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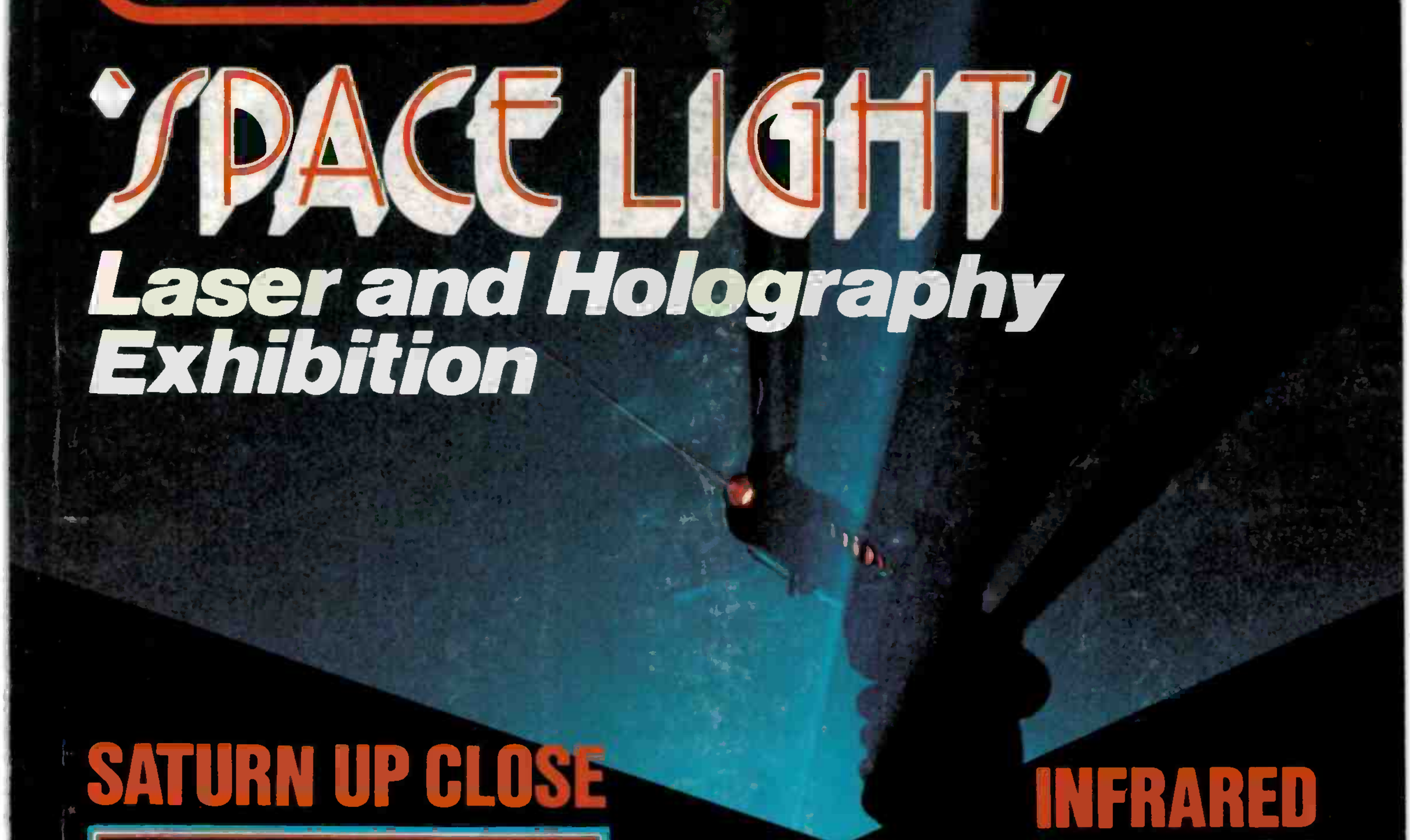
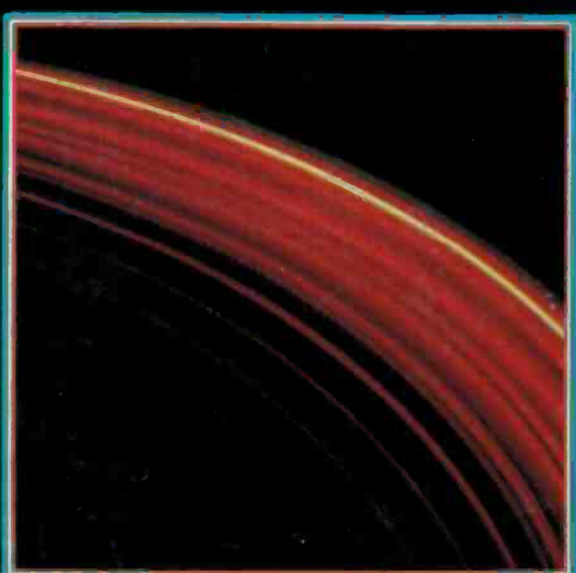


SATURN UP CLOSE



INFRARED BEAM RELAY to build

EPSON PRINTER Reviewed

Dolby C explained

Understanding Component Values

ELECTRONICS TODAY INTERNATIONAL

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Roger Harrison
Editor

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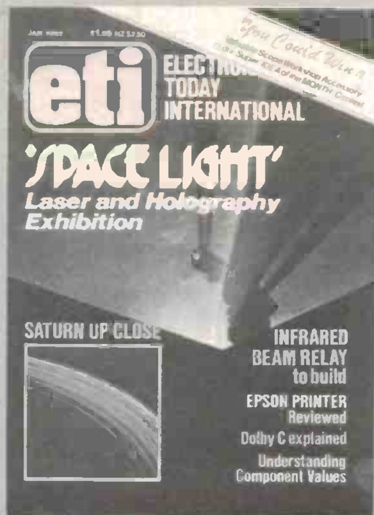

The SPACE LIGHT laser and holography exhibition kicks off this month on a round-Australia tour starting at Sydney's new Power House Museum. Preview of the show and background to holography starts on page 8. Inset is a picture of the rings of Saturn, taken by Voyager-2. The story of its mission starts on page 18.

Cover design by Ali White; photo by Roberta Booth. Inset courtesy JPL.

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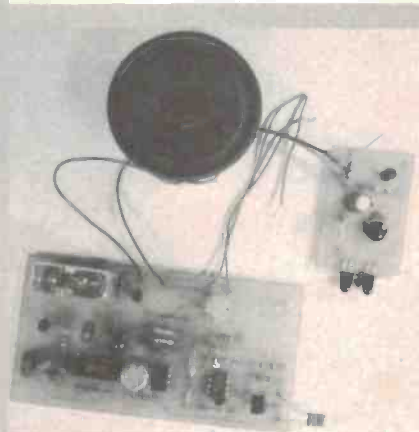

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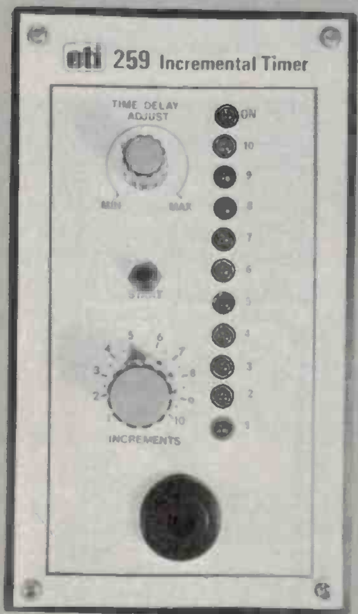

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SPEEDY BASIC 94
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This low-cost machine has upturned the printer market in every country in which it has been introduced, and Australia has proved no exception. This article examines why.

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CIRCUIT SOURCE GUIDE

Dozens and dozens of useful circuits and circuit ideas you'll find endlessly useful when trying-to-patch-up-a-circuit-to-do-a-job-but-you-don't-know-where-to-start-and-it's-Sunday-afternoon-and-there's-not-a-relevant-application-note-in-sight! All sorts of circuits, from analogue-digital converters through function generators and parametric equalisers, to log converters, VCOs and Wien bridge oscillators. Don't miss it!

ZX81 REVIEW

So you want to jump onto the personal computing bandwagon but don't have the $$$$s entrance fee? How about $250, then? Now you're talking — now you're computing! That's what Sinclair's little marvel's all about. Read all about it.

SOUND BENDER

From Darth Vader to Daleks — a sound modifier project to produce all sorts of effects. Built around the ever-popular XR2206, you can mix and modulate the effect with the original signal to produce the desired level of effect. Space age sound effects can be within your grasp!

'660 SOFTWARE

OK, now you've got your project going, why don't you do something with it? Here are a few things to do.

GRAPHIC DETAILS

Full reproductions of the alphanumeric and graphic sets of the popular microcomputers (TRS-80, PET . . .).

Although these articles are in an advanced state of preparation, circumstances may affect the final content. However, we will make every attempt to include all features mentioned here.

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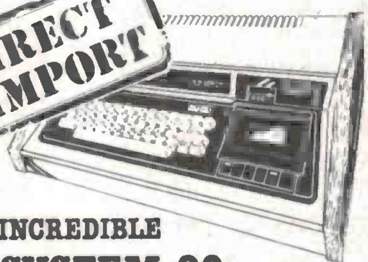

INCREDIBLE

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We're proud to offer this exeptional computer to our New Zealand customers. These are just some of the features: 16K memory, S-100 expandable, compatible with almost all level II programs, works with any standard TV set, has built-in cassette deck and level control. Quite simply, it represents outstanding value for money.
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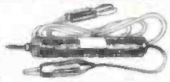
GALACTIC TRADER The objective of this fantastic program is to make a fortune by trading commodities throughout the Galaxy. Has 10 levels of difficulty. Playing time from 20 minutes to 5 hours. Cassette based, requires 16K.
Cat. X-3678 .... $35.00

GALACTIC EMPIRE A sophisticated game of strategy and tactics. Your object is to unity the Galaxy. Superb graphics and detailed manual supplied. Hours and hours of fun. Cassete based, requires 16K.
Cat. X-3679 .... $35.00

COSMIC FIGHTER Similar to Space Invaders, but this time alien destruction requires two hits, then three . . . it becomes exceedingly difficult and fast.
Cat. X-3695 .... $35.00

GALAXY INVASION The idea of this game is to destroy the 'invaders' and save Earth — but beware of the roving flagships! Cassette based, requires 16K.
Cat. X-3693 .... $35.00

MULITMETER RF PROBE



Extend the useful range of your multimeter up into the RF region with this probe. Frequency response is 150kHz to 30MHz and comes equipped with 4mm banana plugs for direct multimeter connection. May be used with most of our multimeters. Cat. Q-1138. .... $NZ $17.95

LONG NOSE CUTTING PLIER

$NZ $6.95

This tool has a fine tip and serrated jaw for general use. Built in cutting edge, chrome plated with insulated handles.
Cat. T-3250

PRECISION CUTTERS

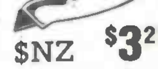
This high quality cutter features a fine, sharp cutting edge and spring loaded handles. Fine quality steel with insulated handles. Cat. T-3310. .... $NZ $11.25

MINI LONG NOSE PLIER

$NZ $4.95

Drop forged steel, chrome plated finish with soft plastic handle grips. Long nose complete with in-built cutter.
Cat. T-3562

TRIMMING KNIFE



This knife is exactly the same as the 'name' brand and comes complete with 5 carbon steel blades. Don't pay for a 'name'! Cat. T-5220. .... $NZ $3.25

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SPACE-LIGHT: Holography and laser spectacular

The largest and most comprehensive exhibition ever staged of the art and science of holography will tour Australian galleries in 1982. A dramatic laser light show will be presented with the exhibition of holograms on the tour.

Holography is a technique for the presentation of truly three-dimensional images, the hologram of an object having all the dimensions of the original object and 'moving' as the viewer moves just like a real solid object. A hologram often looks so real that the viewer will reach out to touch it — only to find there is nothing but focused light.

Professor Dennis Gabor discovered holography at the British Laboratories in 1947, and received the Nobel Prize for Physics in 1951 for his achievement.

A hologram is actually the recording of patterns of laser light waves reflected from an object onto the emulsion of a light-sensitive film. 'Hologram' refers to both the film plate and the three-dimensional image it projects into space. The word 'hologram' is made up of the Greek 'holos', meaning 'whole', and 'gramma', meaning 'message' — the 'whole message'.

To create a hologram of an object a beam of laser light is split in two. The 'reference beam' illuminates the film, and the 'object beam' illuminates the object. Light reflecting from the illuminated object falls on the film, thus interfering with the reference beam in a particular pattern. After the film is developed and re-exposed to the light transmitted over the identical path of the reference beam, this interference pattern recreates the appearance of the object by reconstructing all the points of light that originally came from the object. The resulting holographic image contains all the information about the size, shape, position and reflectivity of the object that you would receive when looking at the object itself. The only significant difference is that the holographic image is not solid.

There are two basic types of holograms: transmission and reflection. Transmitted holograms are viewed with light coming from behind the film, reflected holograms with light reflecting off the surface in front of the film. Both types can be seen with an ordinary light bulb, although sophisticated transmission holograms require special laser light to be seen at their best.

The holograms in the SPACE-LIGHT exhibition have been collected from artists in the USA, UK, Europe and Australia, and include some of the most famous holograms ever produced. The fifty holograms in the exhibition have been selected for their different techniques, as famous scientific holograms, and as representing an excellent range of art holograms.

American works include 'Equivocal Forks', by Harriet Casden-Silver, several pieces by the inventor of holographic movies, Lloyd Cross, and important works by the Polaroid Corporation's Stephen A. Benton. Works from the UK and Europe include Nick Phillips' life-size 'Dustbin' and the Swedish hologram of the famous 'Chinese Horse'.

Australian artists have undertaken prominent work in the field of holography for a number of years, and are well represented in the exhibition. British-born artist Margaret Benyon has lived and worked in Australia for some time and has had several one-

Series of photographs taken of 'Kiss II', a hologram produced by Lloyd Cross, inventor of the holographic movie process. The floating, three-dimensional image blows a kiss and winks as the viewer moves around. ('The Kiss', by Lloyd Cross, a holographic stereogram photo by Daviel Quat).

artist exhibitions in New York, London, Los Angeles and Australia. She is especially known for her use of aboriginal themes in her work. Sydney artist George Gittoes has also worked extensively with holography and uses lasers as a regular part of his performance art pieces.

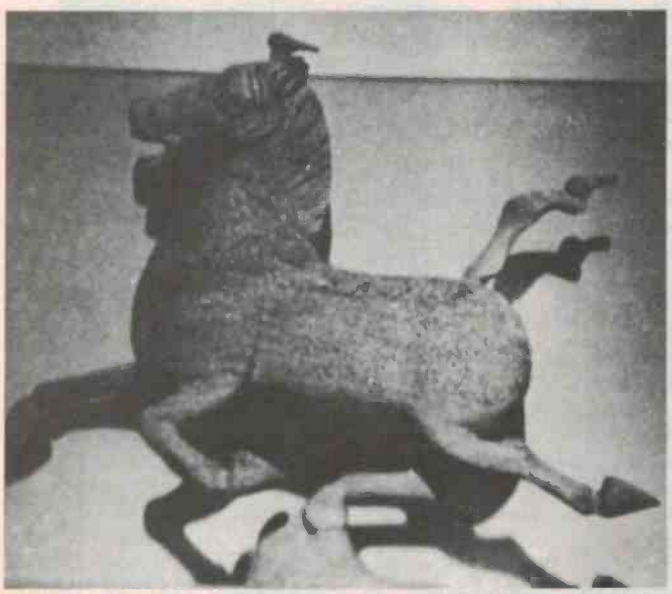
Melbourne artist Paula Dawson is one of the most striking and powerful artists working in holography, and the first Australian to merit classification as a leading world holographer. Her work has great technical virtuosity and tenacity, and since 1976 her ambition has been to create holograms on a massive scale. After work in the CSIRO's National Measurement Laboratory in Sydney she worked at the University of Besancon's Laboratorie de Physique et Optique in France, and it was here after considerable experimentation that she created 'There's no place like home . . .', the highlight of the SPACE-LIGHT exhibition.

Measuring 1.5 m by 1 m, 'There's no place like home . . .' is a massive work of art which, when lit by a powerful laser, recreates a living room 3 m wide by 3 m deep by 2.8 m high. This hologram is the only intact holographic plate of these dimensions in the world, and is certainly the most complex art hologram ever produced. Along with several other pieces, 'There's no place like home . . .' forms the famous holographic house.

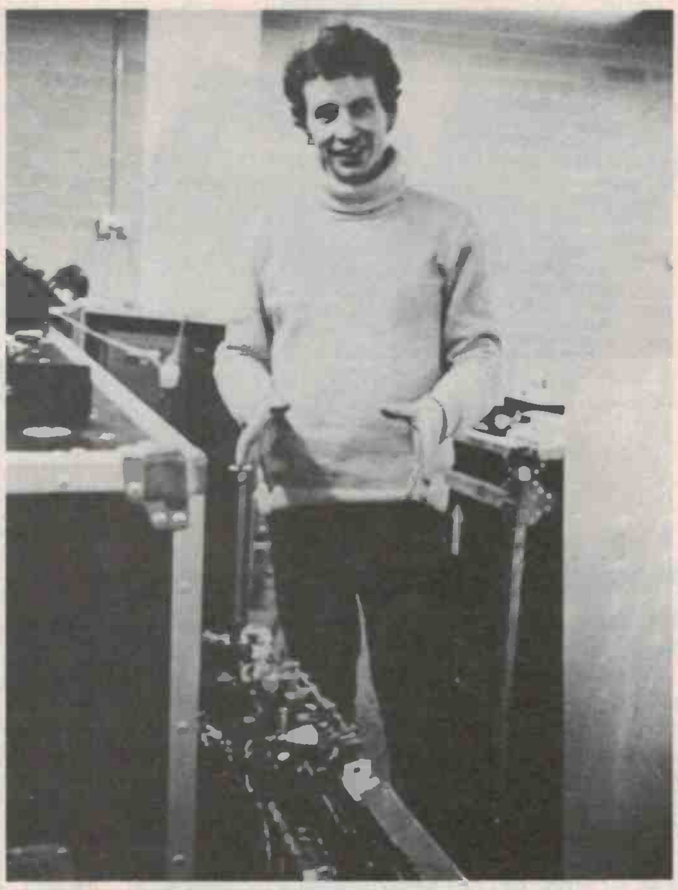
Dr. P. Hariharan of the CSIRO's National Measurement Laboratory in Sydney has produced significant papers showing how bright, multi-coloured holograms approaching natural colour could be produced, instead of just the primary colours of the spectrum. Several of Dr. Hariharan's works are in the exhibition.

Lasers are the first man-made source of highly coherent light, 'coherent light' being light of the same wavelength which, since it is the same colour, comes out from the light source in a co-ordinated way. LASER means 'Light Amplification by the Stimulated Emission of Radiation'.

Early three-dimensional holograms were extremely limited in their effectiveness because no source of coherent light was then ▶



'Chinese Horse', 300 x 400 mm white light reflection hologram made by Laser Gruppen Holovision A.B., Stockholm, Sweden.



Geoffrey Rose, inventor of the Laser Harp and optical designer for Soliel Laser, Melbourne, (Photo: Roberta Booth, 1981).

available, but with the invention of lasers this problem was solved and holograms of extraordinary depth and quality were produced.

During the staging of the SPACE-LIGHT exhibition a laser light show will be presented. It takes the form of colourful light effects which result from the use of special electronic and optical equipment used in conjunction with a powerful laser. The laser show will fill the exhibition space at regular intervals and provide a spectacular view of the artistic possibilities of laser light. Laser light is bounced around the exhibition space in exciting sculptural patterns and forms, providing a fitting background to the holograms on display.

The SPACE-LIGHT laser show has been especially prepared by Soleil Laser, Australia's leading laser display company. Laser artists who have prepared the display are former American Gary Levenberg and Sydney artist Geoffrey Rose. Levenberg has been working with laser displays in Australia following several years' work with lasers in California; Rose is a prominent Sydney artist and the inventor of the laser harp. Together they have presented most of the best laser light shows in Australia to date, including the Melbourne and Brisbane City Square projects and the Sydney Tower opening.

Although small exhibitions of holography have been shown in the USA and the UK, none has approached the scope and scale of the SPACE-LIGHT exhibition. The much smaller 'Light Fantastic' exhibition held recently at the Royal Academy in London attracted 200 000 people in the short space of three weeks.

Director of SPACE-LIGHT is Paul Walton, formerly of the University of London's Goldsmiths College Holography Workshop, who is also a prolific author on communications and the media. According to him, "SPACE-LIGHT will present a look into the future with a technology that already exists today. People will marvel at the incredible three-dimensional images which are seen to exist but cannot be touched or felt."

'Finger Language', 240 x 170 mm hologram by C.F. Reutersward from the collection of Alme Maeght, Paris. (Photo: Hans Hammerskjold/Tio, Sweden).

The SPACE-LIGHT exhibition will begin in Sydney at the Museum of Applied Arts and Sciences/Power House Museum, and will be open from January 1 to February 14 1982. It will then move to the Art Gallery of Western Australia (March 24 to April 18); Lower Town Hall, Melbourne (April 29 to June 6); and Brisbane Civic Art Gallery and Museum (June 23 to July 25).

Don't miss it!

New Kaise digital multimeters

Standard Components recently announced an updated range of their Kaise digital autoranging multimeters.

Designed for the professional and the hobbyist, all models feature fast autoranging on volts and ohms, simple pushbutton operation, large easily read 3½-digit display, and better than 0.8% accuracy.

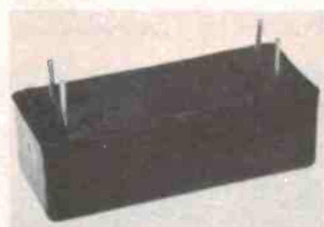
The SK6330 and SK6440 have 10 amp, 200 mA and 20 mA ac/dc current capability, and the SK6330 also features a piezo-ceramic buzzer to indicate overload, range change and continuity.

The new range is available from Standard Components Pty Ltd and their authorised dealers throughout Australia. For further information contact Grant Fisher on (02)660-6066.

New kind of electrolytic from Soanar

Soanar Electronics Pty Ltd, the Australian Agent for NTK of Japan, have just introduced a new style of low impedance electrolytic capacitor into the Australian market.

These unique capacitors, known as the FTE Series, were designed specifically by NTK for use in switching regulators requiring extremely low impedance at frequencies between 10 and 100 kHz.



With printed circuit boards in mind, the case size has been made small and compact with a low profile. This was achieved by the development of a unique element structure and the use of a square-section plastic case.

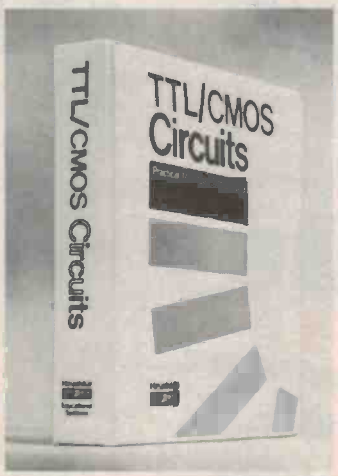
Ripple current at high frequencies is said to be greatly improved compared with ordinary electrolytics, due to the low equivalent series resistance. Even when operated at the specified maximum temperature of 105°C the FTE capacitor is guaranteed for 1000 hours.

