Until recently that is. Lately, it has been taken up with considerable energy by some large concerns.

Barrie Smith

AT 30 cm DIAMETER, the video disc resembles a large audio disc with the added benefit that it produces pictures as well as sound. Audio/video information is recorded on the disc in grooves in the form of a spiral that runs from the inside to the outside. The grooves are in the order of 0.1 microns deep and 1.6 microns apart giving an extremely high density, up to 54,000 video frames.

This capacity is one of the important advantages of the video disc medium. In the PAL format (which Australia uses) the video disc spins at 1500 rpm giving either 36 or 60 minutes of playing time per side. The difference is that the Constant Angular Velocity disc records one video frame per revolution while the Constant Linear Velocity disc stores one frame at the inner most track, increasing to three by the outermost. Thus it permits more information to be stored.

Using the video disc

In a basic system, the video disc slips into a special player and outputs to monitor, amplifier and speakers. It can be controlled remotely by a special unit or keyboard. By operating the keyboard, the user can access any frame on the disc. Peripherals such as printers can be added and the system can be expanded to a multi-screen system, for example. More significantly, the video disc system can be interfaced with computer systems to allow programming around certain segments of a disc or to complement existing software. In more elaborate cases, the video disc programs can interact with large computer systems to provide commercial services, as happens sometimes with booking agencies.

The two features particularly recommending the video disc medium are its high quality video presentation, and the amount of information that can be stored on the disc. Access times to a particular frame are around 2 seconds for 100 to 1000 frames and 5 seconds for up to 54,000 frames. As well as this, the video disc is a hardy little item that can bear many repeated playings. Because it uses the same type of laser technology familiar in compact discs, it has no mechanical parts to wear out or sensitive oxide layers to degrade, as is the case with VCRs.

So what sort of information is found on video discs? Really any sort. Video discs have been found particularly useful in industry for training, as information data bases, to provide product information and simply to entertain.

In interactive mode, the user selects the required frames on the video disc. Each colour picture frame is permanently encoded with a number which is identified by the player's microcomputer, so it can be accessed much like the tracks on a floppy disk.

Applications

While video discs are finding most application in what's termed 'industrial' areas, in the US, Japan and the UK, video discs are also becoming a medium of artistic expression. The video clip is being produced on commercially released video discs at affordable prices. For example, in the US, 8" discs (made for the NTSC format) with five or so tracks sell for about $US15.

The video disc is being used popularly in industry as a training tool tailored to companies' requirements. While discs are available prerecorded, facilities are also available to engineer a program and record it to disc

35 mm film camera rigged to the front of the BMW 635 for shooting at Sandown. Film was transferred to video disc for use in driving simulator.

Laser Concepts' video disc and touch pad as used at Tsukuba.

precisely to a customer's needs — much like a company producing its own training film, for example.

In these cases, a company finds a software consultant who organizes the 'program', and can have it mastered to the video disc formats in Australia, then sends it overseas to be replicated. According to Graham Ham of Pioneer, a company which is prominent in the field, a total package could cost up to $100,000 from conception, through filming, sound recording, mastering, replicating the discs in Europe, buying the players, etc. While this sounds a lot for a training tool, for example, once the training discs are produced they are reusable on each new batch of employees.

Certainly many companies have been impressed with the power of the video disc. How they have used it gives some indication of the possibilities of this new medium.

Getting into the groove

General Motors was one of the first companies to use video disc back in the late 70s. When GMH in Australia heard of it, the company sent a rep to the US to evaluate the system. The result was that over 200 Holden dealers now use the disc to show potential customers the current model range. The video disc has also found its way into service departments and management areas.

The GMH scheme is based on an NTSC (US standard) player which gives GMH access to discs produced by its head office. So far, 50 discs have been produced locally. They have extended to dramatized sales situations that not only amuse but instruct.

IBM has been another user of the video disc with 40 players installed across the country for training potential computer buyers. With the disc interfaced to an outboard computer, computer novices familiarize themselves with their prospective purchase by working through the teaching program on the disc, assisted by pictures or graphics illustrating the various points. This freed IBM engineers from tutoring and gave the pupils hands-on experience at a pace they could set themselves.

The video disc has worked its way into the world of commercial transactions too, not surprisingly. The pace is being set by Budget Rentacar in the US which has been operating six System Alpha machines since early '85. The System Alpha machine, which resembles a juke box in size, presents you with a smiling Budget girl to talk to. The Budget girl asks you for your credit card and tells you to put it into a slot in the machine. The machine reads the card's magnetic encoding and the program proceeds. You'll be whisked through split screens of Chevs, Pontis and VWs, pick up points, periods of hire, etc, until you make your choice by placing your finger on the picture. The service can include options for accommodation in which you are taken along streets and through hotels while you make your choice.

Budget also uses a touchscreen in its setup. The result is that the system can be used by the most computer illiterate person.

As an information store pure and simple, the video disc has been used successfully by the Australian Government which recently commissioned Melbourne company, Laser Concepts, to supply disc machines to provide information on all aspects of the Australian environment — geography, history and technology. The information which had to be easily accessed by the general public was part of an exhibit at the Tsukuba in Japan, so the players had to operate 17 hours a day, seven days a week and provide tracks in Japanese and English. Video tape or film would not have been suitable for this, so the video disc technology was employed.

The installation used a touch pad with a surface divided into eight blocks of subjects. After a two-second wait, the desired subject appeared. Each segment ran for two to four minutes and concluded with a still frame: "Want more?".

As part of an experimental project, Laser Concepts also provided Woolworths with a sophisticated enquiry system. Be it wood, metal, nail or screw, the new 'shop assistant' knew what it was for and where it was on the shelves. Again using a touch pad, the user moves through a series of menus homing in on the specific item required. Along with text and pictures pertaining to the hoe, hammer or hasp, the customer is also told the colour of the aisle in which the item is hiding.

AAV-Australia, the Melbourne company which produced GMH's first disc, produced an exciting new program for the forward-thinking Museum of Victoria. The disc is entitled 'The Australian Collection' and will become part of the museum's computerized public access enquiry system.

The first disc is a single-sided production and contains 22,000 still frames, plus an opening preamble by Bill Peach. Live footage and text are also included. The unit itself features a high resolution screen with touch sensitive screen controls. On approaching the unit, the user is faced with a primary choice menu, eg, 'Flora and Fauna'. If he chooses this, he is shown a secondary menu, possibly with a request, 'Show me a picture of carnivores'. A series of pictures will then appear, step fashion. Each image that appears is accompanied by text supplied by a nearby computer.

Sydney company Skyrider Productions straddles the worlds of entertainment and high tech with its simulator development.

The company designs and builds simulators for you and me — not the type that are used to instruct space shuttle pilots or flight crews of jumbos, but for the general public to sit in, control and feel the thrills of actually moving through the sky — or as with its new product, along a race track.

Skyrider Production's first effort, the 'Sterling Glider Flight Simulator', ran over three years for the Benson & Hedges company, and in that time, carried 60,000 passengers — without a fatality! A film projector created the illusory image! The effect for the participant was convincing to say the least.

The company discovered video disc, and in its new project, a driver and his passenger experience a spin around the track at Sandown in a JPS BMW 635 — in the process breaking the lap record.

The driver has total control over the speed, along with computer-assisted steering. He can go from stop and, over 60 increments, run up to full, teeth-gritting speed. It's not possible to exceed the track record, but it's doubtful if your eyes and stomach could take it anyway. As the track bends and curves, so does the car. Hope you're strapped in. The picture through the windscreen fills your peripheral vision — there's nowhere else to look but out!

Skyrider is due for its first public trial at the Adelaide Grand Prix. Can't wait to try it. ●

AUTOMOTIVE ELECTRONICS

Motor cars are like dresses, the shape changes with the fashions, but the functions stay the same. Right? Well, it has been up until recently, but now fundamental changes are occurring in the way motor cars operate. The cause is electronics.

THE MOTOR CAR is undergoing a revolution. It affects the way engines are controlled, the way the various sub-assemblies like the suspension and brakes operate, and of course, it affects the creature comforts inside. Driving a car of the near future is going to be a very different experience.

The story is not quite as simple as saying that electronics has been applied to motor cars. The reverse is also very true, and just as interesting. Cars have been applied to electronics. Automotive components now have a higher rating than military specifications on a number of counts. Military components are routinely tested at 120°C, for instance. Automotive parts are often specified at 150°C, especially in Australia. They must also be immune to quite enormous variations in supply voltage, dirt and solvents and to large amounts of vibration.

On a hot summer afternoon, as countless beach goers will tell you, the family sedan is a terrible place to be. Spare a thought for the silicon. It suffers more than you do.

The engine

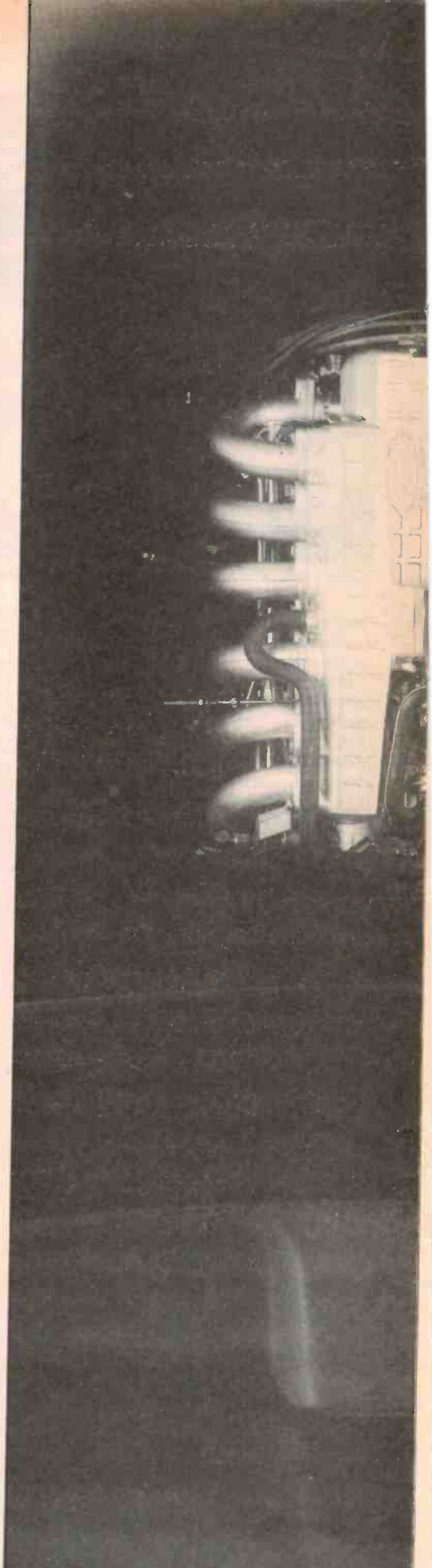
The most obvious and most important application of electronics in a motor car is in the operation of the engine. Mechanical engineers started thinking seriously about the advantages of electronic management after the oil shocks of the mid-70s. The challenge has been to get more power from smaller, less thirsty engines, while pumping less carbon monoxide into the atmosphere.

The engineer's first reaction was to throw their hands up in horror, put a catalytic converter on the exhaust and tell drivers to go slower. This philosophy had limited market attractiveness however, so other solutions were looked at.

All the major manufacturers now have engine management systems either in place or on the drawing board. Finding out exactly what they're doing is not easy, since the motor industry has a tradition of being ridiculously secretive about up and coming developments. Nevertheless, the idea behind them is quite simple: decouple the driver from the engine, and put a computer in between. The computer has input sensors that look at all the significant parameters of the engine, the load it's under, and the driver's wishes, as expressed by the throttle setting. It then changes whatever needs to be changed in order to accomplish the driver's instructions.

The earliest developments in this area were in electronic controls for the carburettor. The carburettor is a device that mixes fuel and air in specific proportions before application to the cylinders. However, the best fuel/air ratio is not static. It changes with the engine temperature, ambient temperature, and acceleration load. Over the years, designers got very cunning at allowing for all these variables by ingenious systems of linkages and so on, but by the early 70s, it was realized that electronics offered some powerful advantages.

The answer was found in single point fuel injection. In these systems, fuel is injected directly to the engine in pulses at a fixed frequency. Engine control is achieved by vary-



Electronics In The Engine. In Ford's Fairmont Ghia a digital computer, EEC4, controls the engine functions. (Courtesy Ford.)

ing the width of the pulses through 255 different levels.

The pulse width is derived from a look up table stored in ROM. In alpha/n systems, it's a function of throttle angle and engine revolutions. In more sophisticated systems, it can be made to depend on temperature, engine load and so on. In still more sophisticated systems, the computer can recognize particular modes of operation and apply special fuel management strategies to start up, after start enrichment, load compensation, deceleration choking, automatic idle speed control, hot start control and so on.

Another natural for electronic control is the ignition system and the generation of the spark. In a conventional engine, the pistons turn a crankshaft, which drives the distributor cam, which drives a contact breaker. The breaker applies an ac to a coil which boosts the voltage by several orders of magnitude and applies it sequentially to the spark plugs.