The capacitance range extends from 100 uF to 22 000 uF at rated voltages between 6.3 V and 200 Vdc. Soanar is not stocking the full range of FTE capacitors at present, but will accept indent orders for any value of capacitance in minimum quantities of 1000 pieces.

Further information and technical specifications are available from Soanar Electronics Pty Ltd, 30 Lexton Road, Box Hill Vic. 3128.

New course in TTL and CMOS circuits

An economical new 'hardware-oriented' course in TTL and CMOS circuits is being offered by Heathkit/Zenith Educational Systems, distributed in Australia and New Zealand by Warburton Franki.



Designed for the electronics student, experimenter, radio amateur or computer enthusiast, these abbreviated circuit descriptions are ideal for the person who wants to learn by doing, according to a Warburton Franki spokesperson.

A hardware-oriented course designed to give 'hands-on' experience, the TTL and CMOS circuits course comprises a series of circuit 'files' arranged in a logical progression. Each file provides the student with a description of the particular circuit and its operation, a circuit schematic, and modifications that can be performed on the basic circuit.

Text reading is condensed and the course places emphasis on actual circuit construction. Examples of the circuits the student will build include seven-segment digital displays, flip-flops, clock generators, data selector distributors and comparators.

Sixty-five electronic components for constructing more than 50 circuits are included with the course. Using the components supplied with the course, the student constructs state-of-the-art circuits on the Heathkit/Zenith ET-3300 Trainer or uses his or her own breadboard and power supplies. To receive full benefit a student needs standard test equipment — a voltmeter and an oscilloscope. The Heathkit/Zenith dc, ac and Semiconductor courses (EE-3101, EE-3102, EE-3103) or equivalent knowledge are prerequisites.

Housed in a sturdy vinyl binder, the Heathkit/Zenith EH-702 TTL and CMOS circuits course should be a useful addition to any reference library.

For more details on the EH-702 TTL and CMOS Circuits Course, see the latest 104-page Heathkit Catalogue. For a free copy write to your local Warburton Franki office.

Master and slave drivers for LCDs

Soanar recently released the new Motorola MC145000 (Master) LCD Driver and the MC145001 (Slave) LCD Driver. These CMOS devices are designed to drive liquid crystal displays in a multiplexed-by-four configuration.

The Master unit generates both frontplane and backplane waveforms and is capable of independent operation. The Slave unit generates only frontplane waveforms and is synchronised with the backplanes from the Master unit.

The 24-pin DIP configuration master drives 48 LCD segments, and the 18-pin DIP configuration slave provides frontplane drives for 44 LCD segments. Several slave units may be cascaded from the master unit to increase the number of LCD segments driven in the system. The devices use data from a microprocessor or other serial data and clock source to drive an LCD segment per bit.

For further information contact Soanar Electronics Pty Ltd, 30 Lexton Road, Box Hill Vic. 3128. (03)840-1222.

ZX81 CONTEST — RESULTS

The winner of this most popular contest, featured in the October '81 issue of ETI, is:

JOHN MORRIS of CROYDON, VICTORIA.

Congratulations, John! Thanks to all those (. . . thousands!) who sent in an entry, or several. The judging proved interesting. It seems that quite a few entrants did not read the rules correctly. Quite a number of you *forgot to include the bottom corner of the contest page*, containing the month and page number, *cut from a copy of the issue*. Many who sent multiple entries forgot to include this with each entry or forgot to include it altogether! It pays to read the rules.

On looking through the answers to the five questions, the first one threw a lot of people. Here are the answers we were looking for, to each question:

Which mathematical functions does the ZX81 provide on the keyboard? SIN, COS, TAN, INT, ARCSIN, ARCOS, ARCTAN, SGN, ABS, SQR, LN, EXP were the least we looked for, though RAND, AND could have been included. Note that +, −, = etc are mathematical operators, not functions. π (pi) is a constant. Answers like 'a full range' were not what we wanted. Mr Morris had the first correct entry picked out.

Can the ZX81 do animated graphics? Simple, YES.

How many columns wide is the print (on the ZX Printer)? Basically, 32.

What happens when you press the COPY key? The ZX Printer prints exactly what's on the screen.

What microprocessor is used in the ZX81? This could be answered 'Z80A', '780-1' or 'fast version of Z80'.

ERRATA

Project 824, Dec. '81: The power transistor, Q1, used in the Slot Car Power Supply is an MJ2955, not a 2N2955. On the overlay, page 29, R3 is shown as 830R, but is really an 820R, as in the circuit and parts list.

Project 159, Dec. '81: On page 37, the text mentions Project ETI-316, where we mean the ETI-326, published in the September '80 issue.

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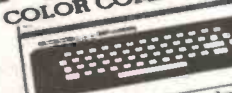

The exciting, newest member of the TRS-80 microcomputer range, COLOR COMPUTER makes computing fun for the entire family. And you can win one simply by completing the coupon below and presenting it at Computerama '82.

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NEWS digest

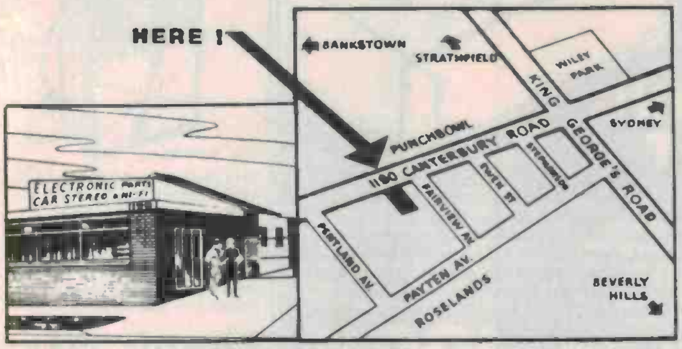
New hobbyist shop

A new shop, trading as GIS Electronics, opened in Punchbowl NSW on December 1 last year, catering to electronics hobbyists generally and in particular to those in the Canterbury/Bankstown area.

The shop is a joint venture between Pre-Pak Electronics and a private investor hobbyist, Mr. Stan Woolley, who manages the store. As a demonstration of long-term commitment to the hobbyist market in this area, the premises have been purchased and extensive renovations are taking place, which should be complete by the New Year.

A full range of electronic parts will be stocked in the air-conditioned shop, together with displays of hi-fi equipment and car radios and stereos, and Pre-Pak's monthly 'Special Buys'. Parking for ten cars is provided on the premises, and trading hours are Monday to Saturday, 9 am to 5.30 pm.

GIS Electronics may be found at 1190 Canterbury Rd, Punchbowl NSW, close to the Roselands shopping complex. Further information may be obtained from Pre-Pak Electronics Pty Ltd, 1A West St, Lewisham NSW 2049. (02)569-9797.



Log. and lin. function generator

A versatile function generator with both linear and logarithmic sweep facilities has been introduced by Philips Test and Measuring Instruments. The PM 5133 provides sine, square and triangular waves from 10 MHz to 2 MHz as well as negative and positive-going pulses and dc. The logarithmic sweep ranges cover more than four decades.

Output frequency and open-circuit voltage is push-button selectable with indication on a three-and-a-half digit LED display. Maximum output is 20 V peak to peak, 10 V peak to peak for pulses, with ±5 Vdc offset. Both stepped and variable attenuation is provided. Frequency and voltage and various sweep modes as well as range and setting errors are indicated by individual LEDs.

Facilities include single cycle and burst with variable start from −90° to +90°. Duty cycle is variable from 10 to 90%. The linear or logarithmic sweep functions can be triggered internally or externally — both manually and electronically remote. Hold and reset facilities are standard.

For more information contact Bruce Druery on (02)922-0181. For commercial inquiries contact Philips Scientific and Industrial Equipment, 25 Paul St, North Ryde NSW . (02)888-8222.

Rock-a-bye baby . . .

Arlec have just released a fully automatic, two-channel FM wireless intercom system (Arlec Part No. AIC1500), which is extremely simple to install and should find many uses both at home and in the workplace.

The AIC1500 uses frequency modulated circuitry for crisp, clear sound with minimal background noise or interference, and incorporates automatic sound-activated transmit/receive switching for completely 'hands-free' operation during conversations.

No wiring between units is necessary; connection is achieved through the normal electric wiring of the building by simply plugging the units into the ac power sockets at the chosen locations. The units can therefore be operated immediately they are plugged in and can be easily changed to other locations when desired. The system may consist of as many units as required.

Communication over considerable distances is said to be possible, restricted only by distribution transformers or when the transmitter and receiver are connected to different phases of the main supply line.

At home the AIC1500 could be used as a security intercom at the front door, for room-to-room, house-to-garden, house-to-granny-flat, etc, communication. It may also be used in a bedroom or nursery as a continuous monitor, a special transmit lockswitch enabling it to be locked on transmit and preventing it from receiving transmissions from other stations in the system to avoid disturbing the occupant of the room. In this mode it is also more sensitive and will transmit sounds of lower intensity than when it is set on automatic.

Applications in industry and commerce are practically limitless, embracing offices, warehouses, factories, shops, surgeries, hospitals, studios, garages, farms, etc.

For further information contact Arlec Pty Ltd, 30 Lexton Rd, Box Hill Vic. 3128. (03)890-0661.

LCD DIGITAL MULTITESTER

A portable 3½ digit, compact tester which is ideal for both home and field applications. Ranges: 0-2V to 0-1000V DC, 0-200 to 0-500V AC. High contrast, easy-to-read, liquid display. Full auto-polarity operation. Over-range indication on each range. This digital multitester is new to Dick Smith, and we're proud to put our name on it! Cat. Q-1445

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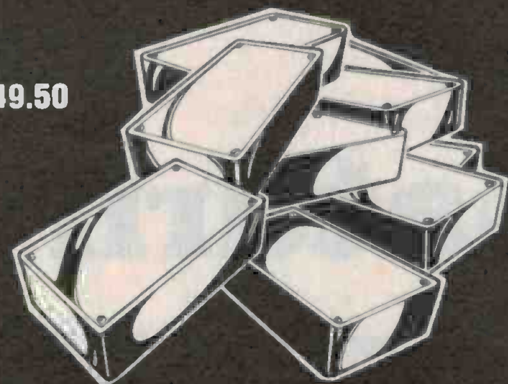

STOCK UP NOW ON DICK'S ZIPPY BOXES WITH ALL ROUND RIBBING

These zippy boxes represent excellent value for money. They are made from tough high impact styrene with moulded corner supports to take the self tapper screws (supplied). The all round ribbing means PCB's can be mounted either way. A natural aluminium lid is also supplied. Thousands of these boxes have been sold. Great quality, great price!

Cat. H-2751	150(d) x 90(h) x 50(w)mm	1-9	$2.75 ea.
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Cat. H-2753	130(d) x 68(h) x 41(w)mm	1-9	$2.20 ea.
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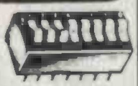

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LOOK AT THIS VALUE POWER SUPPLY

This power supply is designed for use with CB radios at base station but has many other uses as well. Output voltage is 13.8 at 2 amps continuous, 4 amps peak pulse. Front mounted on/off switch and rear mounted output terminals for non-messy wiring. This power supply is excellent quality for the enthusiast who requires a good bench DC supply.
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Quite often, the products we advertise are so popular, they run out within a few days. Or, unforseen circumstances might hold up goods so that advertised lines are not in the store by the time the advert. appears. Please don't blame the store manager or staff; they cannot solve a dock strike on the other side of the world, or even locate a shipment that has gone astray. What we are trying to say is that, if you are about to drive across town to pick up a particular line at a Dick Smith store, why not give the store a ring first (addresses/phone numbers below) . . . just in case! Thanks.

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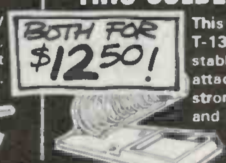

This stand, especially suited to the T-1300 soldering iron, features a stable cast base with screw holes for attaching to your workbench and a strong coiled spring to hold the iron and protect you!

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Saturn up close

Voyager 1 passed within 126 000 km of Saturn in late 1980, giving us the closest view of the giant ringed planet we had ever seen. This flyby laid the groundwork for Voyager 2's 1981 encounter with the planet from only 101 000 km, considerably extending the information gathered on the planet to date.

Brian Dance

IN LATE August/early September 1981 the Voyager 2 spacecraft swept by Saturn at a distance of 101 000 km above the tops of the clouds. The huge gravitational field of this planet swung the craft on towards its next planetary encounter with Uranus in January 1986. Late in 1980, Voyager 1 came within 126 000 km of Saturn's cloud tops, and the knowledge gained from this Voyager 1 encounter enabled us to plan the Voyager 2 mission for maximum data return.

Voyager 2 not only approached closer to Saturn, but it carried two somewhat better television cameras, one for narrow-angle or close-up work and the other for wide-angle work. Thus Voyager 2 was able to provide us with many high-resolution images not only of the surface of the planet itself, but also of its rings and its moons. One of the major discoveries of Voyager 1 was that the Saturnian ring system consists not merely of the few rings one can see from Earth, but that there were hundreds of them. The higher resolution provided by Voyager 2 cameras has shown that there are literally *thousands* of rings!

Jammed platform

On August 25 1981, shortly after Voyager 2's closest approach to Saturn and whilst it was in the shadow of the planet and out of communication with the Earth, a moving platform in Voyager which carries the spacecraft's cameras became jammed. After the spacecraft emerged from behind the planet and resumed communications, commands were immediately sent to point the instruments on the platform away from the Sun to avoid possible damage from the Sun's radiation.

The platform carries two television cameras and two spectrometers (infrared and ultraviolet), apart from a photopolarimeter, which are mounted at the tip of a 2.25 m boom extending from the main body of the spacecraft. The platform can move in two directions, azimuth (or side-to-side) and elevation (up and down). The jamming affected only the azimuth movement.

Engineers first sent a command signal so that the complete craft rotated to point its delicate instruments away from the Sun. The problem of investigating the cause of the trouble was greatly magnified by the enormous distance through which the radio signal commands had to travel. A command signal took nearly 1½ hours to reach the craft and the effect of the command could not be received back on Earth for about another 1½ hours.

The jamming of the scan platform occurred about 45 minutes after Voyager 2 had passed through the ring plane of the planet, and this led to speculation that the problem was caused by the craft being bombarded with dust particles travelling at an enormous velocity relative to the craft.

However, on August 28, the platform was successfully moved in azimuth by command signals from the ground stations, which resulted in the instruments being pointed at Saturn once again. The response of the platform to

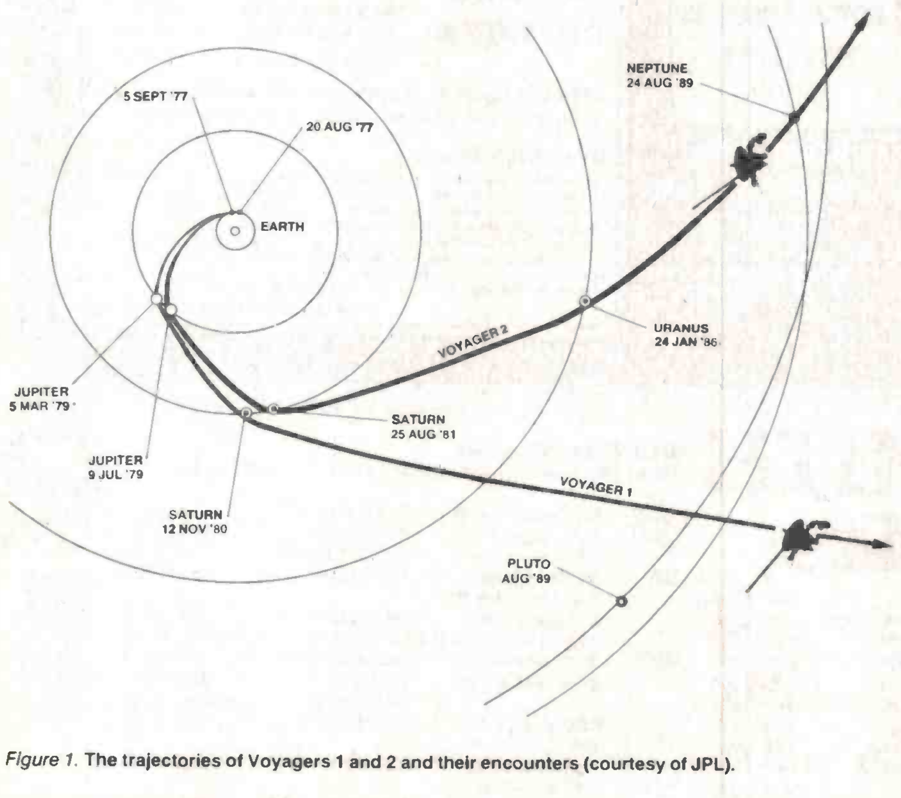


Figure 1. The trajectories of Voyagers 1 and 2 and their encounters (courtesy of JPL).

A Voyager 2 picture of Saturn's northern mid-latitudes showing a strangely curled cloud attached by a thin ribbon to the bright cloud region to the north (top of picture). The cloud has been monitored for seven rotations around the planet and it seems to be forming a closed loop. Other discrete clouds may be discerned to the east. Also evident is a ribbon-like structure in the white cloud region. Voyager 2 took this image on 16 August 1981 at a distance of 9.3 million km, when the smallest feature was about 90 km across.

azimuth commands has sometimes been hesitant and slow, but has steadily improved with use, and scientists are confident that satisfactory operation will be achieved at Uranus. In any case, the platform has been left in a useful position for the Uranus encounter in 1986, so good images should be returned even if the platform should again become jammed.

It is interesting to note that the identical platform aboard Voyager 1 jammed early in this craft's flight, but eventually worked itself free. The reason for the fault in Voyager 2 is not completely clear, but there is a firm opinion that the fault is probably not connected with the possible collision with the ring material. Indeed, the images returned before the craft reached the ring plane gave some indication that everything was not working quite as it should, and the spacecraft designers are wondering whether a small piece of plastic left in the gearbox assembly of the platform could have caused the fault on both craft.

Communications

Voyager 2 receives signals from Earth at a frequency of about 2113 MHz, the receiver being used either with a high-gain 3.7 m diameter parabolic reflector antenna or with a low-gain antenna. Voyager 2's primary receiver failed on April 5 1978, and since then the craft has been operating with its back-up receiver. Both are phased-locked loop receivers able to lock onto and track a received signal over a 500 kHz bandwidth centred on the receiver's 'best-lock frequency' or BLF. A tracking loop bandwidth of at least 150 kHz is required to accommodate Doppler shift effects induced by the rotation of the Earth and by the acceleration of the spacecraft in the region of the planet. In addition to the failure of the primary receiver, the back-up receiver was found to have a shorted capacitor in its phase-locked loop filter, which reduced the tracking loop bandwidth from 500 kHz to 200 Hz. Special equipment was therefore used to keep the frequency received by the spacecraft constant to within about 50 Hz by altering the frequency transmitted from the ground station to the craft to compensate for the rotation of the Earth and for the acceleration of the craft.

Although the receiver operates only in the S-band, the spacecraft contains both S-band and X-band transmitters. The S-band transmitter is a solid state amplifier, but the other three transmitters use travelling wave tubes. The X-band transmitter uses only the high-gain antenna, but the S-band transmitter can use either antenna.

X-band signals from the craft can be received by both the 64 m diameter and 34 m diameter aerials of Deep Space Network stations, but the 26 m Earth stations work only with the S-band signals. The signals reaching the antennae are about 100 attowatts (10^{-16} W), so very low noise, low temperature amplifiers are required to detect it. An improvement of about 1 dB in the signal-to-noise ratio is obtained by suitably processing the signals received by a 64 m and 34 m diameter antenna at two of the three locations (Goldstone, Spain and Australia). This results in a signal being obtained which is equivalent to that which would be provided by a single 72 m diameter reflector at each location.

Loss of the signal from a 34 m station reduces the data rate or increases the error rate, but does not cause the loss of all the data. Loss of the 64 m signal causes loss of the X-band capability and reduces data to the engineering measurements only. The X-band signal is badly affected by bad weather (water vapour or rain) at the receiving station and data loss can be extensive on days when heavy rain or snow falls on the antennae. Critical data was therefore recorded on the spacecraft and re-transmitted twice over separate Earth station networks to provide protection against bad weather.

Clouds

Now that we have considered some of the engineering problems associated with the Voyager mission, let us look at some of the science results returned by Voyager 2.

Saturn has a very turbulent atmosphere in which the clouds are carried along by the winds at high speeds. The winds move fastest in the region of the equator, blowing eastwards at speeds up to some 1770 km per hour (about ten times as fast as a hurricane on the earth). Jupiter has global winds which move at about one-quarter of this speed.

Brown and white spots on the surface of the clouds are enormous regions of storms. One of these was seen by Voyager 1 some nine months earlier and was still raging as Voyager 2 ▶

passed by the planet; it is some 2500 km across. Cyclones and anti-cyclones occur on Saturn and rather resemble the corresponding wind formations in the atmosphere of the Earth. Unlike Voyager 1, Voyager 2 has found easterly winds at several latitudes.

Voyager 2's infrared spectrometer has made measurements on the upper parts of the Saturnian atmosphere which indicate that the temperatures some 40 km below the top of the planet's visible clouds vary from −193°C to −181°C, but the temperature patterns do not seem to correlate with the wind patterns as shown by the television images.

Saturn consists of almost entirely hydrogen and helium and has a density of only about 0.7 g/cm^{-3}. Its equator bulges considerably owing to its rapid rate of rotation — some 10 hours 39 minutes — for such a huge body.

The rings

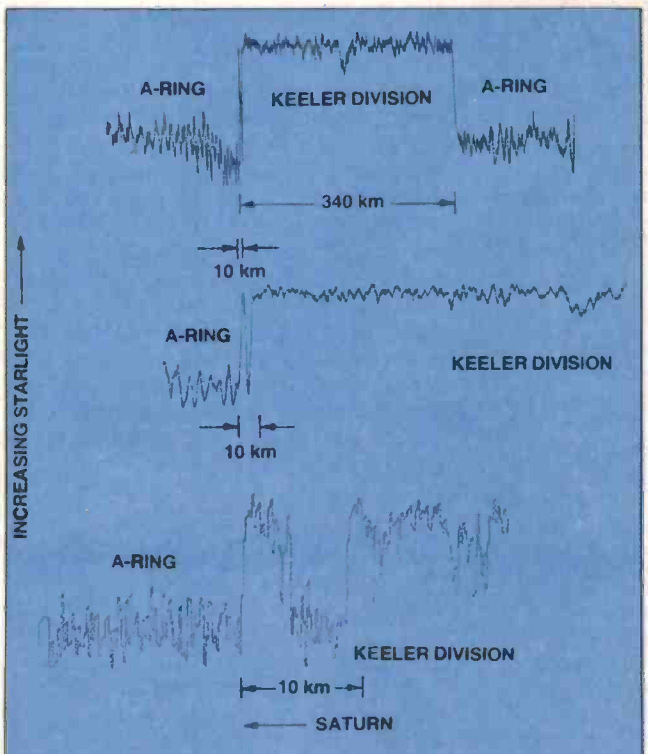
Saturn's rings — some 270 000 km across — are one of the best-known things one can see in a telescope, although they are very thin (about 2 km). They consist of large numbers of ice and rock lumps all independently orbiting the planet like tiny moons. The largest of the ring particles weighs many tonnes, but most are far smaller.

The smallest microscopic fragments in the rings are elevated out of the ring plane by the gravity fields of the planet to form the 'spokes' which were seen by Voyager 1 across the bright ring.