One of the most critical problems in all of this is 'timing', the relationship between the position of the cylinders and the spark. The idea is to impart maximum energy into the cylinder when the piston is at top dead centre, and the petrol/air mixture is at its densest. Because it takes time for the explosion to propagate from the spark gap through the gas, the spark is set to explode marginally before the piston reaches the top of its travel.

The problem is that the times depend on the speed at which the piston is moving in the cylinder. As the engine speeds up the spark must be retarded. As it slows down it must be advanced. Once again, mechanical means are available to do this, but electronics makes the job a lot simpler and more reliable.

In a typical modern system, both these functions will be integrated into the engine management system. This will consist of a processor and a sizeable chunk of ROM. Typically, there will also be interfacing to a diagnostics port, and it may well be designed to handle input from other parts of the car as well, to make up a fully blown car computer.

Handling

The way the motor car feels to the driver as it moves down the road is due to its 'handling' characteristics. These are determined by the mechanical qualities of the suspension, steering, tyres and road surfaces. During the last few years a lot of work has gone into using electronics to improve the way in which these systems operate.

The first move was simple power assistance, ie, applying more pressure to the components than a person could comfortably do. It was specifically applied to brakes and steering. Using electronics, it's possible to make the power assistance behave with a certain amount of intelligence.

For instance, the limits to the amount of braking force that can be applied is determined by the coefficient of friction between the types and the road surface. Push too hard on the brake peddle and the wheels lock up. To improve the efficiency of braking it's possible to develop anti-skid systems. Sensors on each wheel measure the speed of rotation of the wheels. If one of them starts to turn too slowly, brake pressure is momentarily reduced. When it starts to rotate too fast for maximum braking efficiency, the brakes are reapplied.

It's possible to apply this type of system to anti-slide control, and some cars are now starting to appear with automatic four wheel drive, in which the front wheels are only engaged when the rear driven wheels are having difficulty getting traction.

Another aspect of this is in active suspension systems. Active suspensions can, as one would expect, match the car to the terrain by raising or lowering the car. With the advent of a certain amount of intelligence, it becomes possible to match the characterists of the suspension to conditions of variable loads. For instance, when the car is overloaded, or cornering sharply, stresses are imposed on the suspension that adversely affect the way the car handles. These can be compensated for by stiffening it momentarily.

The cockpit

The most visible, indeed often the only visible, indication of the electronic sophistication of a car is the creature comforts available to the driver. The technology of the dashboard display is changing rapidly as mechanical components are replaced by solid state devices including LEDs and LCDs.

A great deal of research work is going on aimed at making these more readable under a wide range of different lighting conditions. Designers are using the flexibility of solid state displays to get away from the mechanical convention that had a big round speedo and two little oblong gauges on the dash for the driver. As a result we may expect some funny looking displays in the near future.

What we need not expect is more dials to watch. There is plenty of evidence to show that drivers find watching the speedometer hard enough without cluttering up the dash with unnecessary details. However, as metering and switching becomes streamlined, we may expect more warning symbols to appear on the dash to alert drivers to non-standard functions. Door open, seat belt undone, light failures, various engine and suspension parameters are all easily and cheaply monitored.

The other big improvement to the display will be in reliability. New fabrication techniques, including chip on glass methods in which the drive chip is bonded directly into the glass will assist with this.

Automotive integration

To make all this happen requires integrated ▶

circuits whose operation can be guaranteed over the life time of the car. This is a tall order. The automotive environment is hot, dirty and full of noxious substances. It is full of electromagnetic interference, and vibrates horribly. Yet with a bit of care and clever design, it's possible to build an IC that can last.

Heat is the number one enemy. Under the dash in summer in Australia it can often reach 180°C. Automotive components need to be specified to 150°C, considerably more than mil specs, to withstand this type of climate.

Heat affects semiconductor devices in a number of different ways. The most profound effect is that the junction becomes 'leaky', ie, impossible to turn off. Other problems are that the base emitter voltage lowers at high temperatures, once again making it difficult to turn a transistor off. The saturation voltage and gain also change.

The net effect is to make a monolithic semi behave in a totally unpredictable manner. Cool, it will behave itself. Hot, it will go beserk. Since most automotive environments are not so hot that the chip will actually be permanently damaged, it will be able to cycle between these two states depending on the temperature at the moment. This could have embarrassing consequences in a variety of situations.

Extremes of heat are not the only problems. The chip must work in extremes of cold as well. Gain falls off and base emitter voltage gets very large. This has caused problems for Australian chip designers, whose product has been tested in Europe, and found distinctly wanting by Swedes up to their eyes in icicles and reindeer.

Most of these problems, however, are now well understood by designers and the result has been a series of relatively temperature insensitive chips. Intel, Motorola, SGS and many of the other big chip makers are now heavily involved in this market, sensing perhaps, the possibilities of the automotive industry.

Another problem that is now slowly coming under control is that of electromagnetic interference (emi). The society of automotive engineers has just published extensive studies of the electrical environment in vehicles. Some of its results are staggering.

At rest, an ordinary motor car will have a nominal 12 V on its supply bus, more normally 12-15 V. However, many of the components used in a car are highly inductive, eg, the horn, starter motor, fuel pump and so on. When these are disconnected, the supply can leap down to − 100 V. The ISO figures show that this pulse can last for about 200 ms. If the component is in series, switching it off will subject the bus to about + 100 V. The most extreme case is caused by the ignition coil. If this is interrupted, it can place up to − 300 V on the bus. Pulse length is about a second in duration.

Transients like these are part of the normal operating environment. But automotive electronics must also be able to withstand ham-fisted mechanics, who might, for instance, connect the battery up with the wrong polarity.

One protection strategy is to accept that the outside world is hostile, and to heavily Zener every pin on the chip. In this way, a 300 V transient can be clipped to 5 V. The problem is that the amount of real estate required on the silicon tends to be large, especially when high currents are involved. It's an acceptable strategy when custom chips are made, but increasingly, automotive ICs are seen as standard parts, and so other solutions are being sought.

The other strategy, of course, is to clean up the environment outside the chip. One way is to construct all inductive components such that they don't dump their load on the supply bus. A Zener capacitor network can do this. However, it tends to be rather expensive.

Another strategy is to supply all the delicate components from a specially decoupled, deregulated 5 V supply. For this reason, many companies have developed specialist, highly stable voltage regulators.

Another angle to this is that much of the electronics requires not just power, but sensors. The sensors often use relatively low voltage signals, which have to be interpreted by a central computer. The sensor lines are immune to inductive problems of course, but can still be subject to + 150 V transients induced by the ignition. Radio frequency interference from CB transmissions is another problem.

To a large extent these problems can be overcome by appropriately loading signal paths. For instance, Schmitt triggers can be used to clean up a signal, and RC networks can be used to take any rf transients to ground. However, this still may not be enough, and appropriate discrimination may be needed in the software. It's also expensive.

Another solution to the sensor problem is to be found in suggestions for simplifying the wiring in motor vehicles. Anyone who has taken the most cursory look under the bonnet will know that motor car wiring is horrendously complex. Given modern multiplexing techniques it's also unnecessary.

Various proposals have been put up to overcome this. In one, a single cable forms a power reticulator to every point in the car requiring 12 V supply, while another carries all the signal information. Each light, each switch, each dashboard indicator, has a unique address, which forms a header code for a series of data bits. The data bits might tell a light to switch on, indicate the state of a switch and so on. The whole system is controlled from a central computer under the dashboard.

A sophistication of this idea is to place the signal path on the same line as the 12 V, thus reducing the cabling in the car to a single 12 V ring going around it. Still a further method is to use optical fibre for the signal path, thus eliminating all possibilities of emi affecting the control of the system.

The only disadvantage of this technique is that each point needs signal processing circuitry, either a transmitter or receiver, plus some encoding and decoding system, and usually a switch in the form of a transistor or relay or something. The obvious way around it is to put it all on a custom chip which can be integrated into various units.

'Futurecar'

As cars become more electronic we can look forward to the integration of many of these functions into one unit all under the control of a very fast processor. Communications around the car will probably use optical fibre because of its noise immunity, with power being carried on a separate cable.

Engine management will become more complex. Mercedes Benz has unveiled a fibre optic-based crank angle detection system that is precise to 0.1 of a degree and will allow unparalleled accuracy in timing. We may expect engines to become lighter and to deliver more power as carburettors, distributors and all the complex timing gear of the car disappear.

The suspension, steering and braking will continue to benefit from electronics. We may expect electronic control to optimize the undercarriage to the conditions the car encounters in real time. For instance, a car cornering sharply on a loose gravel surface would want very different suspension for one going in a straight line on a motorway. Electronics could give it to it.

Inside we may expect cars to benefit from many of the advances in military and space technology. For instance, voice recognition systems are now in the experimental stage in which you can ask for services to be switched on or off. Such systems also act as good anti-theft devices.

Video cameras will replace rear vision mirrors in many applications. Video screens will bring position information from inertial or satellite navigation systems. Prototype systems developed in Germany use an optical disc to provide a map display. Heads-up displays, in which the dashboard appears at infinity through the windscreen, are also under discussion.

It is likely, however, that unless people start driving more slowly, they will continue to die like flies in their cars. Devices mooted for increased safety include radar collision avoidance which will set off an alarm whenever you get too close to the car in front, an alcohol detector that will stop you driving when drunk, alarms that sound when you go too fast, and most cunning of all, a camera that monitors your eyes. If they stop moving, as they do when you are very tired, an alarm sounds to prevent you falling asleep at the wheel. ●

"Can you see the changes Philips Components have made to car manufacturing?"

For something that has so radically changed our lifestyle, the motor car has undergone few really fundamental changes. Its faithful reciprocating combustion engine, for example, is mechanically the same as it was when man was first learning to fly.

Yet one true automotive breakthrough has been the application of modern electronics. Fuel injection systems that "read" the supply, the load and adjust to the demand. Engine management systems that continually monitor and rectify. Consoles that "speak up" about anything from brake failure to seatbelts not fastened.

And while it's true we once got by without this much help, it's amazing how quickly we come to rely on it. Which soon makes products without advanced electronics seem like something's missing.

As a car manufacturer or any "other" manufacturer, there's every chance your products or processes are already affected by the application of this modern technology. Or soon could be. So whether you do it first or second could have a lot to do with what you do next.

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RECEIVING ERS-1 IN AUSTRALIA

Richmond Jeremy

Richmond Jeremy is Corporate Treasurer, Hawker de Havilland.

Satellite ERS-1 planned for launch in 1989 by the European Space Agency is an observation satellite of particular interest to Australia. It will provide synthetic aperture radar imagery of the Earth's surface as well as wind and wave characteristics over oceans. If Australia is to receive data from the sensors on board ERS-1, modifications to the Landsat station data acquisition facility at Alice Springs are required.

EXPLOITATION OF remote sensing data derived from passive reflectance measuring and radiometer instruments aboard satellites and aircraft has reached a very high level of competence and successful application in Australia. Imaging by active microwave instruments provides different terrain atmospheric, sea and ice data some of which is now also being processed by researchers in Australia.

Synthetic aperture radar image data has been available, in limited coverage, from the shortlived Seasat satellite, the SIR-A and SIR-B (shuttle imaging radar) missions as well as from airborne scanners.

Accordingly, it is of considerable interest to Australia that Europe will launch a new quasi-operational remote sensing satellite, ERS-1, embodying active microwave instrumentation and other sensors. The European nations concerned recognize the worldwide importance of this type of satellite and have agreed to allow access by non-participating states to the limited power budget of the SAR instrument.

An Australian Industry study into Australian reception and processing of data from ERS-1 was carried out in 1985, under contract to the Department of Industry, Technology and Commerce (DITAC). The study determined the most cost-effective approach to implementing data reception facilities and proposed the establishment of image processing facilities to suit Australia's needs and to ensure that Australia continues in the forefront of remote sensing data applications.

Tenders for the implementation of facilities recommended by the 1985 study have been called and received by the Space Projects Group of DITAC in early 1986. The intention is that these facilities be in

The ERS-1 satellite. (Courtesy COSSA.)

place by the time the satellite is launched in 1989.

In making recommendations the study considered both the peculiarities of Australia and the nature of ERS-1.

ERS-1 satellite

The development of the first ESA remote sensing satellite, ERS-1 started in January 1985 for launch in 1989. It is expected to be the forerunner of a series of European remote sensing satellites to become operational in the 1990s.

The ERS-1 mission objectives are both economic and scientific. On the economic side, the aim is to establish, develop and exploit the coastal, ocean and ice applications of remote sensing data. The industrial activities that will benefit most from expected forecasting improvements and accurate knowledge of geophysical parameters of ocean and ice include offshore petroleum, ship routing, and fishing. On the scientific side, the satellite is intended to increase understanding of coastal zones and global ocean processes which together with the monitoring of polar ice regions, will represent a major contribution to the World Climate Research Program. Significant advances are expected to be made in fields such as physical oceanography, glaciology and climatology.