Voyager's photopolarimeter was pointed through the rings at the star Delta Scorpii, which is some 989 light years distant. Measurements of the light from this star as it passed through the ring material provided high-resolution data on the number of ringlets, their densities and widths and the widths of the gaps between them. This technique enabled structures of a size down to some hundreds of metres to be observed, whereas the optimum resolution of the Voyager imaging system is seldom better than 10 km. This high resolution could be obtained owing to the small apparent size of the star and the high resolution of the instrument on Voyager 2.

Radio science experiments investigated the effect of the rings on the radio waves emitted from Voyager 2 at both S-band and X-band frequencies; some measurements of the effect of Saturn's atmosphere on radio signals passing through some of the upper layers also provided valuable information (the radio signals will not pass through the bulk of the atmosphere). The interaction of the radio signals with the rings enabled some estimation to be made of the sizes of the particles of the rings. The sizes of these particles varied from one ring to another, but generally the large particles in the rings were fairly evenly spread through the ring, while smaller particles (of diameter less than about 10 cm) tended to collect at the edges of the rings.

There has been much speculation about the mechanical stability of the rings of Saturn and several theories have been tested against Voyager 2 observations. A mechanism is needed to hold the ring particles in orbit or they would have escaped into space long ago. One theory suggests the ring particles resonate in some way with one of the



The high resolution of Voyager 2's photopolarimeter revealed ringlets that are undetectable by the cameras or radio systems. These three plots show increasing resolution of an area including the Keeler (Encke) Division and the edges of the A-Ring. The amount of starlight (from the distant star Delta Scorpii) passing through the rings is plotted as a single line of varying brightness. Peaks in the curve indicate areas where there is little material to block the passage of starlight, while dips in the curve indicate areas where starlight is blocked by material. The Keeler Division is a relatively empty gap and is therefore seen as a peak in the top plot. The dip in the Keeler Division is probably the 'kinky' ringlet photographed by Voyager 2's camera. With increasing resolution (moving down from the top plot), a feature at the inner boundary between the A-Ring and Keeler Division becomes apparent. This feature is believed to be a ringlet.

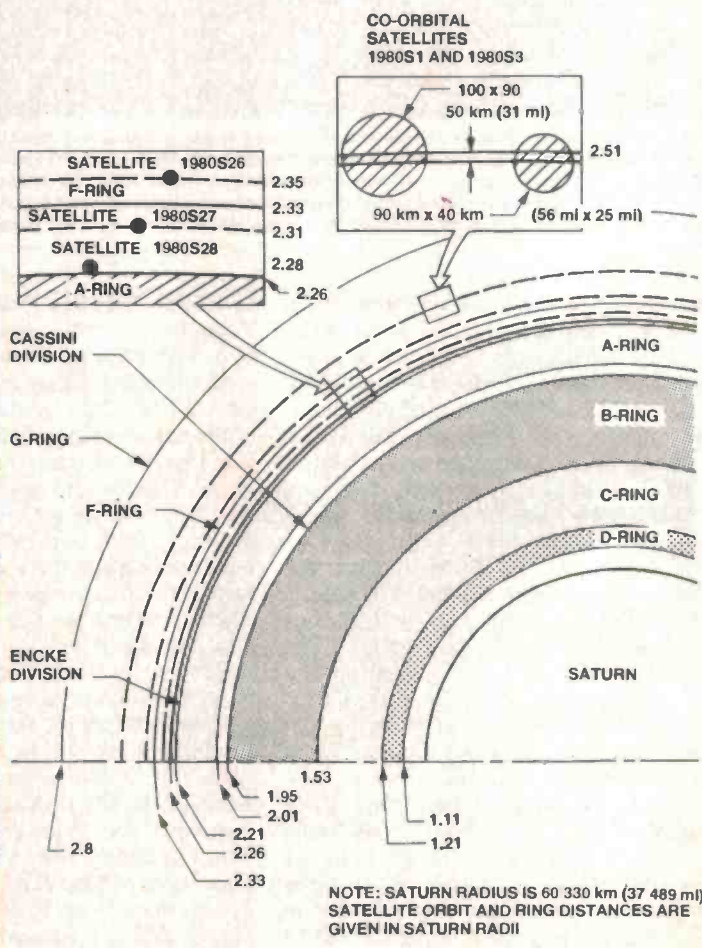


Figure 2. Saturn's rings were given letters in the order of their discovery, but the rings seem to be affected by small satellites in ways not yet fully understood (courtesy JPL).

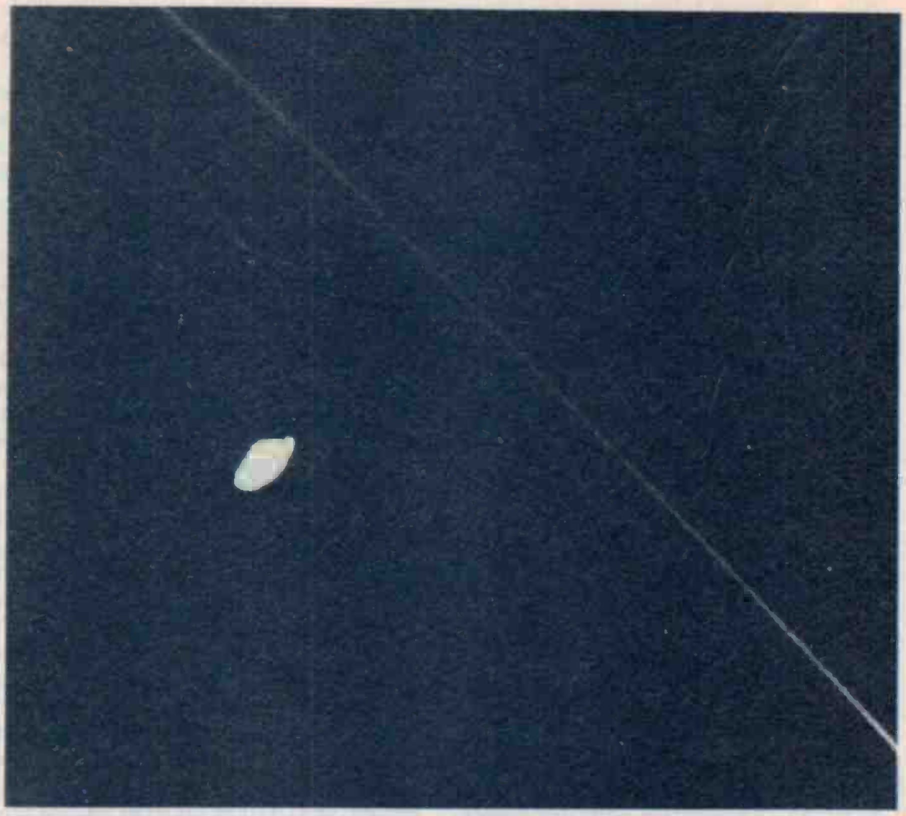
larger satellites, and some of the larger gaps in the rings do occur at orbital resonances with Mimas (for example, some particles make two orbits for every one orbit of Mimas). Another theory suggests that minor moons herd each ringlet, but Voyager 2's cameras could find no evidence for such minor moons other than those already known to shepherd the F ring. Voyager 2 found some evidence to support a third theory of density waves in the ring particles. Yet another theory involves collisions between the particles of the rings; hard objects would rebound from the impacts, but softer ice may shatter.

Voyager 2 gave considerable attention to the mysterious spokes in the B ring and used time-lapse photography, within minutes, mainly near the point where the ring particles emerge from the shadow of Saturn. Most of the spokes disappear before completing a single orbit of the planet, but new spokes can form on top of the remains of earlier ones. The spokes are formed on both faces of the rings (illuminated and unilluminated) and extend outwards from the planet like the spokes of a wagon wheel.

It has been suggested that the spokes are electrostatically levitated particles of fine dust which have been raised above the plane of the remainder of the B ring by the magnetic field of the region. Three images were taken during the ring plane crossing at a time when the rings could be viewed nearly edge-on in an attempt to see this fine dust. However, no evidence of particle levitation could be seen in any of these images — not even in a particularly impressive image taken only 0.5 degree above the ring plane.

During the crossing of the ring plane, the plasma wave radio receiver showed an enormous increase in the intensity of its signal, and the plasma wave investigators believe this was due to the ionisation of minute dust particles striking the spacecraft, although these dust particles are understood to have been too small to damage Voyager 2 in any way.

It is interesting to note that a gap in the outer edge of the A ring, known as the Encke Division (after Johann Franz Encke of the Berlin Observatory, who reported seeing a shading in the A ring in 1837), is likely to be renamed the Keeler Division, since the Working Group on Planetary System Nomenclature of the International Astronomical Union believe James E. Keeler of the Lick Observatory saw this division about 1888 with a 90 cm refractor telescope, whereas it is felt that Encke, using a 22 cm telescope, was probably seeing another feature and not this small gap.



Saturn's F ring and its inner shepherding satellite (1980S27) are pictured in this close-up Voyager 2 image acquired 25 August 1981 from a range of 365 000 km. Features as small as 6 km across are visible. The satellite is elongated and irregular, with its longest axis pointing towards the centre of Saturn (upper right here). As seen here, the F-ring is thin and does not show the multiple braided structure Voyager 1 saw, nor is there any indication of a band or kink in the ring at its closest point in the shepherd; such a feature would be consistent with some of the theories advanced on the formation of the braids.

Lightning

A particularly interesting discovery occurred when Voyager found lightning discharges occurring in the B ring; these discharges were roughly 10 000 times as powerful as the typical lightning flashes which occur on Earth, each having a power approaching 1000 megawatts. It has been suggested that the lightning occurs when a small moon of Saturn interacts with the ring particles and generates a very strong electric field, but no such moon has yet been observed. Neither is it known whether the lightning strokes are in any way associated with the spokes which Voyager 1 found in the same B ring.

Voyager 2 sought the 'braiding' in the very narrow F ring found by Voyager 1 but did not find it. However, it did observe another ring section which appears to be kinked, this being in the Encke division by the A ring; it may be elliptical. However, we know very little as to the mechanism by which these narrow rings can take up such peculiar shapes. It has been suggested that minor moons may affect the uniformity of the rings, but the moons seem to have very little effect on the ring uniformity.

Variations in the colour of the various rings have led to suggestions that these rings may have been formed when bodies of different colours have been broken up. However, this is rather wild speculation and at the present time we must admit that we really know very little indeed about the way the famous rings of this planet were formed.

Bow-shock

The Sun emits a constant stream of sub-atomic particles which are deflected by the magnetosphere of Saturn. A 'bow-shock' wave is formed at the edge of Saturn's magnetosphere — the edge of the region where the magnetic field affects the particles from the Sun. Voyager 2 crossed the bow-shock wave about five times as 'gusts' in the solar wind pushed the magnetosphere in and out of the region in which Voyager 2 was travelling.

The spacecraft had already detected a region in the solar wind where there were few particles. The scientists believe that this region is due to Jupiter moving through the solar wind. Nearer to Saturn, Voyager 2 found that the magnetosphere extended to only some 18.6 Saturnian radii, so it did not even extend out to the orbit of Titan at this point. This may be contrasted with the finding of Voyager 1 that Titan lies in the magnetosphere of Saturn. It is ▶

important to know whether Titan can interact with the high-energy particles trapped within Saturn's magnetosphere.

It is interesting to note that Saturn's magnetic field is tilted only about 1° from the axis of spin of the planet. This is much smaller than in the case of any of the other planets whose magnetic field has been measured. Magnetic fields may be generated by the flow of electric currents within certain parts of a planet, so an investigation into the field may provide information on the current flowing and hence on the type of material inside the planet.

The moons

One of the objectives of the Voyager 1 encounter was a close view of Titan, by far the largest Saturnian satellite and the second largest moon in the whole solar system. Fortunately Voyager 1 obtained good images of Titan or Voyager 2 would have been reprogrammed to accomplish this and would have been unable to continue for encounters with Uranus and Neptune. Voyager 2's encounter with the Saturnian system was therefore mainly determined by the requirement to place it on its desired trajectory to the outermost planets.

Voyager 2 came closer to Enceladus, Tethys, Hyperion, Iapetus and Phoebe than Voyager 1, so images with better resolution could be obtained. Fortunately it returned some excellent images of some of these moons before the platform jammed, but this fault resulted in about two-thirds of the close-up images of Enceladus being lost.

The first flyby of a major moon occurred as Voyager 2 passed Iapetus, which is heavily cratered and has a surface which probably dates back to the early days of the solar system. Strangely enough, this moon has dark and bright sides, and the composition of the dark side (reflectivity about 5%) has created much speculation; it seems too dark to be a silicate and is comparable with the dark material in asteroids which contain much carbon. The density of Iapetus is relatively low, so it cannot all consist of a normal type of rock.

Voyager 2 next passed Hyperion, whose diameter is little more than one-fifth of that of Iapetus, but this strange moon is elongated, with axes some 210 km and 350 km long, and appears to be heavily cratered. Scientists would have expected its long axis to have pointed towards Saturn because of the gravitational effect of the planet, but they have calculated that if it was knocked from this position it would take a time similar to the age of the solar system to return, since it is so far from Saturn that the gravitational field of the planet is relatively small at that distance.

Titan

Voyager 2 passed by Titan at a distance of more than a hundred times that of Voyager 1, so image resolution was greatly inferior to the Voyager 1 observations. However, the images returned were adequate to show that changes had occurred in the atmosphere of the largest of Saturn's moons since the visit of Voyager 1. The photopolarimeter on board Voyager 2 looked for the particles in the atmosphere which scatter light polarised by the scattering process. The colour of the scattered light is related to the size of the particles, since smaller particles scatter light of higher frequency (like the particles which scatter the light in the upper atmosphere of the Earth to produce a blue sky, whereas larger smoke particles can scatter the red light of longer wavelength).

One may well ask why this measurement was not made by Voyager 1 from a much shorter distance, but the answer is that the identical photopolarimeter on Voyager 1 failed. The particles in the atmosphere of Titan were found to scatter radiation from the ultraviolet and red wavelengths; calculations indicate that their dimensions are of the order of 0.1 μm, but there is some evidence that these particles may not be spherical — perhaps crystals, who knows?

Voyager 2 passed minor planets and also Dione and Mimas, but at much greater distances than did Voyager 1. Only about 20 minutes after its closest approach to Saturn, Voyager 2 passed by Enceladus, which lies in the diffuse outermost E ring. The surface of this moon is relatively young and fairly smooth. Some parts of the surface displayed no craters detectable by Voyager 2, and these parts are probably less than 10^8 years old — very young in terms of the age of the solar system. Is Enceladus volcanically active? Its surface seems to suggest that it may show some such activity, but probably not so much as that of the Earth and certainly far less than Jupiter's moon Io — the most volcanically active object found in the solar system.

The surface of Enceladus resembles that of the far larger Ganymede, a moon of Jupiter. Voyager 2 returned an image of Enceladus in which not only the part illuminated by the sun could be seen, but also the remainder of the moon in the light reflected from Saturn. This 'Saturnshine' effect is similar to the 'moonshine' (also known as the 'new moon in the old moon's arms') which we see on earth at a time shortly after new moon, when the light reflected from the Earth weakly illuminates the part of the moon not directly illuminated by the sun.

Tethys

Good images of Tethys, one of the major moons of Saturn, were obtained by Voyager 1, but Voyager 2 not only approached the moon about five times

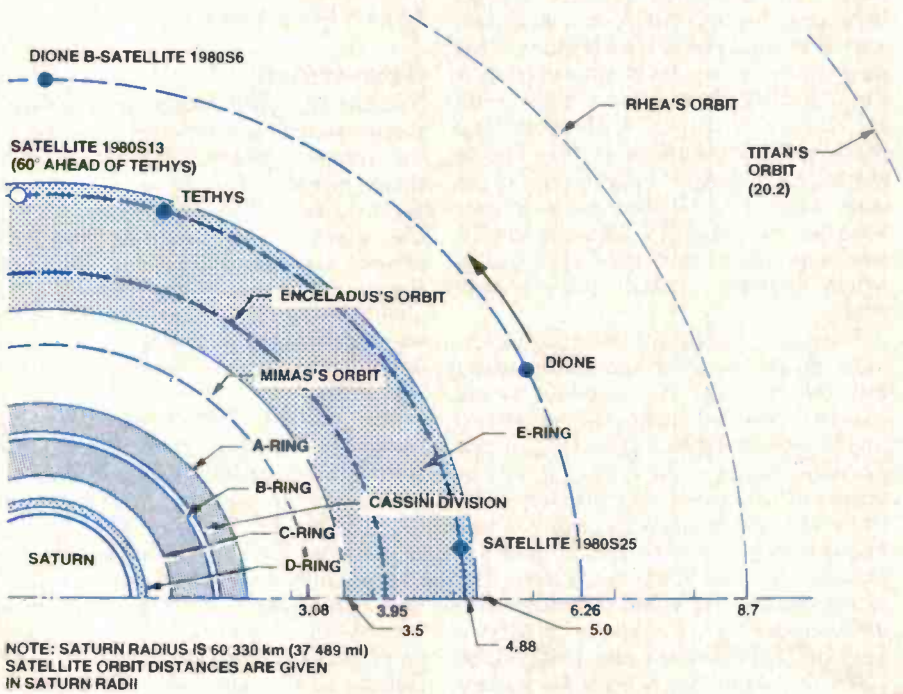


Figure 3. Orbit locations of Saturn's moons relative to the ring system (courtesy of JPL).

closer, but also approached from a different angle. This enabled it to see the largest crater yet found in any of Saturn's moons, with a diameter of some 400 km. It is thought to be a very old crater, even older than the large valley found by Voyager 1 on the other side of Tethys (which was also seen by Voyager 2). It has been concluded that the crater has been flattened by the flow of softer ice and it no longer shows the deep bowl-shape characteristics of fresh craters in hard ice or rock. It was probably formed when Tethys was much warmer than it is at present.

Tethys shows two distinct types of terrain. One of these is bright with densely cratered regions, whilst the other is relatively dark with lightly cratered plains that extend in a broad belt across the satellite. The latter plains are thought to have been formed after the initial cratering process by internal movements in the moon.

Finally, Voyager 2 returned some images of the outermost moon of Saturn, Phoebe, from a distance of some two million km. This moon was not imaged at all by Voyager 1. Phoebe orbits in the opposite direction to the other moons and there has been speculation that it is a captured asteroid.

Saturn's moons have been found to have relatively low densities, which suggests that they contain a substantial amount of water ice with rock, frozen methane, etc. The very low relative density of Iapetus (about 1.1) may indicate that this moon was formed at a lower temperature than some of the other moons, at which temperature methane would solidify and constitute a substantial part of the mass of the moon.

Voyager 2 received some unusual 'pinging' radio signals from the moons Tethys and Dione or from regions near to these moons, some 300 000 to 380 000 km above the cloud tops of Saturn. Scientists have speculated that these signals may arise from a cloud containing ions of hydrogen, carbon, oxygen, etc, which may come from atoms emitted by the moons.

Conclusions

In spite of the problem with the jamming of the instrument platform, the Voyager 2 mission has undoubtedly been an outstanding success, with virtually all its objectives accomplished. This is yet another magnificent achievement of a large team of workers in a project which is so complex that it is difficult to imagine all the details. One should not forget that for 1½ hours all the observations on the night side of the planet had to be recorded on magnetic tape for subsequent transmission to Earth.

Voyager 1 is now moving out of the solar system with all its encounter missions accomplished, but it is searching for new evidence of the limits of the solar wind. Voyager 2 has been swung by Saturn's enormous gravitational field towards its next encounter with Uranus in 1986 and, hopefully, a Neptune encounter in 1989. There is no possibility of it going near to Pluto.

In view of the failure of the main receiver on Voyager 2 and the fault on the back-up receiver, one may well ask what the position would be if the back-up receiver finally failed completely before the Uranus encounter. The on-board computer would then provide the command signals to guide the spacecraft to Uranus and to make a number of measurements there. Such is the power of modern electronics! ●

Acknowledgements

The writer is greatly indebted to Don Bane and to Frank Bristow of the Public Information Office, Jet Propulsion Laboratory, Californian Institute of Technology, for providing excellent photographs and information on the voyager missions. Acknowledgement is also made to Ms. Kit Weinrichter, formerly of NASA's Ames Research Center, California, for much general help over an extended period, especially as regards communications with California.

These three views of Hyperion were obtained as Voyager 2 flew by this satellite of Saturn. They were taken (starting at the top) the morning of 23 August 1981 from a range of 1.2 million km, the morning of 24 August from 700 000 km, and at noon on 24 August from 500 000 km. Together they show the changing aspect of the satellite as Voyager moved in for closer views. Hyperion, roughly 360 km by 210 km and shaped like a hamburger, is probably not in a gravitationally stable position. Its surface is pock-marked with many meteorite-impact craters. It is possible that one of these impacts jostled Hyperion out of position and that the satellite will swing back gradually.

SATURN'S SATELLITES

Name	Diameter	Distance	Closest Approach Voyager-1	Voyager-2
1. 1980S28	40x20 km (25x12 mi)	137 670 km (85 540 mi)	219 000 km (136 000 mi)	287 170 km (178 300 mi)
2. 1980S27	220 km (140 mi)	139 353 km (86 590 mi)	300 000 km (186 000 mi)	246 590 km (153 220 mi)
3. 1980S26	200 km (120 mi)	141 700 km (88 050 mi)	270 000 km (168 000 mi)	107 000 km (66 490 mi)
4. 1980S3	90x40 km (55x25 mi)	151 422 km (94 089 mi)	121 000 km (75 000 mi)	147 010 km (91 350 mi)
5. 1980S1	100x90 km (60x55 mi)	151 472 km (94 120 mi)	297 000 km (185 000 mi)	222 760 km (138 420 mi)
6. Mimas	390 km (242 mi)	185 600 km (115 300 mi)	88 440 km (55 000 mi)	309 990 km (192 600 mi)
7. Enceladus	500 km (310 mi)	238 100 km (147 900 mi)	202 040 km (125 500 mi)	87 140 km (54 100 mi)
8. Tethys	1050 km (652 mi)	294 700 km (183 100 mi)	415 670 km (258 300 mi)	93 000 km (57 800 mi)
9. 1980S25	30-40 km (19-25 mi)	294 700 km (183 100 mi)	237 332 km (147 471 mi)	284 396 km (176 715 mi)
10. 1980S13	30-40 km (19-25 mi)	294 700 km (183 100 mi)	432 295 km (268 616 mi)	153 518 km (95 392 mi)
11. 1980S6	160 km (100 mi)	378 060 km (234 920 mi)	230 000 km (143 000 mi)	318 200 km (197 720 mi)
12. Dione	1120 km (696 mi)	377 500 km (234 600 mi)	161 520 km (100 400 mi)	502 250 km (312 000 mi)
13. Rhea	1530 km (951 mi)	527 200 km (327 600 mi)	73 980 km (46 000 mi)	645 280 km (401 000 mi)
14. Titan	5140 km (3194 mi)	1 221 600 km (759 100 mi)	6490 km (4033 mi)	665 960 km (413 800 mi)
15. Hyperion	290 km (180 mi)	1 483 000 km (921 000 mi)	880 440 km (547 100 mi)	470 840 km (292 600 mi)
16. Iapetus	1440 km (895 mi)	3 560 100 km (2 212 100 mi)	2 470 000 km (1 534 900 mi)	909 070 km (564 900 mi)
17. Phoebe	160 km (99 mi)	12 950 000 km (8 047 000 mi)	13 537 000 km (8 411 500 mi)	1 473 000 km (915 300 mi)

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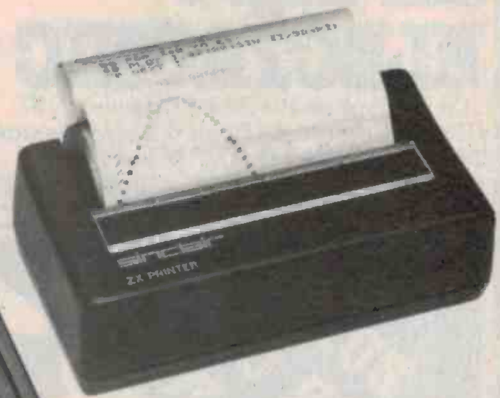

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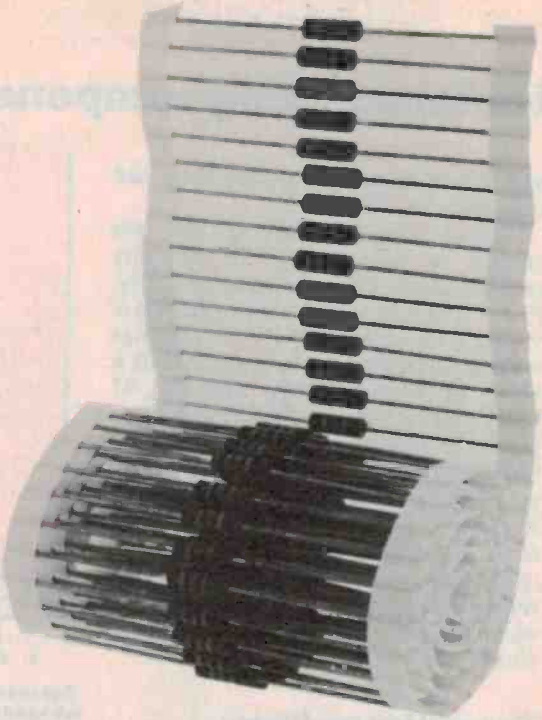
Understanding component values



To the beginner in electronics, and to quite a few not-so-beginners, the values and units given to electronic components such as resistors, capacitors and RF chokes seem confusing. This article should clarify things for you.

William Fisher
Roger Harrison

THE DECIMAL point has been almost abolished in electronics. The little dot was so small it often disappeared when things were printed, and in any case not everybody recognises its meaning. The French, who invented the decimal system, use a comma instead, and so do most Europeans. Other countries use commas for different purposes, like separating hundreds from thousands in large numbers. So when you see a number written 1,500 you don't immediately know whether it's meant to be fifteen hundred or one-and-a-half to three decimal places! When engineers from all over the world sat down to decide on a standard international numbering system, they decided that the best thing to do with the decimal point/comma was to get rid of it altogether.

It has been replaced by a letter. To show where the decimal point was, any letter would do. For example, you might write one-and-a-half as 1a5 or 1b5 or 1c5, or you could use a capital letter, say 1P5 or 1Q5.

Normally in electronics you're not dealing with pure numbers. You're dealing with numbers of *somethings* — so many volts, so many watts, amps, ohms and so forth. Most of these quantities have letters that are used as abbreviations for them. 5 V means 5 volts, for example, 5 A means 5 amps, 5 W means 5 watts. When you want to express fractional amounts of these quantities, you use the abbreviation letter in place of the decimal point, like this: 5V6, 1A5, 3W7. You don't have much trouble seeing that these last three mean 5-point-6 volts, 1-point-5 amps and 3-point-7 watts. Unfortunately, there isn't a letter of our alphabet that stands for ohms, but we're all quite used to seeing a capital R for resistance, so we use that to indicate ohms, like this: 4R7, 2R2, 100R. These mean of course 4-point-7 ohms, 2-point-2 ohms and 100 ohms.

Mini and maxi units

Lots of things aren't commonly or conveniently measured in the standard size units. Capacitors, for example, are never measured in Farads, because a whole Farad is an enormous capacitance. Practical capacitors have values measured in thousandths, millionths and even smaller fractions of a Farad. At the other extreme, resistors often have values of thousands and millions of ohms. Now it's obviously inconvenient and confusing to write 0F000001 for one microfarad or 100 000R for one hundred kilohms, so what you do is alter the decimal-point-indicating letter to show the size of the units you are using. For example, 1k5. Clearly this means one-and-a-half somethings and from kilograms and kilometres everyone knows that the little letter 'k' indicates a thousand. So 1k5 must mean one-and-a-half thousand, that is 1500. Similarly, 4k7 means 4700, 2k2 means 2200 and so forth. It's usually clear enough from the context whether you're talking about resistance or capacitance or frequency or whatever, so you don't need to write ohms or anything afterwards.

As well as k for one thousand, there are a number of other letters that stand for multiples of the basic unit. Here they are:

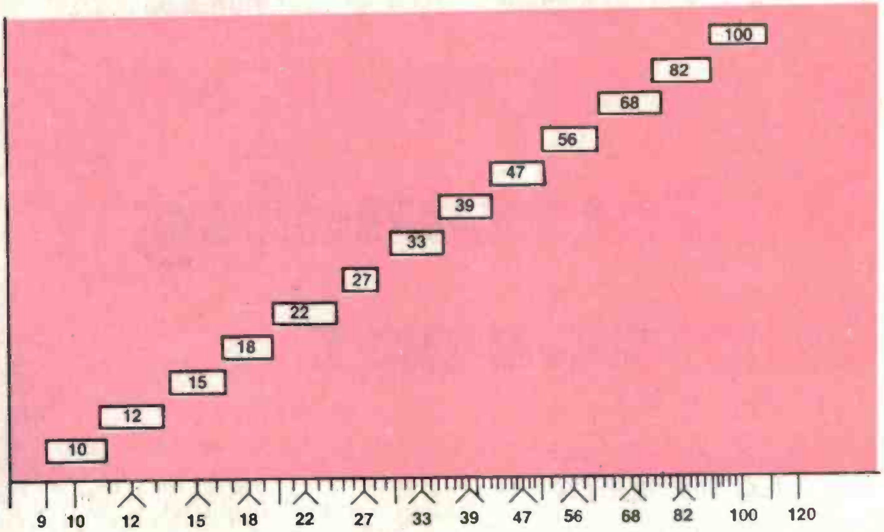
G (Giga) = 1 000 000 000 (one thousand million, 10^9)
M (Mega) = 1 000 000 (one million, 10^6)
k (kilo) = 1 000 (one thousand, 10^3)
m (milli) = 1/1000 (one thousandth, 10^{-3})
u (micro) = 1/1 000 000 (one millionth, 10^{-6})
n (nano) = 1/1 000 000 000 (one thousand millionth, 10^{-9})
p (pico) = 1/1 000 000 000 000 (one billionth, 10^{-12})

Occasionally you'll come across *tera* (T) which is one million million (10^{12}) ▶

Understanding component values

and *femto* (f) which is one thousand billionth (10^{-15}).

Armed with this information, you should be able to read almost any printed value of an electronic quantity. For practice, here are a few examples of values you might not be too familiar with. A capacitor marked as 47p has a value of 47 picofarads, which is 47 billionths of a Farad. One marked 4p7 has only a tenth the value, 4-point-7 billionths of a Farad. A 100n capacitor is 100 nanofarads or 100÷1 000 000 000 Farads = 1/10 000 000 Farad. At the other end of the scale, a resistor marked as 15M has a value of 15 Megohms, i.e: 15 million ohms; one marked 1M5 has a value ten times less at 1-point-5 million ohms.



This shows the tolerance extremes of all the values in the E12 series, represented by a horizontal bar. The left hand end and right hand ends of each bar represent, respectively, the lower limit and the upper limit of the value. Most overlap, you will note.

Translation problems

The standard international numbering system makes everything simple as long as everybody sticks to it, but unfortunately there are still some occasions when you come across values written in an older style and you have to translate them into the new style. This mainly happens with capacitors.

The first problem is that the old symbol for 'micro' was different. It was a Greek letter called mu, which is pronounced like the noise a pussycat makes, and looks like this: μ. This symbol caused some confusion in the past, because it sometimes got mistaken for m, which has always meant 'milli', a thousand times larger. So μ was officially replaced by 'u'. If you see a capacitor marked, for example, 10μ, you can translate that directly into 10u and know that it means 10 microfarads. Nevertheless, μ is still widely used.

Another confusing thing is the still common practice of marking or specifying capacitor values in *fractions* of a microfarad, like 0.001μ (1000p, or better, 1n). To convert fractions of a microfarad into modern values, you have to multiply by 1000 to get the answer in nanofarads, or multiply by 1 000 000 and get the answer in picofarads. Don't panic! To save you trouble, here is a list of typical old-style values and how they translate into new style. From this list you should be able to work out very quickly the new-style version of any old-style capacitor value.

0.1μ = 100n	0.47μ = 470n
0.01μ = 10n (10 000pf)	0.047μ = 47n
0.001μ = 1n (1000p!)	0.0047μ = 4n7
0.0001μ = 100p	0.00047μ = 470p

Small resistances

Resistors with small values sometimes cause difficulties. Because small resistances are not very commonly used, most people are not accustomed to thinking in terms of milliohms (thousandths of an ohm), so the little letter 'm' isn't used for resistors. A resistance of one-tenth of an ohm is not written 100m (for one hundred milliohms), but 0R1 (for one-tenth of an ohm). As usual, the letter R indicates the position of the decimal point and shows that the unit of measurement is whole ohms. In the same way, 2R2 means 2-point-2 ohms, 5R6 means 5-point-6 ohms and so forth. Even smaller values are still written as fractions of an ohm, but the 0 before the decimal-point-indicating letter is usually omitted. For instance, R01 means point-01 ohms (one hundredth of an ohm), R001 means point-001 ohms (one thousandth of an ohm), R33 means 33/100ths of an ohm and R068 means 68/1000ths of an ohm.

Zeroes

Some component values are written with a zero before or after the multiplier character to indicate the value quite unambiguously. For example, a 1000 pF capacitor, rather than being written '1n' may be written 1n0. Or a point-1 (0.1) ohm resistor, rather than being written R1, may be written 0R1.

Preferred values

Why is it that resistors and capacitors only seem to come in certain values? You almost never see a 25R resistor, only 22R or 27R ones. 600k resistors are likewise as rare as hens' teeth, but there are any number of 560k and 680k ones. For one thing, manufacturers can't make every possible value of resistor. If they made resistors in every whole number of ohms between 1R and 10M, they'd be making ten million different products and selling only a few of each. Very capital inefficient, as they say. Resistors would be ridiculously expensive and manufacturers would go bankrupt. Obviously, only a restricted number of values can be produced.

But why these peculiar values that actually are produced? What's so special about 4k7 or 56R or 820R? Why not stick to simple numbers? The reason is that these particular values allow the *least* number of different values to be made. How come? Well, resistors are not made with absolute accuracy — that costs too much and isn't usually necessary. Most circuits will accept a variation of 10% in resistor values without problems. So resistors are made with values that are anything up to 10% higher or lower than their marked value. This is called a tolerance of 10% and such a resistor is usually called a 10% resistor. For example, a 100R, 10% resistor might have a value anywhere between 90R and 110R. Given this amount of variation, there would obviously be no point in also making 10% resistors with nominal values like 94R or 107R, because these values are already covered by the ±10% spread of the 100R resistor.

So in a series of 10% resistors, what should be the next highest value above 100R? A value of, say, 111R would be too low, because the 111R resistor would also have a tolerance of 10%, so its possible values would spread down to below

100R, completely overlapping the upper range of variation of the 100R resistor. To avoid this kind of overlap, the next highest value 10% resistor needs to be about 120R. A 120R 10% resistor has its possible values spread between 108R and 132R. There's still a small overlap, but to get rid of the overlap completely without leaving a gap you'd need a value of one hundred and twenty two and two ninths ohms (work it out for yourself if you like algebra), which is rather an awkward number. 120R is a nice round number, so that's the 'preferred value' next in the series. By similar reasoning, the next value in the series of 10% resistors is 150R, then 220R, 270R, 330R, 390R, 470R, 560R, 680R, 820R and then 1k. It doesn't take much to see that the obvious next preferred value after 1k must be 1k2, then 1k5, 1k8 and so on. In other words, the same sequence of values keeps repeating, multiplied by ten at each repetition. This series of preferred values is known as the *E12 series*, because there are 12 values in the series. For reference, here are two 'decades' of the E12 series:

10	100
12	120
15	150
22	220
27	270
33	330
39	390
47	470
56	560
68	680
82	820

Even though resistors are nowadays more commonly made with a tolerance of 5%, the old E12 series of preferred values is still the most widely used. There is a similar series, called E24, which is worked out in just the same way as the E12 series, except that a tolerance of only 5% is assumed.

For closer tolerances, there's the E48 series (2%) and E96 series (1%) with, respectively, 48 and 96 values per decade.

Capacitors are made to wider tolerances than resistors — 20% is not at all uncommon, so they are usually supplied in a restricted range of preferred values. The significant figures in this series are 10, 15, 22, 33, 47 and 68. As there are only six values per decade, it is called the E6 series.

Close tolerance values are written in the same way as we've described previously, so if you come across a 1k02 resistor or a 34p8 capacitor you'll know you're dealing with close tolerance components. In the first case, you have a 1020 ohm resistor, in the second case you have a 34.8 pF capacitor. ●

Preferred numbers in a decade for the E6, E12, E24 & E96 series

E6 20%	E12 10%	E24 5%	E96 1% and 2%					
10	10	10	10.0	10.2	10.5	10.7		
		11	11.0	11.3	11.5	11.8		
	12	12	12.1	12.4	12.7			
		13	13.0	13.3	13.7	14.0	14.3	14.7
15	15	15	15.0	15.4	15.8			
		16	16.2	16.5	16.9	17.4	17.8	
	18	18	18.2	18.7	19.1	19.6		
		20	20.0	20.5	21.0	21.5		
22	22	22	22.1	22.6	23.2	23.7		
		24	24.3	24.9	25.5	26.1	26.7	
	27	27	27.4	28.0	28.7	29.4		
		30	30.1	30.9	31.6	32.4		
33	33	33	33.2	34.0	34.8	35.7		
		36	36.5	37.4	38.3			
	39	39	39.2	40.2	41.2	42.2		
		43	43.2	44.2	45.3	46.4		
47	47	47	47.5	48.7	49.9			
		51	51.1	52.3	53.6	54.9		
	56	56	56.2	57.6	59.0	60.4		
		62	61.9	63.4	64.9	66.5		
68	68	68	68.1	69.8	71.5	73.2		
		75	75.0	76.8	78.7	80.6		
	82	82	82.5	84.5	86.6	88.7		
		91	90.9	93.1	95.3	97.6		

Tolerance extremities for the E6, E12 and E24 preferred value series

−20%	−10%	−5%	nominal value	+5%	+10%	+20%
8	9	9.5	10	10.5	11	12
		10.5	11	11.6		
	10.8	11.4	12	12.6	13.2	
		12.4	13	13.7		
12	13.5	14.3	15	15.8	16.5	18
		15.2	16	16.8		
	16.2	17.1	18	18.9	19.8	
		19.0	20	21.0		
17.6	19.8	20.9	22	23.1	24.2	26.4
		22.8	24	25.2		
	24.3	25.7	27	28.4	29.7	
		28.5	30	31.5		
26.4	29.7	31.4	33	34.7	36.3	39.6
		34.2	36	37.8		
	35.1	37.1	39	41.0	42.9	
		40.9	43	45.2		
37.6	42.3	44.7	47	49.4	51.7	56.4
		48.5	51	53.6		
	50.4	53.2	56	58.8	61.6	
		58.9	62	65.1		
54.4	61.2	64.6	68	71.4	74.8	81.6
		71.3	75	78.8		
	73.8	77.9	82	86.1	90.2	
		86.5	91	95.6		
E6	E12	E24		E24	E12	E6
← lower extremities					upper extremities →	

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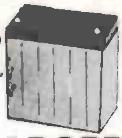

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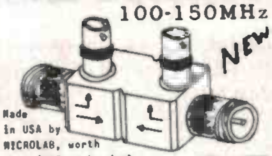

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EG-610ED-2F	12.0	8.4 - 15.0	2400	80	CW
EG-510ED-2B	12.0	8.4 - 15.0	2400	80	CCW

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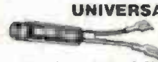

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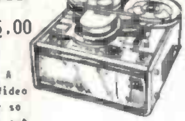

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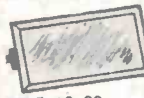

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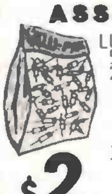

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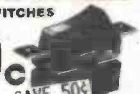

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7413	0.42	74LS75	0.38
7420	0.30	74LS86	0.42
7427	0.30	74LS92	0.76
7430	0.30	74LS93	0.68
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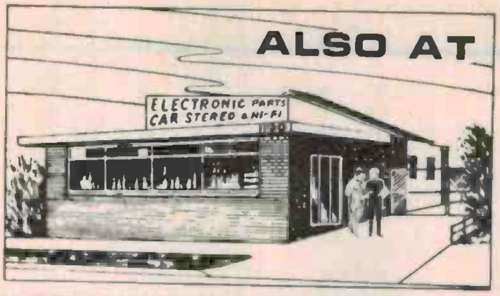

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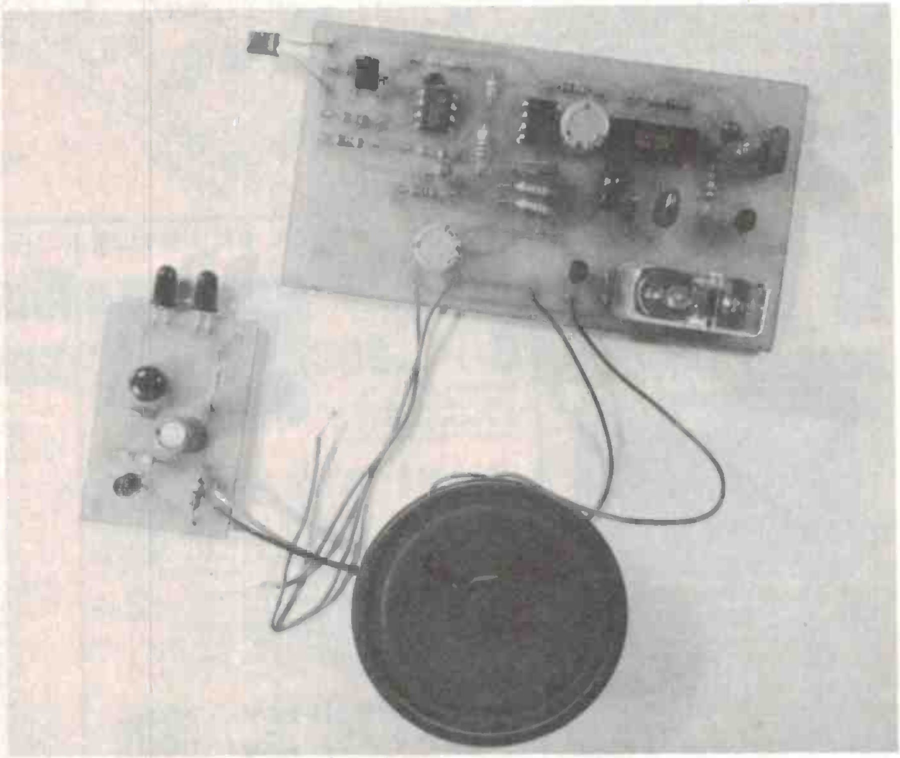
Infrared 'trip' relay

Cut the beam of invisible light and 'trip' a relay or alarm — this simple project can be used as an automatic 'door minder', door opener, a burglar alarm or whatever.

Phil Wait
William Fisher

EVERYONE is familiar with the kind of door that's operated by an invisible beam. As you approach the door your body interrupts the beam, which triggers a switch to open the door. The same principle can be used for other things as well, like a 'door minder' alarm. The beam is set up across the doorway and when a person walks through it an alarm is set off.

This project is the basis of such a system. It comprises a transmitter which emits a beam of infrared radiation and a receiver which detects that radiation. As long as the receiver continues to receive the radiation nothing happens, but if the beam is interrupted a relay is energised (or 'tripped') and latched on for a fixed period of time. The contacts of this relay could carry the current for any 12 volt device, like a lamp, a piezoelectric siren, a small motor or whatever the application calls for. At the same time as the relay is energised, a low-level oscillator is switched on so that a buzzing noise can be heard through a loudspeaker if this is wanted.



The infrared beam is produced by two infrared light emitting diodes. These are just like any other LED, except that the light they emit has a longer wavelength. They use quite a lot of current, so to prevent batteries going flat too quickly they are supplied with very brief pulses of current at intervals of a few milliseconds, so that they emit short, intense bursts of radiation. This also makes it easier to detect the radiation. The range of the system is about two metres, which we thought was adequate for many applications. You could increase the range to about three metres by using two transmitters instead of one, but to increase it further requires a disproportionate amount of power. The range is inversely proportional to the square of the radiated power, so that doubling the range means quadrupling the amount of radiation transmitted, tripling the range means increasing the transmitted radiation by nine times, and so forth.

Construction

We recommend that you use our designs of printed circuit boards to construct the transmitter and receiver, but they are not essential.

Start by mounting the resistors on both boards, referring to our layout diagrams for their positions. Like all the components, these go on the plain side of the board, with their leads pushed through the holes and soldered to the tracks on the other side. Next, solder in all the capacitors on both boards, making sure that all the electrolytic or tantalum capacitors are correctly oriented with their positive leads at the ends we have shown.

Now mount the two infrared LEDs (LED1 and LED2) on the transmitter board. They must go in the right way round, with their cathodes (marked k on our diagrams) at the correct end. After that, mount the two transistors on the transmitter board (Q1 and Q2), making sure that their base, emitter and collector leads (marked b, e and c on our diagrams) are in the correct positions.

Turning to the receiver board, mount the two potentiometers (RV1 and RV2), then insert the diode (D1) and the infrared detecting diode (IRD1), making sure their cathodes are at the correct ends. In the case of IRD1 you also have to make sure that the sensitive side, of the diode faces away from the board so that it can be pointed at the transmitter. The diode has two faces, one flat and one bevelled near the top, the flat side being the sensitive side. Mount IRD1 high enough above the board for it to be bent over to face the proper way.

Then mount the two transistors (Q1 and Q2), making sure you get all their leads in the right places. After that you can tackle the integrated circuits (IC1, IC2 and IC3). Make sure you put them in with the notch or spot at the same end

PARTS LIST — ETI 570

ETI-570a Transmitter

Resistors .... all ½W, 5%

R1 .... 47R
R2 .... 10M
R3 .... 3R3

Capacitors

C1 .... 1n greencap
C2 .... 100u/16 V electro.

Semiconductors

LED1,2 .... CQY89A or similar
Q1 .... BC558, BC178 or similar
Q2 .... BFY50 or similar

Miscellaneous

ETI-570a pc board; case to suit, etc.