ERS-1 will be launched from Kourou (French Guiana) by the Ariane launcher into a sun-synchronous (ie quasi-polar), circular orbit with a mean local time (descending node) of 10.30. At 14.1/3 orbits per day, the baseline repeat cycle will be three days, but there will be sufficient fuel to enable the repeat cycle to be changed several times within the three-year mission through a small change of the orbit altitude. Repeat cycles up to 35 days will be possible. In all cases, the stability of ground track repeat cycles will be maintained within ±1 km. The nominal orbit altitude of 777 km has been selected as a compromise between the higher air drag of a lower orbit and the need for greater power for the radar instruments at the higher orbit.

Instrumentation

The satellite's instrumentation will consist of a core set of active microwave sensors comprising an active microwave instrument (AMI) and a radar altimeter (RA). The AMI combines the functions of a synthetic aperture radar (SAR), a wave scatterometer and wind scatterometer, and will operate in the C-band measuring the wind fields and the wave spectrum over oceans. In its *image mode* (acting as an SAR) the AME produces high quality wide swath imaging over ocean, coastal zones and land. The *wind mode* brings into force the scatterometer function to measure the change in radar reflectivity of the sea surface due to the perturbations caused by wind close to the sea. When operating in *wave mode*, the AMI will measure the change in radar reflectivity of the sea surface caused by ocean surface waves.

A synthetic aperture radar image of the plains region north of Adelaide.

The RA operates in the Ku-band (13.7 GHz) as a nadir-pointing active microwave instrument. Over ocean it is used to measure wave height, the wind speed and the meoscale topography. Over ice it is used to determine the ice surface topography, ice type and sea/ice boundaries.

The other instruments on board will provide significant enhancement of the in- ▶

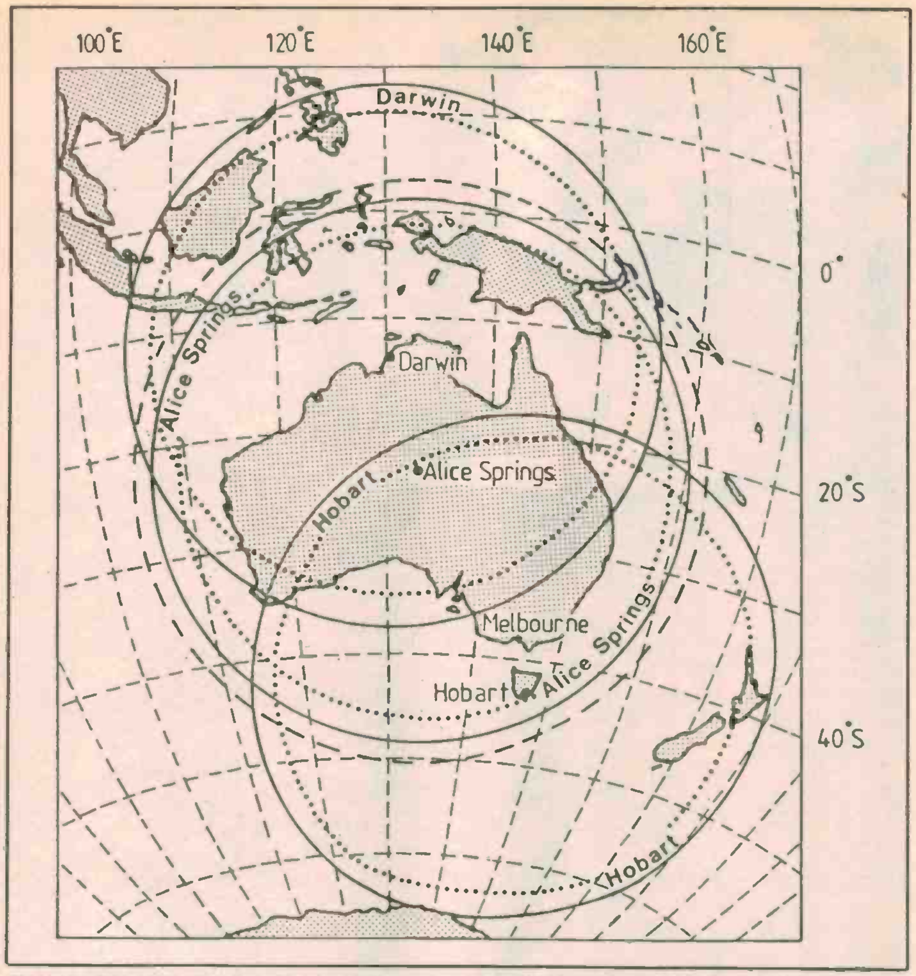


Figure 1. Coverage of ground receiving station for an orbit height of 777 km. Circles show the subsatellite points for a 2° elevation from the three sites. Dotted circles are for a 5° elevation. Dashed circle is zero degree elevation coverage for Alice Springs.

terpretation of the data from the core sensors, particularly as regards improved observation of ocean processes. The ATSR/M, or along track scanning radiometer and microwave sounder, is as it sounds basically two instruments: a passive infrared radiometer measuring in three infrared wavelengths and a microwave sounder. The purpose of the ATSR is to determine sea surface temperature, cloud-top temperature, cloud cover computations, land and ice surface radiances and to investigate daytime sea state from sun glint. Taking measurements of an area from two different directions allows a comprehensive atmospheric correction of the radiometer data. The microwave sounder will be included to establish total atmospheric water vapour content, liquid content and rain areas, and land and ice surface emissivity.

A precision range and range rate equipment (PRARE) device will provide range determination, leading to higher accuracy altitude measurements. It will also extend the ERS-1 mission to ocean circulation studies and geodetic applications such as sea-surface topography and crustal dynamics.

On the ground these devices are to be supported by a laser retro-reflectometer (LRR) which permits the accurate determination of the satellite height by use of laser ranging stations. The measurements will be utilised for the calibration of the radar altimeter in zenith overflight and for improvement of the satellite orbit determination with respect to the radial component during normal satellite tracking.

The satellite includes an on-board tape recorder which can store one orbit's worth of data from some instruments. Output from this recorder (multiplexed with one of the real-time data streams) will be available only to selected ground stations in the Northern Hemisphere and will not be recorded in Australia.

Receiving

The industry study excluded consideration of PRARE and LRR which require specialized active ground facilities not involved in the ground reception of the satellite instrument data. PRARE and LRR facilities will be established in Europe for accurate determination of the satellite's orbit characteristics, and these characteristics will be available from ESA.

ERS-1-to-ground data links applicable in Australia are two X-band links: at a high rate and a low rate. At the high rate the data stream carries the SAR imaging, at a carrier frequency of 8140 MHz ±0.4 MHz, modulation QPSK differentially encoded, and bit rate of 105 Mbs. The low rate stream carries the data from all the other instruments of interest at a carrier frequency of 8040 MHz ±0.4 MHz, modulation BPSK, and bit rate of 4.375 Mbs (being 1.0375 Mbs convolutionally encoded).

Two primary considerations govern the choice of site for an ERS-1 Receiving Station. Firstly, it is desirable to choose a location which covers as much as possible of Australia and its coastal zones. Secondly, for reasons of economy, it is important to take advantage of exsiting suitable infrastructure.

Other considerations can also influence the choice of site for reception of a satellite such as ERS-1. For example, the ability of SAR to provide images despite cloud cover could make the choice of Darwin a good site for imaging the hot wet tropical islands to our north like Papua-New Guinea and portions of Indonesia. On the other hand, Hobart would provide reception coverage of the southern ocean, an area of great interest to scientists in several disciplines.

The primary considerations, however, led to the choice of Alice Springs and the modification of the existing Australian Landsat station facility there.

For purposes of comparison, Figure 1 shows coverage circles for stations located at Alice Springs, Darwin and Hobart.

Of crucial importance during the study was consideration of the Australian Landsat station's plans for an upgrade of its facilities to enable X-band reception of thematic mapper (TM) images from Landsat 4/5 series satellites. Such an upgrade would give basic reception capability for SPOT and ERS-1. Indeed, prior implementation of the ERS-1 modification would provide the necessary 'front end' for a TM upgrade. Accordingly the ERS-1 technical specification for Alice Springs modification was divided into subsystems clearly to identify the overlap and interface between the two projects.

Another aspect of ground reception which required consideration was the experimental X-band modification of ALS Alice Springs, known as the CSIRO/ALS Signal Processing Experiment. This experiment involves modification of the antenna by instalment of a dichroic sub-reflector and an X-band receiving horn, with associated low noise amplifier and down-converter to enable reception of TM data. No provision is being made for the X-band tracking feed and servo system interface which ERS-1 will require.

Figure 2 is a schematic block diagram showing the division of the Alice Springs facilities into discrete subsystems. The

GEOPHYSICAL MEASUREMENTS AND ERS-1 PERFORMANCE PARAMETERS

Main Geophysical Parameter	Range	Accuracy	Main Instrument
Wind Field			
velocity	4-24 m/s	±2m/s or 10% whichever is greater	wind scatterometer & altimeter
direction	0-360°	±20°	wind scatterometer
Wave Field			
significant wave height	1-20 m	±0.5 m or 10% whichever is greater	altimeter
wave direction	0-360°	±15°	wave mode
wavelength	500-1000 m	20%	wave mode
Earth Surface Imaging land/ice/coastal zones etc	80 km (minimum swath width)	geometric/radiometric resolutions: a) 30 m/2.5 dB b) 100 m/1 dB	SAR imaging mode
Altitude			
over ocean	745-825 km	2 m absolute ±10 cm relative	altimeter
Satellite Range		±10 cm	PRARE
Sea Surface Temperature	50 km swath	±0.5 K	ATSR (IR)
Water Vapour	in 25 km spot	20%	microwave sounder

subsystems which overlay the same requirements of a TM upgrade are:
(1) antenna subsystem;
(2) down-converter subsystem (less the data down-converter, test-up converter and associated coupler);
(3) tracking subsystem;
(4) bore-sight antenna subsystem; and
(5) optional automatic control subsystem.

The optional automatic control subsystem was not implemented when the original ALS facility was established. Present Landsat MSS image reception takes place in daylight hours when the Landsat satellite is in descending node (ie, the pass is from north to south). For satellite passes at night no data is taken because MSS image data is derived from sunlight (visible and infrared) *reflectance* from the Earth's surface.

ERS-1 data is recoverable at night from its instruments which do not require sunlight, that is, the active microwave instrument, the radar altimeter and the ATSR/M. The latter instrument measures thermal and microwave radiation from sea and land surfaces equally.

The night and day radiation measurements capability of ATSR/M is shared by the AVHRR instrument of NOAA (Tiros series) satellites. The ALS TM upgrade specifications include provision for AVHRR reception and the inclusion of automatic control for night-time acquisition.

Acknowledgements

The author is indebted to the Space Programs Branch of the Department of Industry, Technology and Commerce (DITAC) for permission to reproduce material from the Hawker de Havilland Final Study Report on ERS-1. ●