ETI-570b Receiver

Resistors .... all ½W, 5%

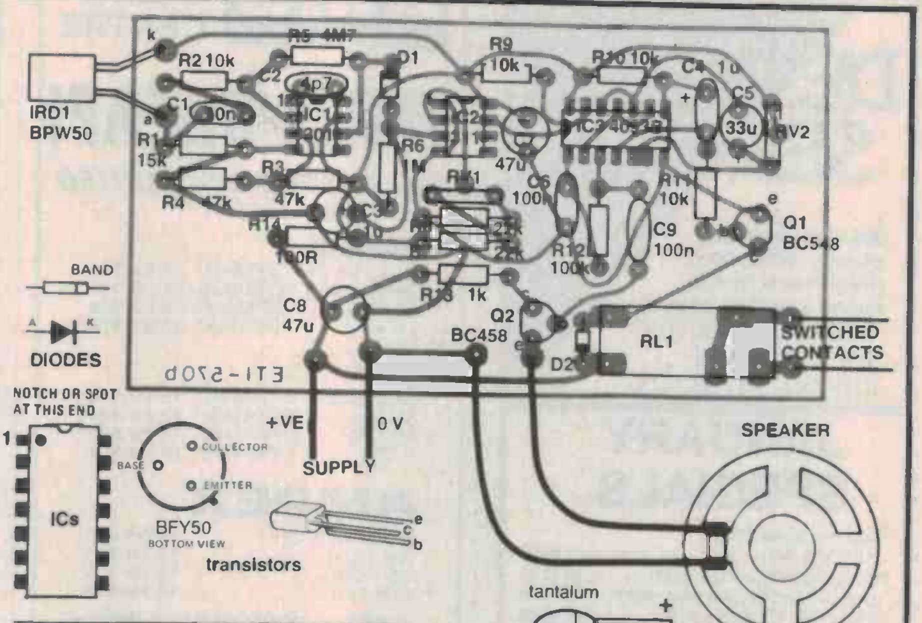
R1 .... 15k
R2,R9-R11 .... 10k
R3, R4 .... 47k
R5 .... 4M7
R6 .... 1M
R7, R8 .... 22k
R12 .... 100k
R13 .... 1k
R14 .... 100R
RV1 .... 100k min. vertical mount trimpot.
RV2 .... 1M min. vertical mount trimpot.

Capacitors

C1 .... 10n greencap
C2 .... 4p7 ceramic
C3, C4 .... 1u/16 V tantalum
C6, C9 .... 100n greencap
C5 .... 33u/16 V tant, or RBLL
C7, C8 .... 47u/16 V electro

Semiconductors

D1 .... 1N914,1N4148 or sim
D2 .... 1N4002, etc.
IRD1 .... BPW50 or similar
Q1,Q2 .... BC548,BC108 or similar
IC1 301
IC2 311
IC3 .... 4093B



Miscellaneous

RL1 .... SPDT pc mount relay with 12 V coil

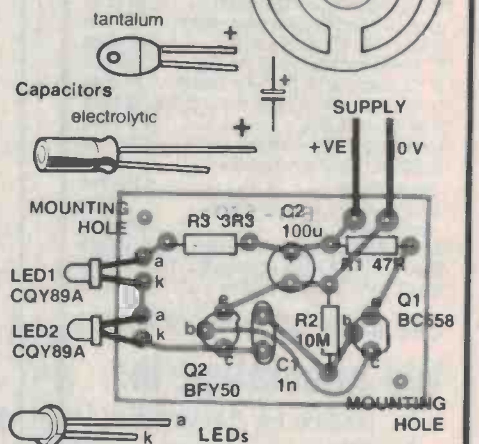
ETI-570b pc board, miniature 8 ohm speaker, case to suit, etc.

Price estimate

We estimate the cost of purchasing all the components for this project will be in the range:

$21—$25

Note that this is an estimate only and not a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreglass or phenolic base), type of front panel supplied (if used), etc — whether bought as separate components or made up as a kit.



as our layout diagrams show, and take care when soldering them in that you don't overheat them. Use a reasonably small bit, don't spend too long over each pin and allow the whole IC to cool down for a few seconds between soldering each of the pins.

Finally mount the relay, connect the loudspeaker to the board (using insulated hookup wire), attach two insulated leads for the power supply, and attach the battery clip to the transmitter board. The transmitter and receiver are now both completed.

Setting up

Connect a 12 volt battery or power supply. Adjust RV1 for minimum resistance. With the transmitter turned off, increase the value of RV1 until the relay just operates. You will notice that the relay will switch off as the latch resets at the end of the timing period, then switch on again as the latch is set again.

Turn on the transmitter and move it away from the receiver, keeping the two LEDs pointing towards the receiver all the time. You should be able to move two metres away without anything happening. If you find that the receiver is not sensitive enough, you can add another infrared receiving diode in parallel with IRD1 to increase the amount of radiation it picks up. If the range is OK, check that the relay operates when the beam is broken.

The volume of sound from the speaker can be altered by altering the value of R13. Reducing the value of R13 increases the volume, increasing R13 reduces it. You can also vary the time that the relay contacts are closed by varying the setting of RV2.

Housing

As individual applications of this project will vary widely, we have not described how to house it in any specific way. However, a few hints may help. The transmitter could be housed in any convenient small container, such as a jiffy box or even a cheap plastic soapholder from a chain store. The two infrared LEDs can be mounted in any convenient position, secured with common LED 'collar' mounts. When mounting the LEDs, keep in mind how you will mount the transmitter box so that the LEDs face in the desired direction.

The receiver can also be mounted in any suitable housing. The infrared receiver diode may be mounted off the pc board or the board positioned so that the diode is held against a hole cut in one side of the case. Alternatively, the receiver diode may be mounted on a tagstrip bolted in an appropriate position. You can secure a small piece of infrared filter plastic over the hole in the case. This will provide some physical protection for the diode. Kodak 'Wratten 89c' or a similar type of filter plastic will do. Make sure you correctly identify the sensitive face of the diode.

For outdoor applications, where the units may be exposed to the weather, we recommend you use aluminium diecast boxes. They're more expensive than other housings, but they're very robust and can be sealed against the weather. ▶

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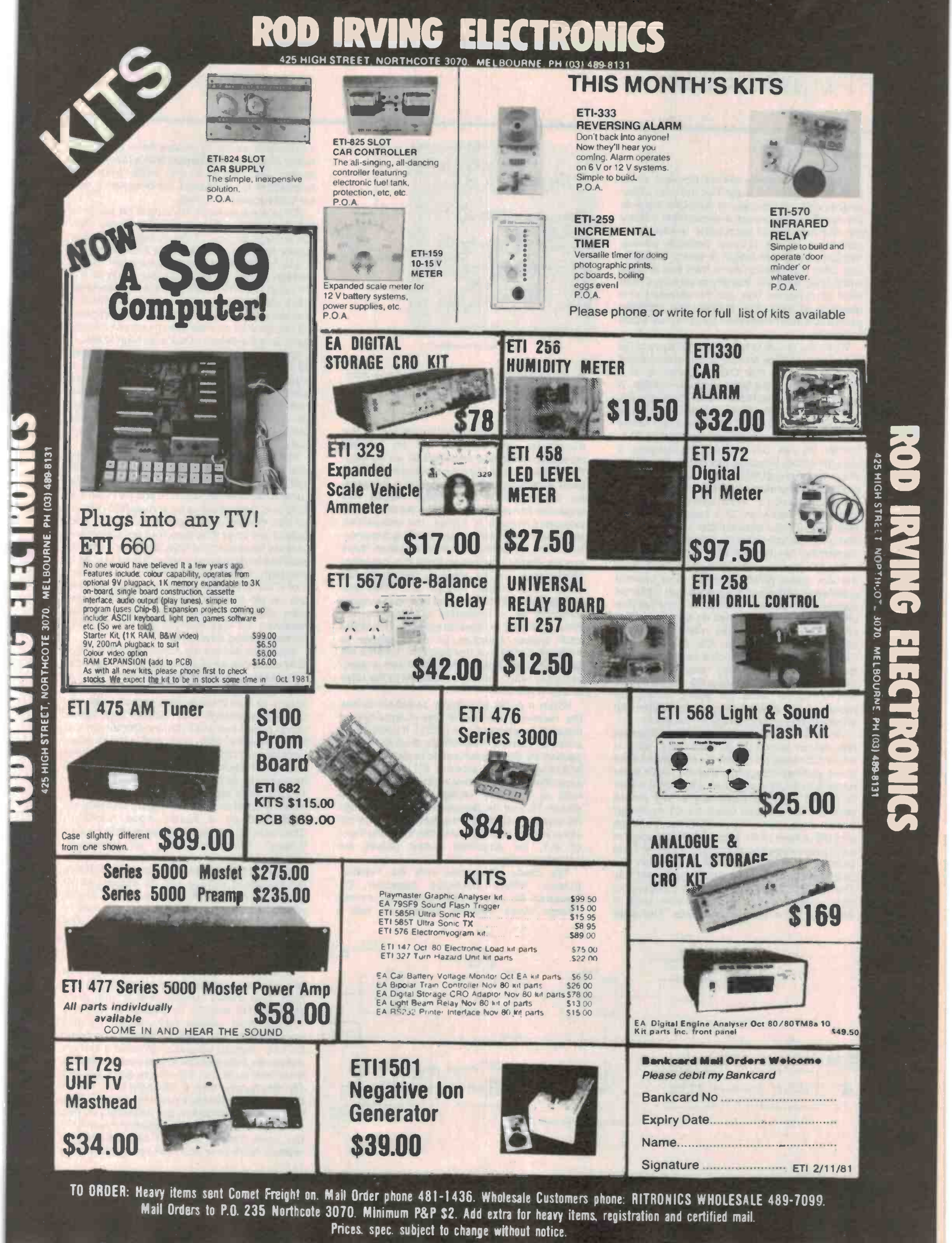


HOW IT WORKS

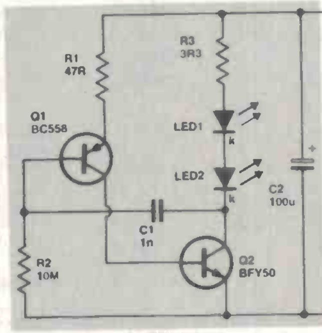
TRANSMITTER

A serial multivibrator allows frequent short pulses of current through two infrared LEDs, so that they emit pulses of radiation towards the receiver. To ensure a reasonable battery life, the duration of each pulse is kept short compared to the interval between pulses. Because the pulse length is short, the LEDs can pass a current of more than one ampere without burning out, thereby producing a high level of radiation that can be detected at a distance of about two metres. The radiation output is further increased by using two LEDs in series.

When the circuit is turned on, the base of Q2 is at a low voltage and Q2 is therefore turned off. This means that Q2's collector is at a voltage close to the battery supply voltage. A small current therefore flows through R3, LED1, LED2, C1 and R2 to ground. The voltage drop across R3 caused by this current keeps the base of Q1 at a 'high' voltage, so that Q1 is turned off. As C1 charges, it develops a voltage across its plates that opposes the flow of current through R3. The voltage on the base of Q1 therefore starts to drop, and when it has dropped about 0.7 volts below the supply voltage, Q1 turns on. This allows current to flow through the base-emitter junction of Q2 and turn that transistor on also, so that a large current can flow through R3 and the two LEDs.

The current through Q2 is large because of the low value of R3, and the high internal resistance of the battery means that it cannot supply this current without a considerable drop in the voltage across its terminals. The current therefore comes mainly from the discharging of capacitor C2. Once C2 has discharged, the low voltage across the battery terminals cannot drive enough current through R1 and Q1 to keep Q2 turned on, so this transistor turns off again, cutting off nearly all the current through the LEDs and allowing the battery voltage to rise again.

While Q2 is turned on, its collector voltage is low, which allows C1 to discharge, so that when Q2 turns off again the circuit is in the same state as it began in and the whole cycle repeats itself over and over again until power is turned off. The frequency of the pulses depends on the time taken for C1 to charge (which depends mainly on the battery voltage and the values of C1 and R2). The duration of each pulse depends on the time taken for C2 to discharge (which depends mainly on the battery voltage and the values of C2 and R3). The values we have specified for components give pulses a few microseconds long at intervals of a few milliseconds. The peak current through the LEDs is about one amp, but the average current is only about one milliamp.



INFRARED TRANSMITTER

RECEIVER

The pulses of infrared radiation emitted by the transmitter are detected by an infrared receiving diode and amplified by an op-amp. The output pulses from the op-amp are used to keep a capacitor discharged, and a comparator IC compares the voltage across this capacitor to a reference voltage. As long as the reference voltage is higher, the comparator puts out a 'high' voltage and nothing happens. When the infrared beam is interrupted, there are no current pulses to keep the capacitor discharged, so its voltage rises and the comparator output swings low. This low voltage operates a latch, one of whose outputs switches on a transistor to allow current through a relay to close its contacts. The other latch output switches on an oscillator to produce a tone in a loudspeaker. When a set period of time has expired, the latch is automatically reset, cutting off current to the relay and loudspeaker.

When a pulse of infrared radiation strikes the receiving surface of the reverse-biased infrared receiving diode (IRD1), it conducts a pulse of current. The voltage drop across R1 caused by this current pulse is applied to the inverting input of op-amp IC1 via coupling capacitor C1. The non-inverting input of IC1 is held at a steady voltage by the potential divider R3 and R4. Negative feedback through R5 sets the gain of IC1 at around 500. Since the input pulses are applied to the inverting input of IC1, the amplified output pulses are negative-going.

The diode D1 passes only the negative pulses, which discharge capacitor C3. Because R6 has a high value, C3 cannot charge much between pulses, so that a continuous series of pulses from the transmitter keeps C3 discharged, with a low voltage across its plates. If the beam from the transmitter is interrupted, C3 charges up and the voltage across it rises.

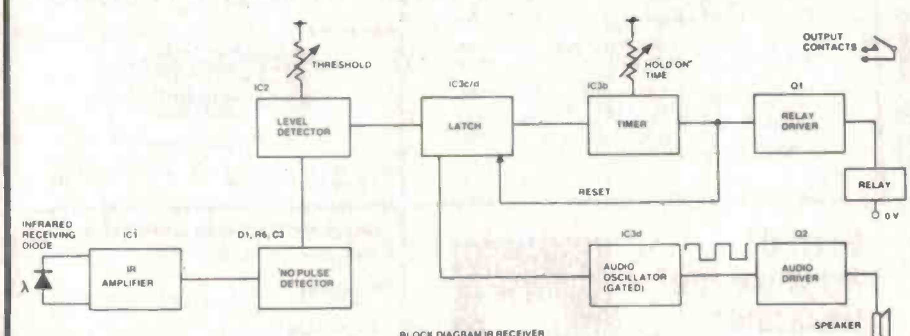
IC2 is a comparator. Its output (at pin 7) is high when the voltage on pin 2 is higher than the voltage on pin 3. If the voltage on pin 3 is higher than the voltage on pin 2, the output of IC2 is low. Pin 2 is held at a constant preset voltage by the potential divider chain of R7, RV1 and R8. When pulses are being received, C3 is discharged and the voltage on pin 3 is therefore low; when the beam is interrupted, C3 charges up and the voltage on pin 3 rises, switching the output of IC2 from high to low.

IC3b, IC3c and IC3d are Schmitt-triggered NAND gates connected as a latch circuit. If either of the inputs of a Schmitt-triggered NAND gate is low, then its output is high. If both inputs rise above a 'threshold' voltage, the output goes low. If either input then falls below a second threshold voltage, the output goes high again.

When power is first turned on to the circuit, pins 5 and 6 of IC3b are held high via RV2, so that its output (pin 4) is low. This means that current can flow through R10 and C4 to pin 4 of IC3b and the voltage drop across R10 caused by this current makes pin 8 of IC3c go low. Output pin 10 of IC3c therefore goes high and so does input pin 12 of IC3d. If pulses are being received from the transmitter, pin 13 of IC3d is also high, so that output pin 11 is low. Input pin 9 of IC3d is therefore held low also, and this low on pin 9 keeps the output of IC3c high, even after pin 8 goes high again, because capacitor C4 has charged up and stopped current flowing through R10.

When the pulses are interrupted, pin 13 of IC3d goes low, sending output pin 11 high. Pin 9 therefore goes high too and since pin 8 is also high, output pin 10 goes low. Current then begins to flow through RV2 and C5 to pin 10, causing a voltage drop across RV2 which sends pins 5 and 6 of IC3b low. Output pin 4 of IC3b therefore goes high and current flows from this pin through R11 to turn on transistor Q1, allowing current through the relay to close its contacts. At the same time, the high on pin 11 of IC3d is applied to input pin 2 of IC3a, which is another Schmitt-triggered NAND gate configured as a square wave oscillator. Capacitor C5 slowly charges up from current through RV2, developing an increasing voltage across its plates. After a while, the voltage on C5 forces the inputs of IC3b above the threshold voltage and its output (pin 4) goes low, cutting off the bias current to Q1, which therefore turns off and stops current to the relay so that its contacts open again. The low on pin 4 of IC3b allows a pulse of current to flow through R10 and C4, which resets the latch.

When pin 2 of IC3a goes high, the other input (pin 1) is initially low, so that output pin 3 is high. This allows current to flow from pin 3 through R12 and C6 to ground. At first the voltage drop across R12 caused by this current keeps pin 1 low, but after a short time C6 has charged up and developed a voltage across its plates, which forces pin 1 above the threshold level. Pin 3 therefore goes low and C6 discharges into it through R12. As C6 discharges, its voltage drops and after a little while pin 1 drops below the threshold, so that pin 3 goes high again. The oscillator is then in the same state it began in and the process repeats itself over and over again, producing



BLOCK DIAGRAM IR RECEIVER

SILICON PHOTO P-I-N DIODE

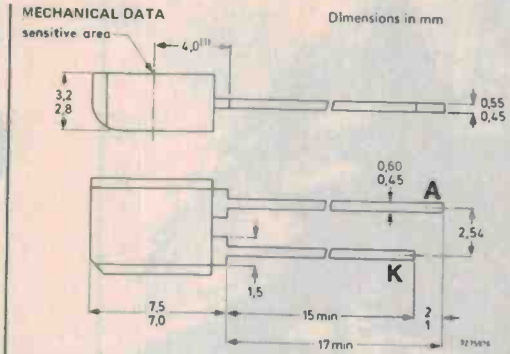
Silicon photo p-i-n diode in a plastic envelope with an infrared filter.

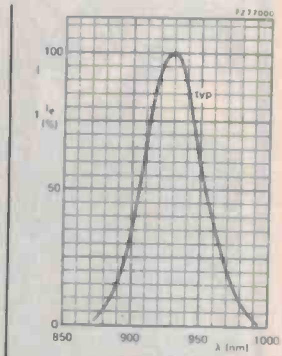
QUICK REFERENCE DATA

Continuous reverse voltage	V_R	max.	32	V
Total power dissipation up to T_{amb} = 47,5 °C	P_{tot}	max.	150	mW
Junction temperature	T_j	max.	100	°C
Dark reverse current V_R = 10 V; E_e = 0	$I_{R(D)}$	<	30	nA
Light reverse current V_R = 5 V; E_e = 1 mW/cm²; λ = 930 nm	$I_{R(L)}$	>	30	μA
Wavelength at peak response V_R = 5 V	λ_{pk}	typ.	930	nm
Sensitive area	A	typ.	5	mm²

MECHANICAL DATA

Dimensions in mm



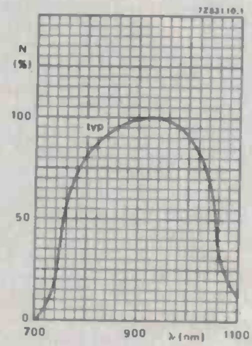


GaAs LIGHT EMITTING DIODE

Epitaxial gallium arsenide light emitting diode intended for remote-control applications. It emits radiation in the near infrared when forward biased. Infrared translucent epoxy encapsulation (dark blue).

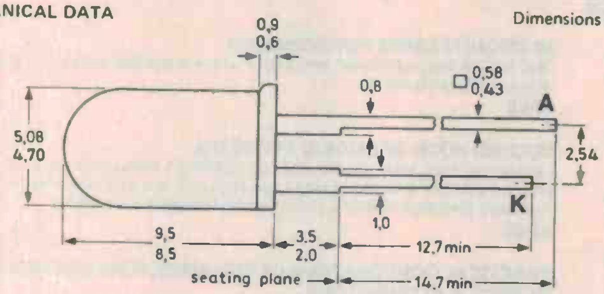
QUICK REFERENCE DATA

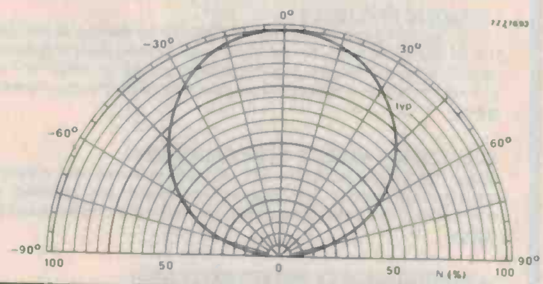
Continuous reverse voltage		V_R	max.	5	V
Forward current (d.c.)		I_F	max.	130	mA
Total power dissipation up to T_{amb} = 25 °C		P_{tot}	max.	215	mW
Junction temperature		T_j	max.	100	°C
Radiant intensity (on-axis) at I_F = 100 mA	CQY89A	I_e	>	9	mW/sr
	CQY89A-1	I_e		9 to 20	mW/sr
	CQY89A-2	I_e	>	15	mW/sr
Wavelength at peak emission		λ_{pk}	typ.	930	nm

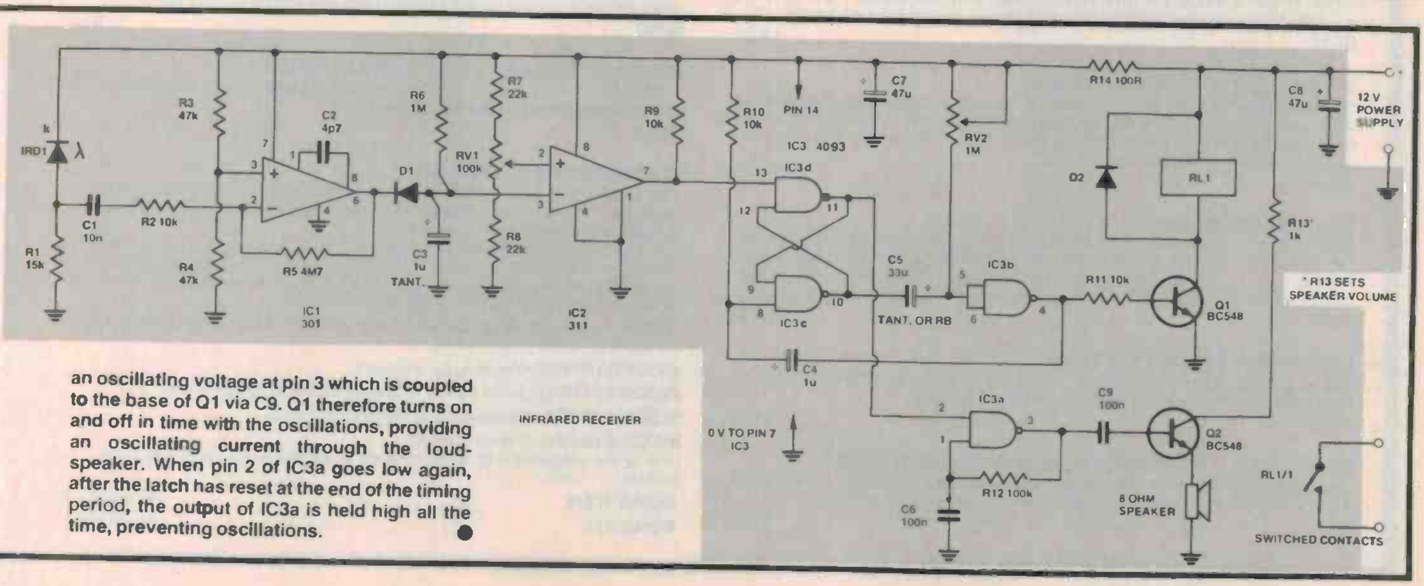


MECHANICAL DATA

Dimensions in mm







an oscillating voltage at pin 3 which is coupled to the base of Q1 via C9. Q1 therefore turns on and off in time with the oscillations, providing an oscillating current through the loudspeaker. When pin 2 of IC3a goes low again, after the latch has reset at the end of the timing period, the output of IC3a is held high all the time, preventing oscillations. ●

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ALMOST EVERY driver, some time in their driving career, will back into something while reversing. All you do is wince and say a few expletives deleted if it happens to be the gatepost, garage door, etc, but it's a horrifying experience if you run into a person. Apparently, in a large number of accidents where people are injured while a driver is reversing a car, a friend or member of the family is the victim. Too often, it's a child. Whilst it's not possible to completely eliminate the risk, you can go a long way towards reducing it significantly by alerting people when reverse gear is selected in the vehicle. A loud, attention-getting audible alarm is a good way to do it, hence this project.

Our alarm is intended to be installed at the rear of the vehicle, connected across the 'reversing' lights. Reversing lights have been commonly fitted to vehicles, as part of 'standard' equipment, since about 1968-70. They have been a compulsory fitment in cars (sedans, etc) sold in Australia since January 1972 and 'general purpose' vehicles (off-road types, etc) since January 1973, and in trucks up to 4½ tonnes since July 1973, trucks over 4½ tonnes since July 1975. Reversing alarms for trucks or other vehicles are not a compulsory fitment, but many Japanese trucks have included them for the past few years.

Getting attention

This alarm has been designed to get your attention in two ways. Firstly, it is LOUD . . . *piercing,* in fact. The noise maker is a piezoelectric alarm. These employ a ceramic piezoelectric element and generate an audio signal at a few kilohertz at sound pressure levels *in excess of 90 to 100 dB* a few metres from the alarm. Their electrical energy to sound energy conversion efficiency is very high. They are somewhat directional, but that's fine for this sort of application. A variety of types are available and may be used with this project. However, we suggest you purchase a type which is specified to produce a sound pressure level (spl) of at least 90 dB at 2 m distance from the alarm.

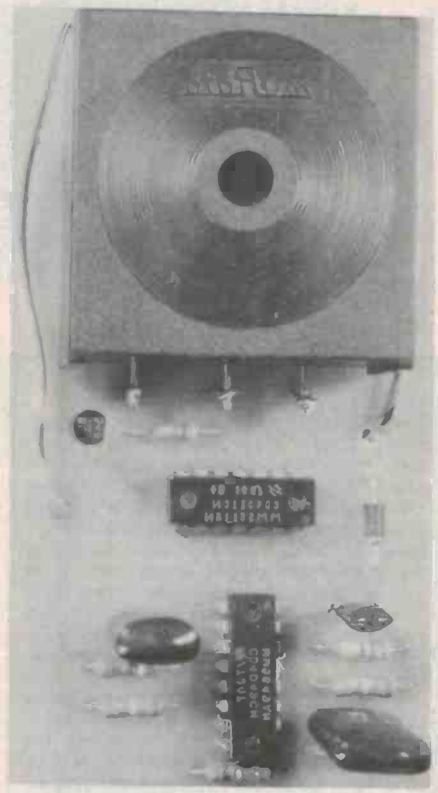
The second attention-getter we have incorporated is to *pulse* the alarm. But, to improve its attention-getting, it is a staccato pulse rate rather than an even rate. The project will work on 6 V or 12 V electrical systems, positive or negative (conventional) 'ground'.

Two CMOS ICs are used. One is a 4049 hex inverting buffer with three pairs of inverters arranged as pulse oscillators, each set to a different pulse rate. Another IC combines outputs of the oscillators to produce the staccato pulse rate. The composite pulses drive a transistor, which turns the piezo alarm on and off.

Construction

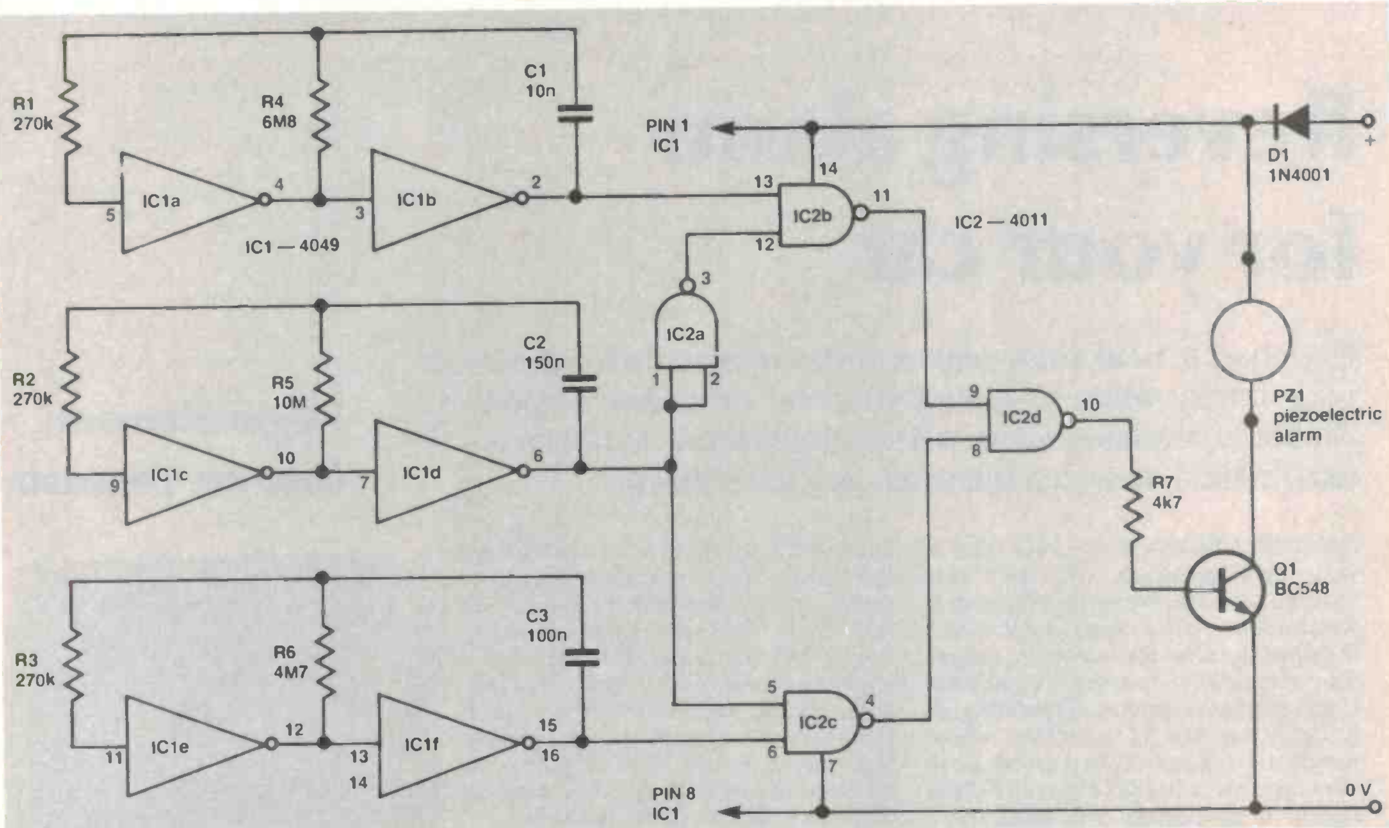
While we have designed a printed circuit board for this project it is not essential to use one and the unit could be constructed on matrix board, Uniboard or Veroboard if you wish. However, our construction description applies to the pc board we designed.

First thing to do is make sure all the component holes are drilled. There's nothing more infuriating than getting most of the components in place only to find one won't fit because the hole is undrilled. It's especially infuriating if you've made the board yourself! Undrilled holes are generally a rarity with commercially-made boards.



Simple, but effective. Built around a piezoelectric alarm, our project will operate on 6 V or 12 V systems.

The next thing is to insert all the resistors and capacitors. As with most projects assembled on pc board, all the components are mounted on the plain side of the board. The resistors and capacitors do not have any particular orientation, but make sure you put the correct values in the right places. Next, ▶



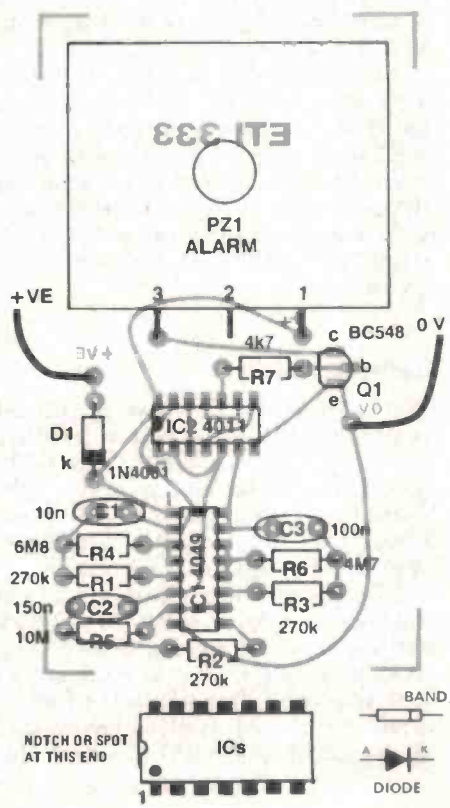
HOW IT WORKS — ETI 333

Three pairs of gates from IC1, a 4049 hex inverting buffer, are arranged as three 'ring-of-two' oscillators, each having a different period. The outputs of these three oscillators are gated together and the composite signal drives the base of Q1. A piezoelectric alarm in the collector of Q1 is thus pulsed on and off by the composite signal. Because the three oscillators are not synchronised their phases are random and an attention-getting staccato sound is produced, something like: beep-beep/bip-bip-bip-bip/beep-bip/beep-bip-bip-bip, etc.

The shortest period oscillator is formed by IC1a, IC1b, R1, R4 and C1. It has a period of about 140 ms (70 ms on, 70 ms off). The longest period oscillator is formed by IC1c, IC1d, R2, R5 and C2. It has a period of about four seconds (2 s on, 2 s off). The last oscillator has a period of only one second and is formed by IC1e, IC1f, R3, R6 and C3.

The four gates from IC2, a 4011 quad NAND, are employed to gate the oscillator outputs together to provide the composite signal. The base of Q1 is driven from the output of IC2d, via R7, which limits the base current to Q1 to an appropriate value.

The piezoelectric alarm may be any suitable type that can operate over a voltage range of five to 15 volts. This type of alarm was chosen as it is very efficient and produces a very loud, high-pitched noise. Diode D1 protects the circuit against damage from reverse-supply connection. The circuit will work over a voltage range from 5 V to 18 V (limited by the operating voltage range of the CMOS ICs).



PARTS LIST — ETI 333

Resistors .... all ½W, 5%
R1,2,3 .... 270k
R4 .... 6M8
R5 .... 10M
R6 .... 4M7
R7 .... 4k7

Capacitors
C1 .... 10n greencap
C2 .... 150n greencap
C3 .... 100n greencap

Semiconductors
D1 .... 1N4001, 1N4002 or similar
IC1 4049
IC2 4011
Q1 .... BC548, BC108 or similar

Miscellaneous
PZI — Murata piezoelectric alarm; ETI-333 pc board; wire etc.

Price estimate

We estimate the cost of purchasing all the components for this project will be in the range:

$8 — $10

Note that this is an **estimate** only and **not** a recommended price. A variety of factors may affect the price of a project, such as — quality of components purchased, type of pc board (fibreglass or phenolic base), type of front panel supplied (if used), etc — whether bought as separate components or made up as a kit.

insert the transistor, Q1. Take care to get it the right way round, otherwise the alarm won't work at all and you may destroy the transistor when you first apply power.

Now you can install the two integrated circuits. As they are CMOS devices handle them only by the ends of the package, not by the pins, and insert them carefully in the board, taking care to orientate them correctly. Identify pin 1 on the package before you take them out of their protective packaging. You'll find a notch in the pin 1 end or an indentation adjacent to pin 1 on the IC package.

When soldering the ICs in place, solder pin 8 and then pin 1 of IC1 first, then pin 7 and pin 14 of IC2. Let the ICs cool down and then solder all the other pins. Use a hot iron with a fine tip and do it quickly. You can pause every few pins to let the ICs cool down before continuing.

Next comes the protection diode, D1. It is important you get this in the right way round, otherwise it may offer no protection at all! The piezo alarm is attached last of all. The Murata type we used has three connections, marked 1, 2 and 3 on the package. Pin 1 connects to the collector of Q1 and pin 3 connects to the pad on the board that goes to the cathode of D1 (it's marked with a '+' on the copper side of the board). Whatever piezo alarm you use, the '+' lead will be identified in some way. We mounted our Murata alarm on the pc board using a double-sided sticky pad.

Testing

Now you can attach leads to the supply +ve and 0 V pads on the board and test the project. Use different coloured wires to identify the leads. Just check, last thing, that all the components are the correct ones and inserted the right way round. You can use an ordinary 6 V or 9 V battery to test the project; it only draws between 20 and 30 mA on 12 V, somewhat less at lower voltages.

All you have to do is connect it up and see if it emits a staccato series of piercing beeps!

If it doesn't, disconnect the supply and check you have the components correctly placed on the board. Check the polarity of D1 and the piezo alarm. Check with a multimeter that the supply is getting to the supply pins on the two ICs. You might also check that the unit is drawing current. Any problems here will give clues to where the fault may lie.

Installation

We'll have to leave the installation details up to you. However, a few pointers may assist. The board may be mounted anywhere convenient and the piezo noise maker put remote from the board, in a spot where it is protected from the weather, but can be readily heard — but *always* at the rear of the vehicle, *facing rearward*. The supply connections from the board should be connected in parallel with one of the reversing lights. In some vehicles, the whole pc board and piezo alarm assembly will fit inside the rear light housing.

Make a trial fitting and test it out before permanently mounting the unit. Make sure it can be heard above other loud sounds (such as a revving car engine a metre or two away). ●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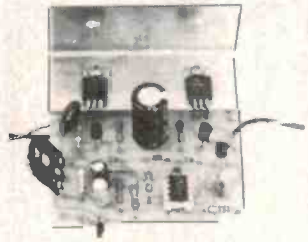

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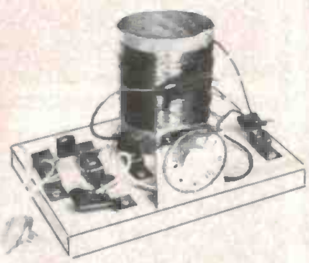

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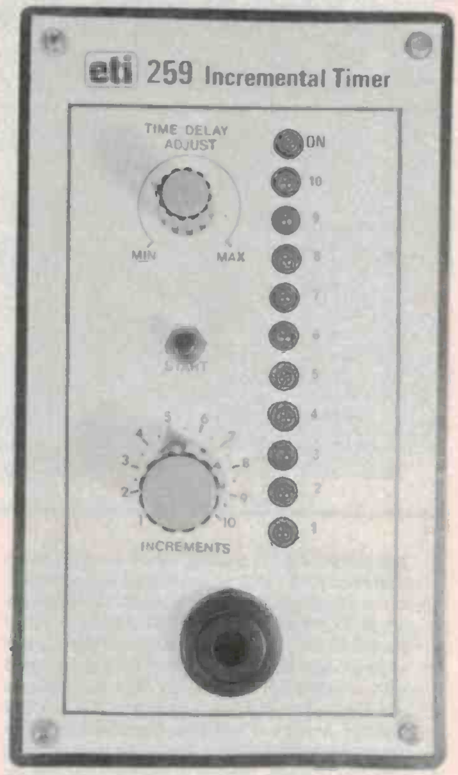
Card Expiry Date ....



Versatile, low cost 'incremental' timer

This timer is based on the popular LM3914 LED display driver IC, rather than a 'timer' IC, and provides period timing in preset increments — you choose the number of increments, up to a maximum of 10. The period between increments may be preset by a front panel control and a 'bar' of LEDs indicates 'where you are'. A switched 240 Vac output is provided along with audio indication of the end of timing.

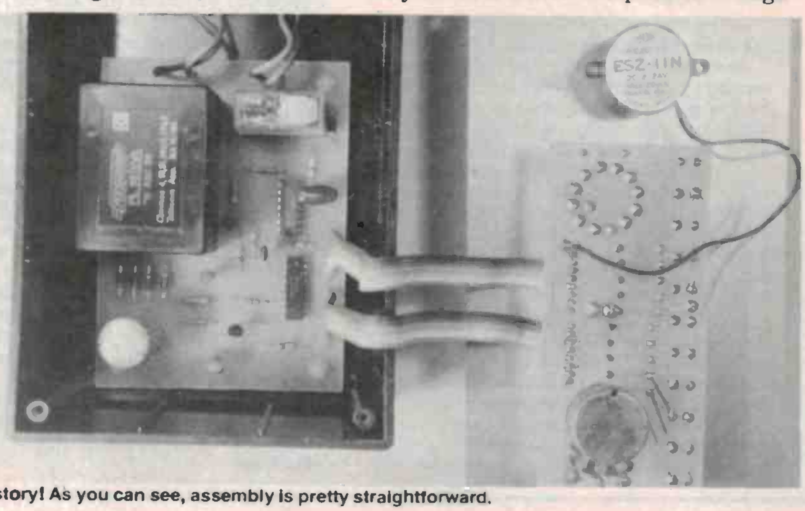
Graeme Teesdale

MANY ELECTRONIC timers published make use of a timing device, such as the ubiquitous 555 IC or UJTs like the 2N2646, to generate pulses at predetermined intervals which are used to operate a relay or alarm. Some employ digital counting techniques, using the mains frequency as a timing reference. This project employs an LM3914 LED display driver IC in an unusual way. The input is driven with a voltage that increases linearly with time. That is, the voltage increases equal amounts in equal periods of time.

The outputs of the LM3914 go 'active' in turn, lighting a LED, and further circuitry detects when a selected output goes active, setting off an audible alarm, tripping the relay circuit and resetting the timing.

At the one time, we obtain all the usual features included in many other timers, plus a 'bargraph' indication of how the timing period is progressing. This is very useful in the timing of many processes — particularly photographic processing, such as print development and resist development in the manufacture of pc boards. You can also coordinate a sequence of activities as the process continues, using the display to prompt you.

The total time, and thus the period between increments, may be varied by means of a potentiometer and the circuit has been arranged so that this provides about a 10:1 variation. The maximum period may be chosen by selecting the value of one capacitor. Accuracy is typically 1% over a wide temperature range.



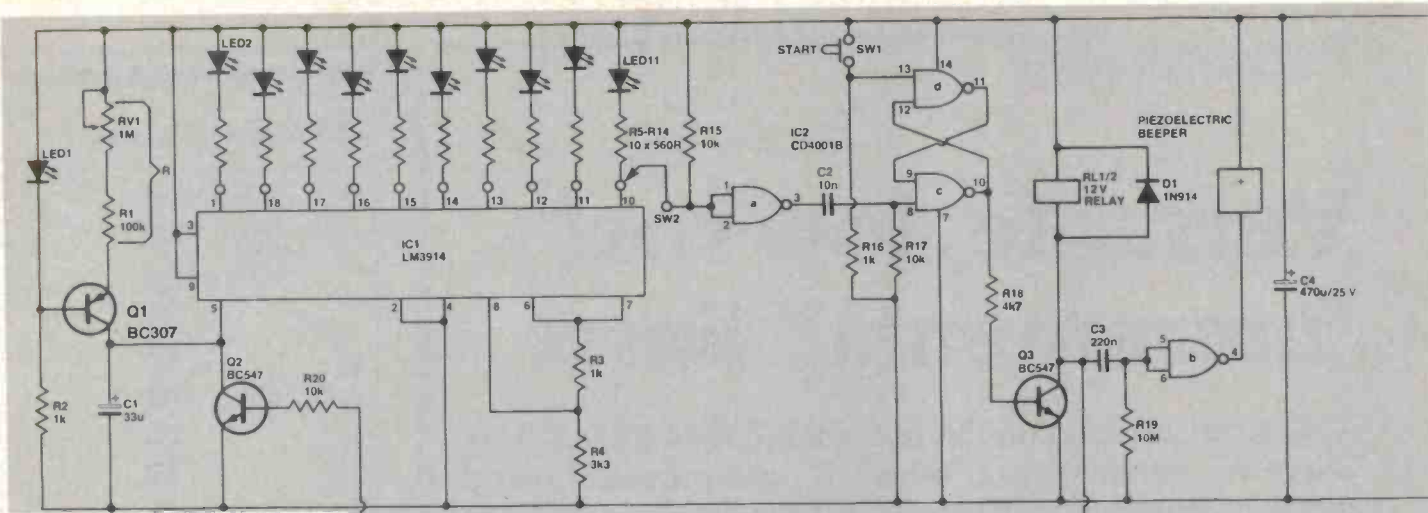
The inside story! As you can see, assembly is pretty straightforward.

Construction

Two pc boards are employed and the whole unit is housed in a standard 'jiffy' box measuring 196 x 113 x 60 mm. Although not absolutely essential, we recommend you use the pc boards designed for this project. The boards simplify construction and help ensure that there are few wiring errors. One board holds the power supply, relay and most of the electronics. This is the larger board, and is mounted in the bottom of the jiffy box. The other, smaller board holds all the display LEDs, the potentiometer, the increment selector switch, the START pushbutton and a few resistors. It is connected to the other board by two ribbon cables. This board is mounted to the front panel of the box via the securing nuts of the START button and the increment selector switch. The piezoelectric buzzer is separately mounted to the front panel.

Commence construction by drilling the box and front panel. The larger pc board (ETI-259a) should be used as a template to mark the hole positions for the four mounting bolts it requires. Also mark hole positions for the 240 Vac mains input cable. We strongly recommend you use a clamp-type grommet to secure the cable where it enters the box. Also mark out the hole positions for the 3-pin mains output socket. The terminal block may be bolted to the bottom of the case or glued ('liquid nails' will do).

The front panel artwork, obtainable from ETI, may be used as a template to mark out the hole centres ▶



C1 SELECTED TO OBTAIN DESIRED PERIOD — SEE TEXT

HOW IT WORKS — ETI 259

The LM3914 LED display driver is connected as a zero-to-5 V (full scale) voltmeter to display in the bargraph mode. Thus, each LED will turn on at increments of 0.5 V as the input rises from 0 to 5 V. The input to IC1 is driven by the voltage across capacitor C1. This is charged with a constant current so that the voltage across it will rise linearly with time. That is, the voltage across it will rise equal amounts in equal periods of time. Thus, as the voltage across C1 rises, the LEDs will light up one by one until the voltage reaches 5 V or until C1 is discharged.

A relay and alarm circuit is built around IC2 plus Q3 and associated components. SW2 selects at which 'increment' the relay and alarm are operated by selecting one of the outputs of IC1. When that output goes 'active' (when the LED lights) the alarm sounds, the relay drops out and the timer is reset by discharging C1. For example, if the third increment is selected (pin 17, IC1) then LEDs 2, 3 and 4 only will light, the alarm sounding when LED4 lights. C1 is then discharged at that time, resetting the timer ready for its next use.