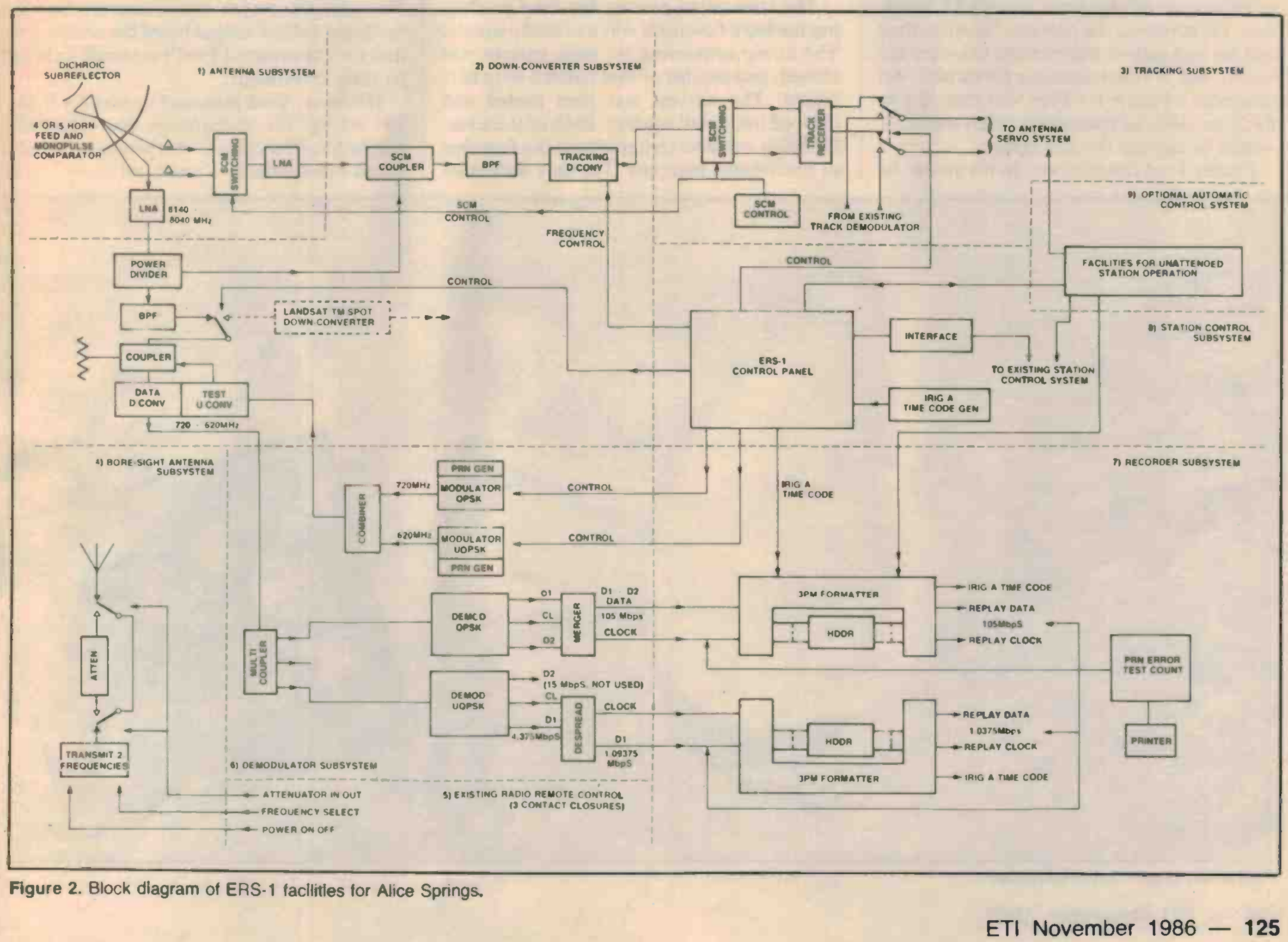


Figure 2. Block diagram of ERS-1 facilities for Alice Springs.

Vegie-tables

a folly by P.B. Jones, complicated by Neale Hancock

IT TOOK FIVE YEARS. But at the end of that time Australia had insurpassable home grown technology. Never again would school children complain about the cost of pocket calculators. Never again would the world's best treasurer bewail the exchange rate. For a while we were king of the heap.

It all started when Fred of the CSIRO built a water monitoring circuit for his home vegie patch. Instead of measuring water content by ground resistance his device used attenuation of high frequency pulses. That is, he had a vegie bed heated by five millisecond bursts of 52 megahertz radio signals.

It was after this that Fred noticed an unusual amount of interference to his TV reception. He pondered the problem for some time and devised various experiments to isolate the source, not at first suspecting his turnips. An unneeded obstacle for Fred was that just as he came close to tracing the interference, it would be turnips for tea again!

Finally Fred cottoned on. In his garage he stuck a set of oscilloscope probes into a fresh turnip and to his amazement he watched it repeat the 5 ms bursts of 52 MHz it had been nurtured on. He borrowed a more precise instrument to check his observations. It provided an incredible amount of information about the electrical properties of his irradiated turnips and Fred's mind boggled at their possible applications in bio-electronics.

However, his research into plant biotechnology was almost nipped in the bud, when a radio inspector from the Department of Communications arrived on his doorstep wanting to check his yard for 'Electrical Disturbances'. Fred worried that his secret would be discovered as the radio inspector combed the yard with a noise locating device. Puzzled by the high readings in the vicinity of the turnip patch and seeing no sign of any equipment, the inspector left, thinking that his noise locator was on the blink.

Fred was encouraged by the electronic properties of his turnips and decided to undertake some research into the applications of turnip technology. He went on to train turnip cells to perform simple logic functions, and even perfected planned cell growth patterns. The term "logic cell" took on a whole new meaning.

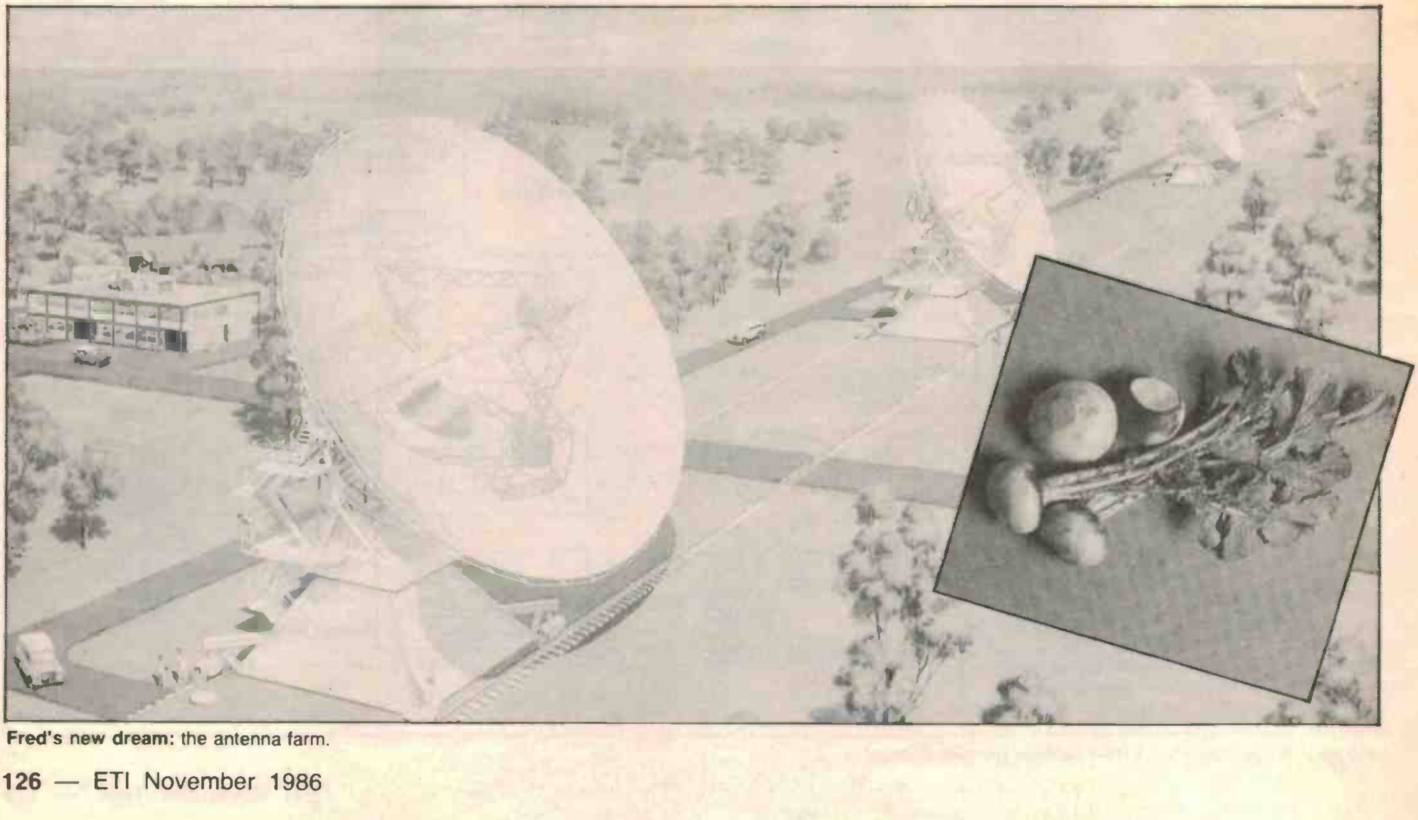
The fabrication process for mass producing the logic functions was extremely simple. The turnip containing the logic pattern was cloned, and turnips of that pattern were harvested. The harvest was then peeled and chipped into small squares. Each of these turnip chips was able to implement the function of the original logic cell. The only drawback was that each chip had to be placed on a base of damp cotton wool for it to work.