Now, let's get down to individual circuit details. First, the constant current source that charges C1. Transistor Q1 plus LED1, R2, RV1, and R1 form the constant current source. Figure 1 shows the collector characteristics of a typical silicon transistor. This shows that, if you hold the base current constant, the collector current will remain substantially constant for a widely varying range of collector voltage. Figure 2 shows the general circuit of a 'constant current generator' using an npn transistor, as in our circuit. The voltage between the base and the emitter return (the +ve supply rail) is held fixed by a zener diode. Thus, the voltage (Ve) across the emitter resistor, Re, is fixed at a value equal to the zener voltage (Vz) minus the base-emitter voltage drop of the transistor (about 0.6 V for a silicon transistor). With a fixed voltage across Re, the current through it will be constant. Thus the emitter current of the transistor, and therefore the collector current, will be constant. The resistor supplying current to the zener is generally chosen so that the zener current is five to ten times the base current of the transistor.

When you charge a capacitor with a fixed current, the voltage across the capacitor will rise linearly with time. As we want to drive IC1 with a voltage that increases linearly with time in order to obtain equal time increments, C1 is charged from the constant current generator formed by Q1, R2, RV1, R2 and LED1. Note that LED1 (a green LED — as an 'on' indicator) replaces the zener. The forward voltage drop of a LED behaves much like a zener, the LED used having a voltage drop of around 2.5 V. To vary the rate of charge (and thus the time it takes to charge C1 to a particular voltage) the current supplied by the constant current generator can be varied by varying the emitter resistance of Q1. RV1 performs this function.

The maximum period can be determined approximately from the following formula:

Total Time = 5 x C1

where C1 is in uF. Thus, a 33 uF capacitor (as specified) will charge to 5 V in around 165 seconds with RV1 set at maximum resistance. The tolerance on tantalum capacitors is quite broad, so the formula is only approximate.

The voltage across C1 'ramps' upward as it charges. As the input to IC1 is quite a high impedance, it has little effect on the charging rate of C1.

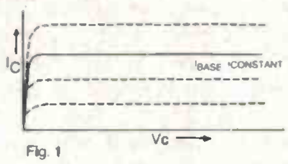


Fig. 1

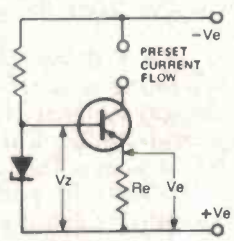


Fig. 2

Let us now consider the overall operation of the timer, commencing at switch-on.

At switch-on, the output of the RS flip-flop formed by gates 'c' and 'd' from IC2 (pin 10) will be low as the inputs, pins 8 and 13, are low. Thus no bias is applied to the base of Q3 and the relay will not be operated. Its collector voltage will be the same as the +ve supply rail and thus the base of Q2 will draw current via R20 and Q2 will be on. C1 will be unable to charge as the collector-emitter junction of Q2 will shunt the collector current of Q1 to the 0 V rail. As there is no input to IC1, no LEDs will be lit.

When the START button is pressed (SW1), the output of the RS flip-flop (pin 10), formed by gates 'c' and 'd' from IC2, will go high, turning on Q3. The collector of Q3 will conduct and the relay will operate. The collector voltage of Q3 will fall to nearly 0 V and the base of Q2 will no longer be forward-biased and Q2 will thus turn off. The collector current of Q1 will then commence to flow into C1 and the voltage across it will rise. As the voltage at the input of IC1 rises, LEDs 2 to 11 will turn on at 0.5 V increments.

If we now assume that SW2 was set to select the fourth increment (pin 16 of IC1, driving LED 5), then the input of gate 'a' from IC2, connected as an inverter, would go low when LED 5 turns on. Initially, the input to gate 'a' from IC2 is held high by R15, its output will be low and C2 will be discharged. When its input goes low (at the selected increment) its output goes high and C2 charges rapidly via R17. Thus a voltage pulse is applied to pin 8 of IC2 — one input of the RS flip-flop. This causes pin 10 of IC2 (output of the RS flip-flop) to go low again, removing gate bias from Q3, which turns off, de-activating the relay. When this happens, the collector voltage of Q3 goes high and C3 charges via R19. Now, gate 'b' from IC2 is connected as an inverter, its input being connected to R19/C3. When pins 5/6 of IC2 go high, pin 4 goes low and the piezoelectric beeper sounds. C3 takes a second or two to charge, the voltage across R19 decreasing as it does so. When it falls below the 'low' threshold of pins 5/6 of IC2, pin 4 goes high once more and the beeper ceases to sound.

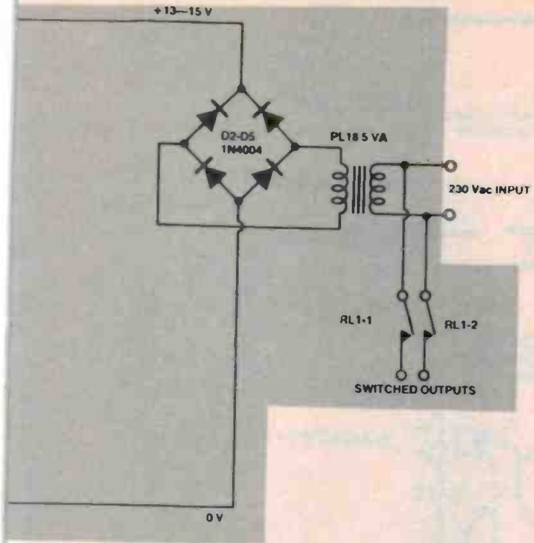
When the collector of C3 goes high when LED 5 lights (remember?), Q2 receives base bias once more, via R20. It turns on again, shunting the collector current of Q1 to 0 V and discharging C1. Thus the timer is reset at the end of the selected period.

By varying RV1, the time it takes C1 to charge to a particular voltage is varied, and thus the period of each increment and the total period can be varied. The time interval of the first increment is slightly shorter than the subsequent increments as Q2 is not capable of discharging C1 completely due to its collector-emitter saturation voltage (about 200 mV or so).

A conventional diode bridge rectifier is employed and C4 provides smoothing. A Ferguson pc-mount transformer is employed to drop the 240 Vac mains to a suitable voltage. Only one secondary winding from this transformer is used, providing 9 Vrms to the rectifier, which thus gives a dc supply of around 13-15 volts.

Resistors are used from each output of IC1 to each LED cathode to ensure that the outputs of IC1 drop below the 'low' threshhold of the inputs to gate 'a' of IC2 when the IC1 outputs are 'active'.

The relay contacts are rated at 5 A and will switch a load of up to 1200 watts, providing the load has a unity power factor (i.e: it's resistive).



PARTS LIST — ETI 259

Resistors	all ½W, 5%
R1	100k
R2,3,16	1k
R4	3k3
R5-14	560R
R15,17,20	10k
R18	4k7
R19	10M
RV1	1M lin. pot.
Capacitors	
C1	33u/16 V tant.
C2	10n greencap
C3	220n
C4	470u/25 V electro.
Semiconductors	
D1	1N914,1N4148 etc.
D2-D5	1N4002,1N4004 etc.
IC1	LM3914
IC2	4001
Q1	BC307,BC177 etc.
Q2,Q3	BC547,BC107 etc.
LED1	TIL220G green LED
LED2-11	TIL220R red LEDs

Miscellaneous

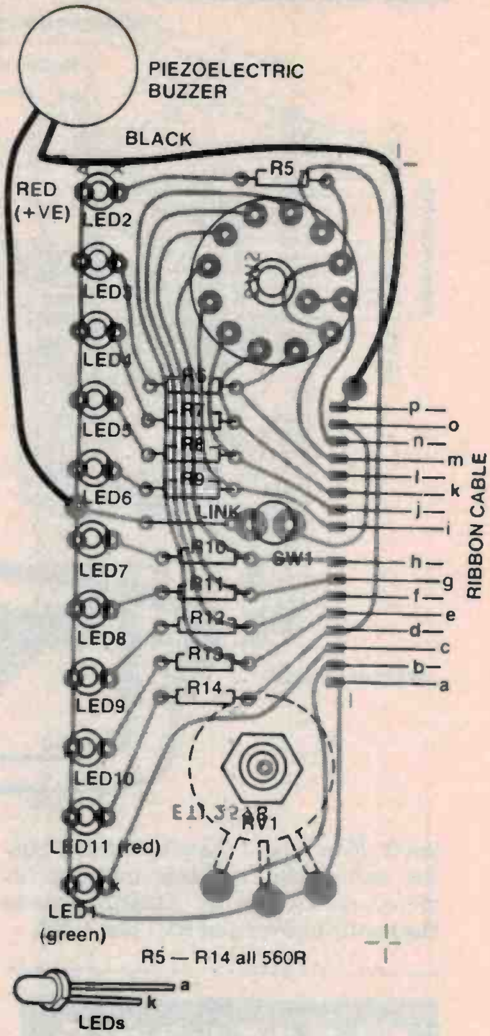
ETI-259a and ETI-259b pc boards; T1 — PL18/5VA transformer or similar; SW1 — miniature pushbutton; SW2 — 1-pole, 10-position rotary switch; RL1 — 12 V relay with 240 Vac/5 A contacts e.g: Fujitsu FRL-621DO12 or Takamisawa VB 12STAN or Pye 265/12/G2V; piezoelectric alarm or buzzer, e.g: Piezo-II type ESZ-11N; jiffy box 196 x 113 x 60 mm or similar; four-way or six-way terminal block; mains cord, cable clamp and plug; 3-pin mains socket; LED mounts; Scotchcal panel; ribbon cable; wire; nylon nuts and bolts, etc.

Price estimate

We estimate the cost of purchasing all the components for this project will be in the range:

$32 — $45

Note that this is an **estimate** only and not a recommended price.



for drilling the front panel. Centre punch them before drilling. Leave the panel at this stage, as it will be completed later.

The 3-pin mains outlet socket may be mounted to the box at this stage. Attach mains wire to each pin connection, using the appropriate colour coding (brown — active, blue — neutral, green/yellow — earth). Each wire needs to be about 70-80 mm long. Now secure the mains input cable. Strip the end first and cut the blue and brown wires so that they are 120-150 mm shorter than the green/yellow wire. This ensures that, should the cable ever be pulled out of the case, the earth wire will be the last to break.

The two pc boards may now be assembled. Tackle the smaller board first. Install the link first — it's in the middle of the board. The resistors should come next; these are all the same value — 560 ohms. Mount the LEDs next, inserting them in the board one by one and making sure you have each the right way round, as indicated on the overlay — cathode lead faces into the board. Each LED is positioned so that the distance between the board and the base of the LED is 12 mm. When distanced correctly, solder the leads in place.

The increment selector switch, SW2, may be mounted next. The holes in the pc board for its pins should be the correct size; check this. The switch can only go in one way. Carefully line up the pins and insert the switch in the board, pushing it all the way home. Solder the pins. Now the START pushbutton may be mounted. Make sure the holes for its pins have been drilled oversize too. You will need to trim the lugs on the pushbutton so that they fit in the pc board holes. Mount the pushbutton, making sure that the distance between the board and its mounting shoulder (with washer) is the same as that for SW2. You could temporarily mount the board to the front panel, using SW2 to secure it, and then solder the pushbutton's pins when the board is parallel to the panel.

The potentiometer is mounted last. Position it so that its lugs are over the appropriate pads on the pc board and then secure it to the board with its nut. Use a spring washer or a star washer under the nut. Then bend the lugs down to the pc board pads and solder them in place.

Last of all, attach two pieces of 8-way ribbon cable. These should each be about 130-150 mm long.

The front panel assembly may now be completed. If you're using a Scotchcal stick-on panel, this should be carefully attached to the ready-drilled aluminium jiffy box panel. Smooth it on, rubbing from the centre outwards to remove any bubbles. Cut the holes in the Scotchcal with a scalpel or other sharp-bladed knife. Insert the LED mounts in their holes next. Now you can mount the pc board, making sure that the LEDs all seat correctly in the mounts. Carefully tighten the nuts on the shafts of the START pushbutton and SW2 so as not to damage the Scotchcal on the panel. A large solder lug was secured between the washer for the pushbutton and the front panel to provide a mains earth ▶

CHANGING THE PERIOD

The total time period may be altered by changing the value of C1. The approximate maximum period may be found from this formula:

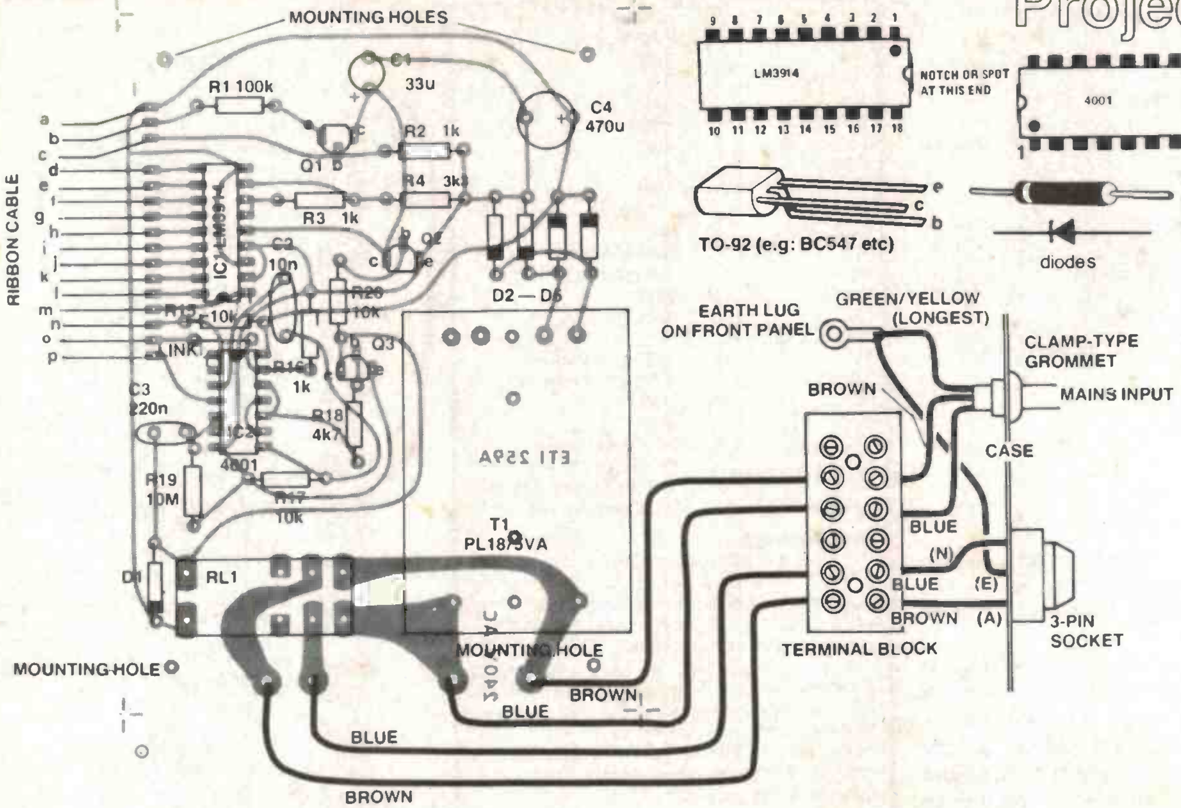
Period (approx.) = 5 x C1

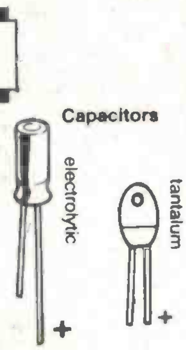
where the value of C1 is in uF. It's only approximate as the tolerance on tantalum capacitors is quite broad. Thus with a 33u capacitor for C1, as specified, the maximum period is around 165 seconds or so. Given a desired period, calculate the capacitor value from:

C1 = period/5

and the value will be in uF. Choose the next highest preferred value, for safety's sake. You can then set the maximum period, and thus the period of the increments, using RV1, calibrating the unit with your watch. It's advisable not to use a capacitor any greater than about 120 uF — but this will give you a maximum period of 10 minutes!

Note that an RBLL-type electrolytic may be used for C1, but accuracy may suffer a little compared to tantalum types. The voltage never gets above 5 V, so a capacitor rated at 6 V, 10 V or 16 V is perfectly adequate.





FRONT PANEL ARTWORK
Front panel artwork for the ETI259 may be obtained by sending a large, stamped, self-addressed envelope marked ETI-259 FRONT PANEL to: ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011.

point. Now mount the piezoelectric buzzer and solder its leads in place, as shown on the overlay. Attach knobs to the shafts of SW2 and RV1 last of all.

The next stage of construction to tackle is the large pc board. All the resistors and capacitors should be mounted first, taking care that you get C1 and C4 the right way round. Next, mount the diodes and the three transistors, again taking care with orientation. Mount IC1 (the LM3914) next — get it the right way round, followed by IC2. The latter is a CMOS IC and should only be handled by the ends of the package. When soldering it in place, solder pins 7 and 14 first, followed by the other pins. Use a hot iron with a clean tip when soldering the IC pins, solder each one quickly and pause every few joints to let the IC package cool down a little.

Mount the relay next. We used a type which can be readily soldered in place — a Fujitsu type FRL 621D012, although the board has been laid out to take several other common types. Make sure the board has been drilled out to accept the relay used before commencing construction.

The pc mount transformer can now be mounted to the board and its pins soldered in place. Note that it can only go on one way. Last of all the ribbon cable from the smaller pc board can be attached and then two pairs of mains wires, each about 40-50 mm long. These are the mains input and switched mains output leads. Use colour-coded wires, cut from mains cord, to avoid wiring errors.

The main pc board may now be mounted to the case. Use nylon nuts and bolts. Raise the board off the bottom of the box a few millimetres using fibre spacers. Use nylon nuts and bolts for the terminal block if it is bolted to the box too. Now complete the mains wiring, as indicated in the overlay/wiring diagram. The earth lead from the mains input cord goes to the solder lug attached to the front panel (under the pushbutton). A lead from this lug goes to the earth pin on the 3-pin mains output socket.

After a careful final check, you're ready to test the unit.

Testing

Set the 'Time Delay Adjust' control to minimum and the 'Increments' switch to 10. Plug the timer into the mains and turn it on. Wait five seconds or so for the power supply to reach full voltage and press the START pushbutton when the sweep second hand of your watch, or the seconds display on your digital watch, is at a convenient point. The LEDs 1 to 10 will light up, the piezoelectric buzzer sounding when LED 10 signals the end of the timing period. If you have used a 33u capacitor for C1, as per the parts list, then this should take close to 15 seconds. The relay should pull in when you press the START button, dropping out when LED 10 lights. You can calibrate the Time Delay Adjust pot. to suit the applications for which you use the project so that you obtain the required period.

A little experimentation and practice will show you how to use the unit to best advantage. ●

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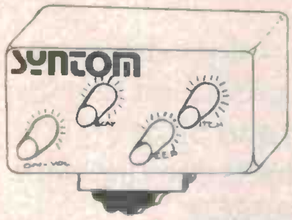

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Lab Notes

Zero-voltage switching with the CA3059

Ray Marston

The control of mains power employing triacs has wide application — light dimmers, motor controllers, etc — but the radio frequency interference (RFI) produced can be difficult to suppress. A more elegant solution is to switch the mains on and off at or near where it passes through the 'zero volt' point. This article discusses the technique with reference to an IC developed specifically for this application — the CA3059.

THERE ARE TWO basic ways of switching mains power to a load — either via a mechanical switch or via a solid state switch such as a triac. Mechanical switches are fairly slow-acting devices; they suffer from severe arcing at the moment of switching and generate a great deal of RFI (radio frequency interference) at switch-on and switch-off. This RFI can often be heard on domestic radio and TV sets and can cause malfunctioning of some electronic equipment (particularly digital equipment).

Triac switches are fast-acting devices and do not suffer from arcing problems. Nevertheless, they are still capable of generating considerable RFI at switch-on. Why? As the triac turns on, the load current may rise from zero to several amps in a mere couple of microseconds;

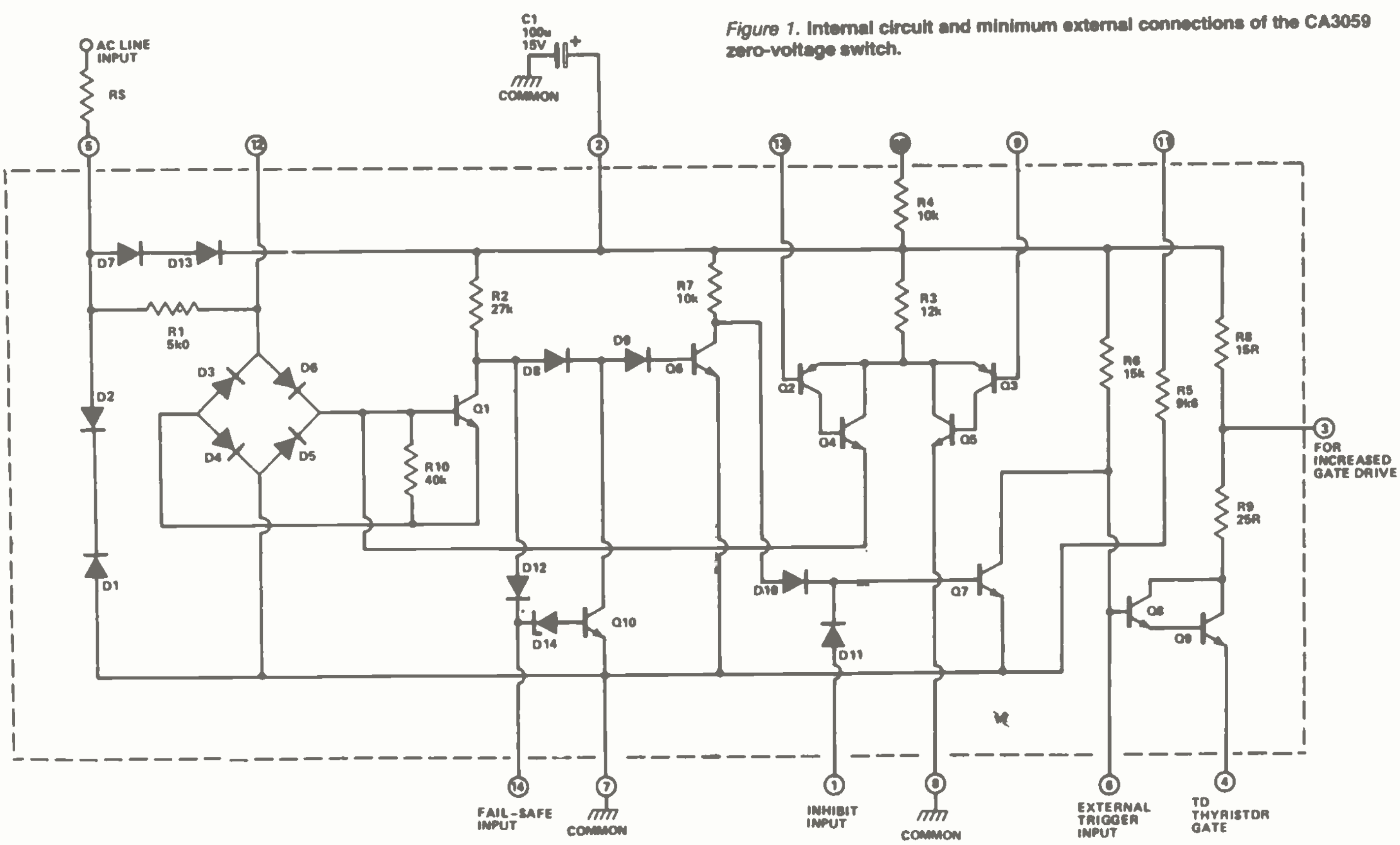

Figure 1. **Internal circuit and minimum external connections of the CA3059 zero-voltage switch.**

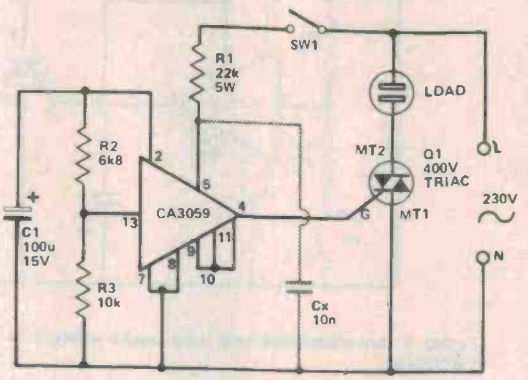

Figure 2. A simple mains-switched zero-voltage switch. Cx may be used to overcome latching deficiencies of some triacs.

since this current flows through the mains wiring, the wiring may radiate a great 'splurge' of RFI in response to this heavy surge current. The magnitude of the RFI is proportional to $\delta i/\delta t$ and can be reduced by either reducing the surge current amplitude or increasing the surge current rise time, or possibly both; once the triac has turned on, the subsequent large 'rise time' of the 50 Hz mains signal causes virtually zero RFI even when load currents of tens of amps are being drawn.