The major advantage of his unique technology was that it dramatically lowered manufacturing costs. Instead of spending millions of dollars on staff and processing equipment, all that was required was a few yokel farm hands and a couple of sacks of superphosphate. An added bonus was that the excess production lots could be canned and marketed.

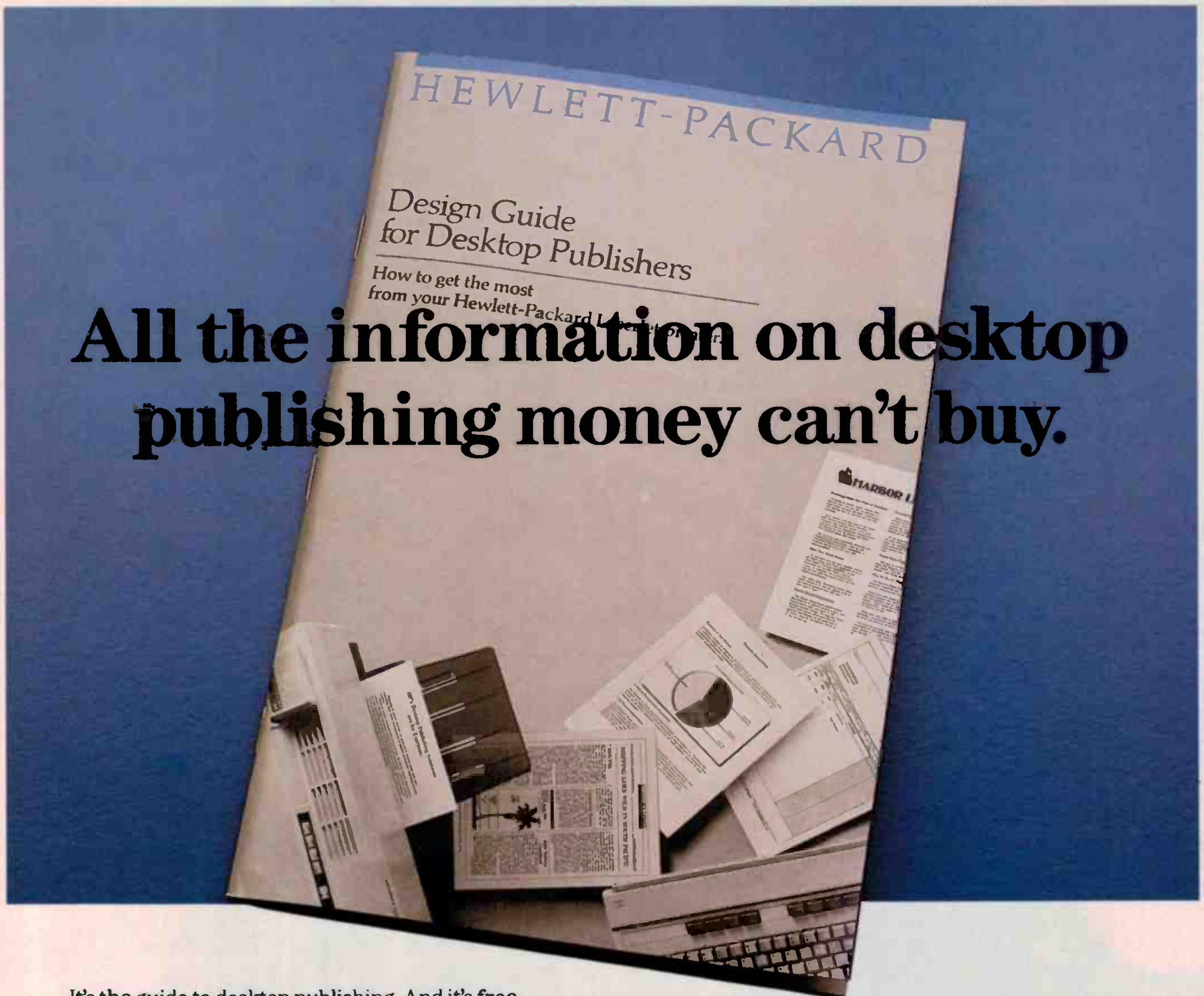
By using turnips as the raw material for his logic cells, Fred estimated that he could reduce the cost of a full function calculator by 60%. Whilst this was a reasonable reduction in cost, he was disappointed as he expected it to be reduced more. A high crop failure rate was to blame, so he decided to use hardier plants: potatoes and corn. When he had grown logic patterns using these two plants, he could not only produce turnip chips, but potato chips and corn chips as well. He also tampered with some exotic plants which, he discovered, had a strange doping effect.

When it came time for Fred to report on the results of his research into bio-electronics, he was canned by his colleagues in the scientific and technological fraternity who frowned at his use of vegetable based bio-conductors. You see, the major manufacturers had already got behind animal based bio-conductors and they considered Fred's research a threat to their investment.

However, Fred managed to make a living by selling his technology to vegetarian engineers, who considered the use of animal based bio-conductors unethical. ●



Fred's new dream: the antenna farm.



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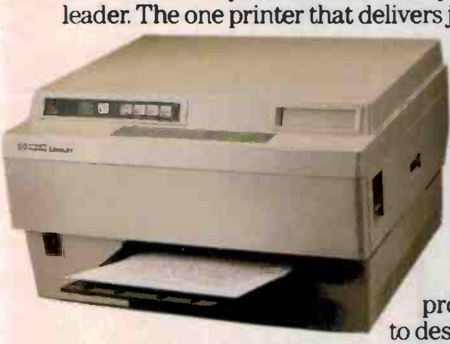

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