Thus the degree of triac switch-on RFI is proportional to the value of instantaneous mains voltage at the moment of triac turn-on. If a 100 ohm load is being driven from 230 Vac mains, the surge current will be 3.25 A if switch-on occurs at a 'crest' value of 325 V, or a mere 32.5 mA if switch-on occurs at a 'near zero-crossover' value of 3.25 V.

Triacs are self-latching devices. If they are turned on by a brief gate signal, they remain on until their main-terminal currents fall below a minimum 'holding' value of a few milliamps. They automatically turn off at the end of each mains half cycle as their main-terminal currents fall to near-zero. They can be turned on near the start of each half cycle as soon as their main-terminal currents are capable of exceeding the minimum holding value.

Thus, a triac can be persuaded to generate virtually zero switch-on RFI by feeding it with gate current *only* when the instantaneous mains voltage is close to the zero or crossover value at the start of each half cycle. This technique is known as 'zero-voltage switching'. Special zero-voltage triac-driving ICs are available from a number of manufacturers. One such device is the CA3059, manufactured by RCA.

The CA3059 zero-voltage switch

The internal circuit and minimal external connections of the CA3059 zero-voltage switching IC are shown in Figure 1. The device is housed in a 14-pin DIL package and incorporates dc power supply circuitry, a zero-crossing detector, triac gate drive circuitry and a high-gain differential amplifier/gating network. Circuit operation is as follows.

Mains power is connected between pins 5 and 7 of the device via limiting resistor Rs (22k, 5 W when 230 V mains is used). D1 and D2 act as back-to-back zeners and limit the pin 5 voltage to ±8 V. On positive half cycles D7 and D13 rectify this pin 5 voltage and generate approximately 6.5 V across the 100 μF capacitor connected to pin 2. This capacitor supplies sufficient energy storage to drive all internal circuitry and provide adequate triac gate drive, with a few milliamps or so spare drive available for powering auxiliary (external) circuits.

Bridge rectifier D3-D6 and transistor Q1 act as a zero-voltage detector, their action being such that Q1 is turned on (driven to saturation) whenever the pin 5 voltage exceeds ±3 V. Gate drive to an external triac can be made via the emitter (pin 4) of the Q8-Q9 Darlington pair of transistors, but is available only when Q7 is turned off. When Q1 is turned on (pin 5 greater than ±3 V) Q6 is turned off through lack of base drive, so Q7 is driven to saturation via R7 and no triac gate drive is available from pin 4. Triac gate drive is thus available only when pin 5 is close to the 'zero-voltage' or crossover mains value. When gate drive is available, it is delivered in the form of a narrow pulse centred on the crossover point with pulse power supplied by C1.

Vive la differential

The CA3059 incorporates a differential amplifier or voltage comparator, built around Q2 to Q5, for general purpose use. Resistors R4 and R5 are externally available for biasing one side to the amplifier. The emitter current of Q4 flows via the base of Q1 and can be used to disable the thyristor (pin4) gate drive by turning Q1 on. The configuration is such that the gate drive can be disabled by making pin 9 positive relative to pin 13. The drive can also be disabled by connecting external signals to pin 1 and/or pin 14.

CA3059 switching circuits

Figure 2 shows the simplest possible way of using the CA3059 as a 'noiseless' switch with the zero-voltage switching provided via the IC and the triac and with on/off switching controlled by SW1. The circuit action is quite simple. The IC is connected to the mains via SW1 and limiting resistor R1; dc energy is stored by C1. The IC is wired in the 'enabled' mode by biasing the pin 9 side of the internal differential amplifier at half-supply (dc) volts via the pin 10 and 11 connections and by biasing the pin 13 side above half-supply via the R2-R3 divider network. Switch SW1 passes only a few milliamps of current and thus generates negligible RFI. The circuit can power mains loads such as lamps and heaters via a suitable rated triac.

The 'zero-voltage' triac-gate-drive pulse of the CA3059 is very narrow. In some applications, the pulse may terminate before the triac main-terminal currents have reached their minimum holding levels and self-latching may fail to occur. This problem can be overcome by wiring Cx as shown in Figure 2. This ▶

Lab Notes

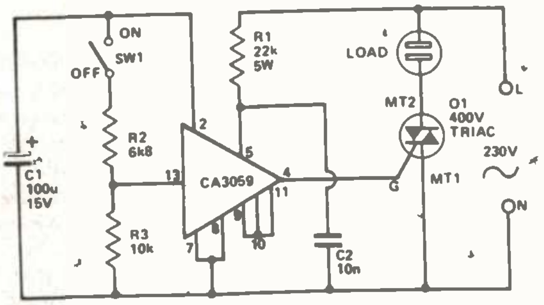

Figure 3. **Direct-switched zero-voltage switch.**

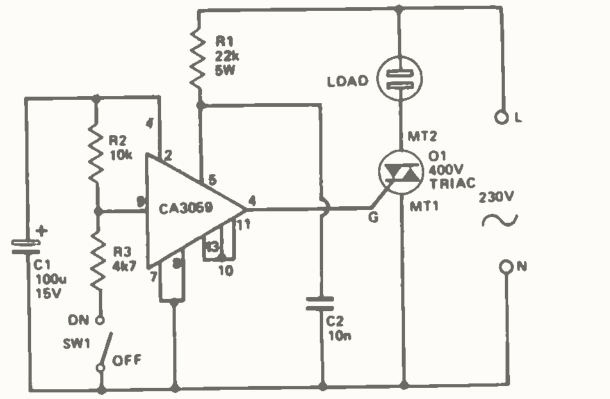

Figure 4. **An alternative and very useful method of direct-switching the CA3059 IC.**

capacitor, in conjunction with R1, gives a slight phase shift to the pin 5 signal and extends the 'zero-voltage' pulse further into the start of each mains half-cycle. A value of 10n is adequate in most applications.

The Figure 2 circuit consumes virtually zero mains power under the 'off' (SW1 open) condition. The only defect of the circuit is that SW1 operates at full mains voltage. This defect can be overcome by using the switch to directly enable or disable the CA3059 logic circuitry, as shown in Figures 3 and 4, but in this case the circuit consumes a few watts of power (via R1) when the circuit is in the off mode.

The Figures 3 and 4 circuits work by

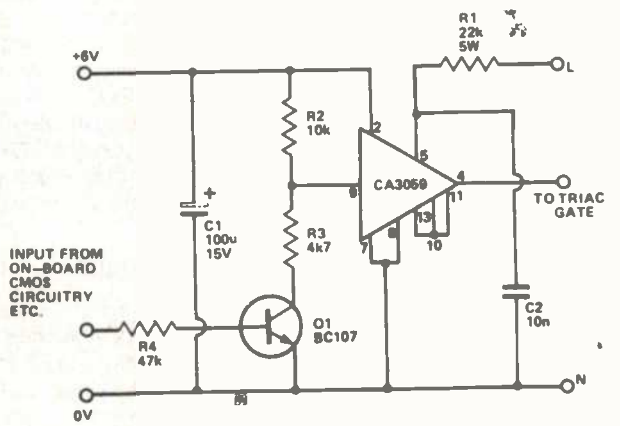

Figure 5. **One method of transistor-switching the CA3059 via on-board CMOS circuitry such as one-shots, astables, etc.**

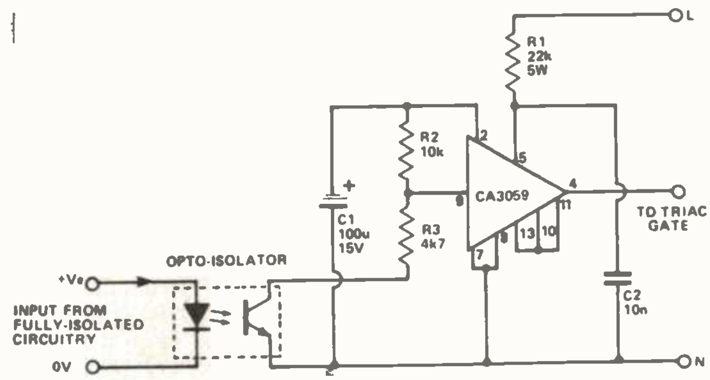

Figure 6. **A method of remote-switching the CA3059 via an opto-isolator.**

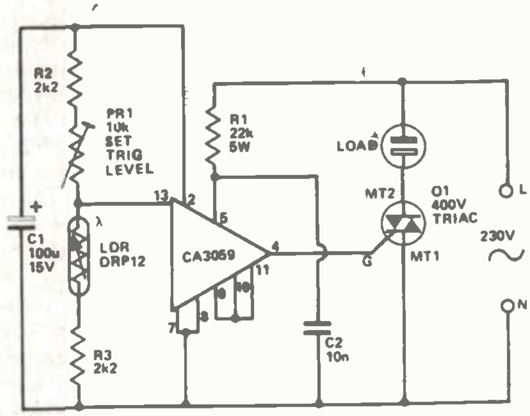

Figure 7. **A basic dark-activated zero-voltage switch.**

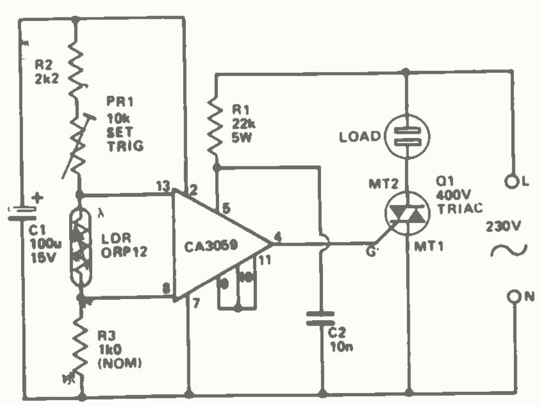

Figure 8. **A dark-activated zero-voltage switch with hysteresis provided by R3.**

using the switch to enable or disable the triac gate drive via the internal differential amplifier of the IC. Remember, the drive is enabled only when pin 13 is biased above pin 9. In the Figure 3 circuit, pin 9 is biased at half-supply volts and pin 13 is biased via R2-R3 and SW1. In Figure 4, pin 13 is biased at half-supply and pin 9 is biased via R2-R3 and SW1. In both circuits, SW1 handles maximum potentials of 6 V and maximum currents of 1 mA or so.

Note in Figure 4 that the circuit can be turned on by pulling R3 low or can be turned off by letting R3 float. Figures 5 and 6 show how this simple fact can be put to use to extend the versatility of the circuit. In Figure 5 the circuit can be turned on and off by transistor Q1, which in turn can be activated by on-board CMOS circuitry (such as one-shots, astables, etc) that are powered from the 6 V pin 2 supply.

In Figure 6, the circuit can be turned on and off by fully-isolated external circuitry via an inexpensive opto-isolator; the isolator needs an input current of only a milliamp or so to give the 'on' action.

CA3059 comparator circuits

The built-in differential amplifier of the CA3059 can readily be used as a precision voltage comparator that turns the triac on or off when one of the comparator input voltages goes above or below the other. If these input voltages are derived from transducers such as LDRs or thermistors, the on/off power control action can be controlled by ambient light levels or temperatures. Figures 7 to 10 show some practical circuits of these types.

Figure 7 shows the circuit of a simple dark-activated zero-voltage power switch. Here, pin 9 is tied to half-supply volts and pin 13 is controlled via the R2-PR1-LDR-R3 potential divider. Under bright conditions the LDR has a low resistance, so pin 13 is above pin 9, the triac is enabled and power is fed to the load. The precise threshold level of the circuit can be preset by PR1.

Figure 8 shows how a degree of hysteresis or 'backlash' can be added to the above circuit, so that the triac does not switch annoyingly in response to small changes (passing shadows, etc) in the ambient light level. The hysteresis level is controlled via R3, which can be selected to suit particular applications.●

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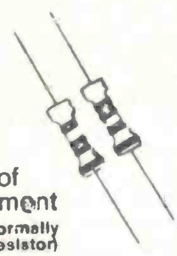

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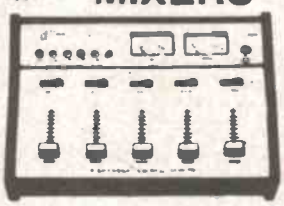

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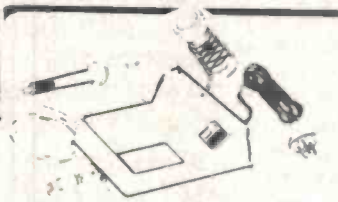

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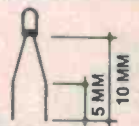

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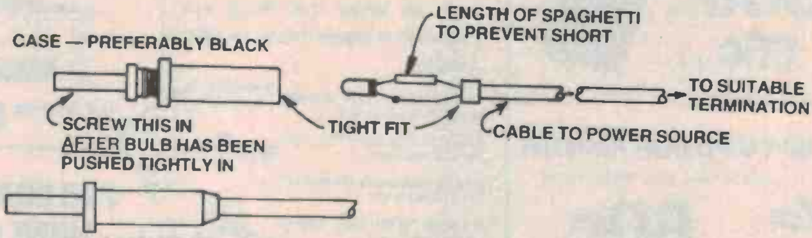

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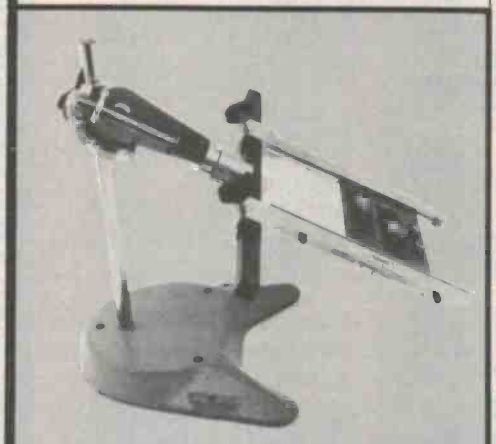

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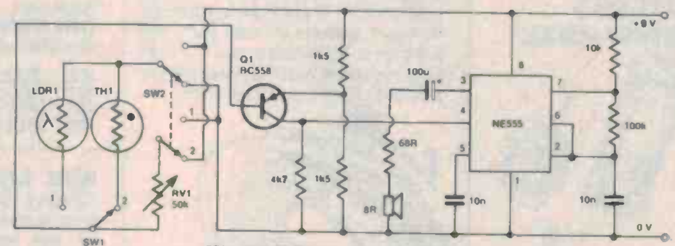
When Q1 turns on, it sets the 55, which commences to oscillate, its output driving the 8 ohm speaker, providing the alarm sound.



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

Winner will be advised by telegram the same day the result is declared. The name of the winner, together with the winning idea, will be published in the next possible issue of ETI.

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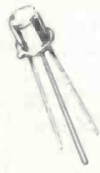

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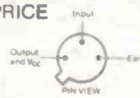

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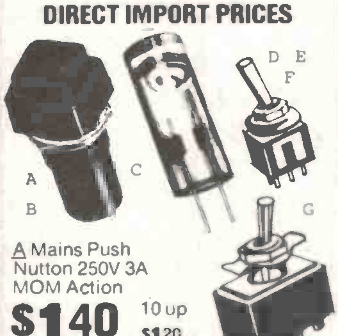

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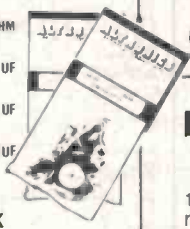

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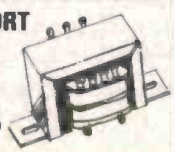

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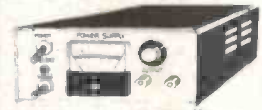

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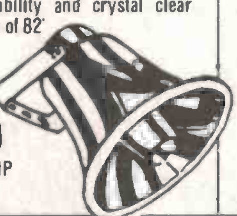

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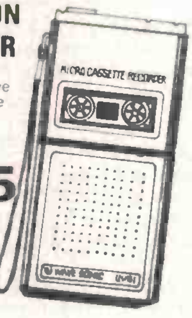

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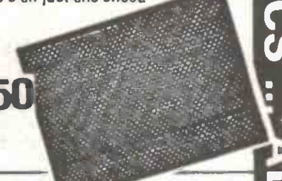

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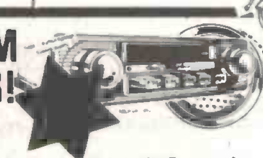

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PRICES/QUALITY OK the prices are about the best in Australia right? And with our quality control, we guarantee full replacment or refund for goods returned to us (in original condition) within 14 days of purchase apart from our 100% parts and labour warranty for a full 3 months. Then all thats left is to tell you about our three brilliant delivery services.

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All with ¼ in shafts

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DPDT contacts rated 240V AC 10 AMP includes socket

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S4066	12	400	SPDT	3A	350V	2.00	1.60

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S4068

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S4068	24V	1600	DPDT	2A	120VA	4.50	3.90
S4070	12V	185	4PDT	1A	60VA	4.95	4.50
S4071	24V	700	4PDT	1A	60VA	4.95	4.50

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(Brillantly designed by Australia's top audio engineer David Tilbrook)

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Kit includes absolutely all components and full instructions and includes superb instrument rack cabinet.
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Extra thin, quality altronics import. Ideal for student, business man and overseas traveller for those currency conversions etc - and at our price who needs "Duty Free?" Slips neatly into the wallet.

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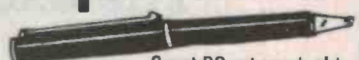

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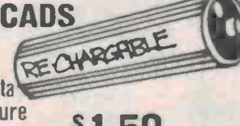

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INFRA RED LED SAVE 60%

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1-24	25-99	100 up
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*Audio Power module kit $59.95 (1 channel) *Power transformer $37.50 with copper flux strap *Electro's 8000 MF/75V $9.50 *Mosfet semi's hitachi 2SK134, 2SJ49 $6.00 ea.

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Includes superb finish front panel/heat-sink and every last nut and bold, even solder! FULL INSTRUCTIONS INC.

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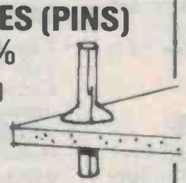

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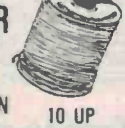

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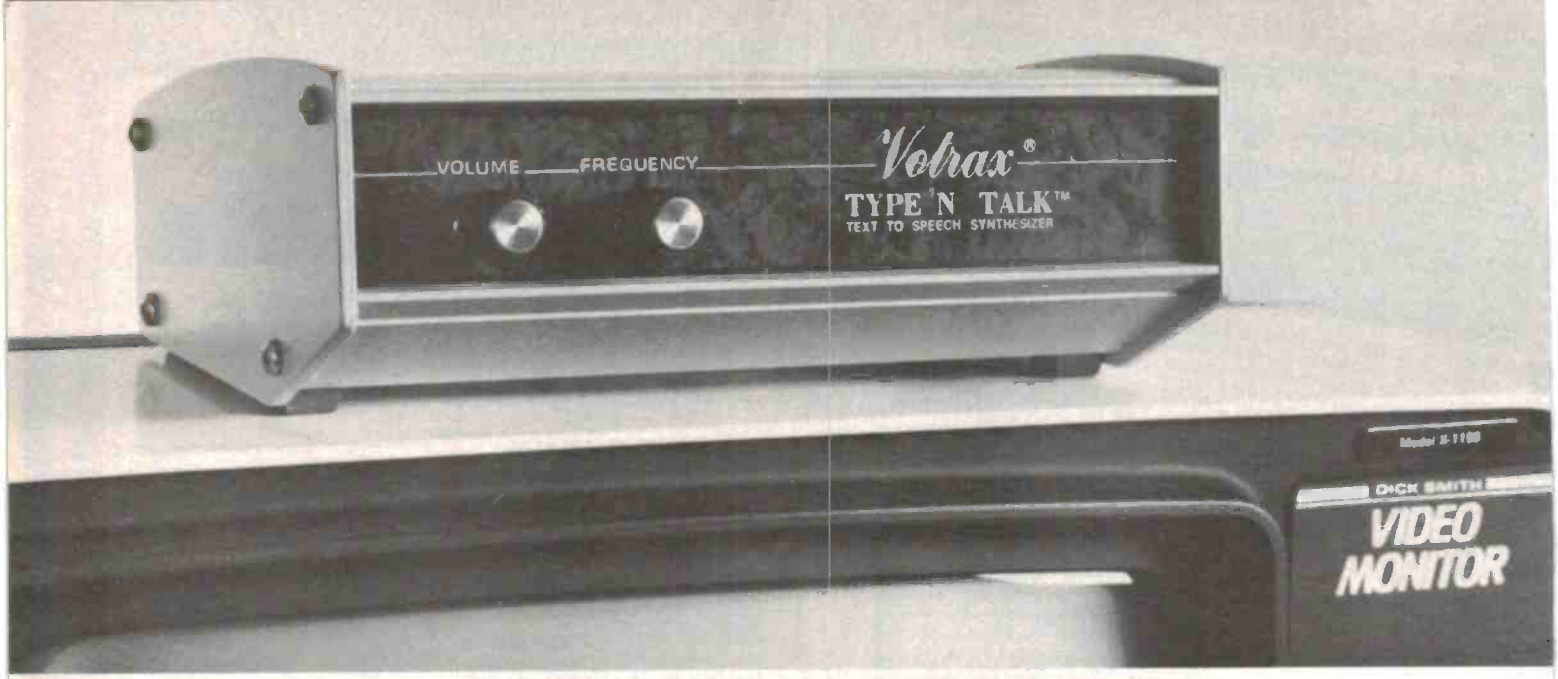

TYPE-'N-TALK™ IS T.N.T.

The exciting text-to-speech synthesizer that has every computer talking.

Cat. X-3290

- **Unlimited vocabulary**
- **Built-in text-to-speech algorithm**
- **70 to 100 bits-per-second speech synthesizer**

Type-'N-Talk™, an important technological advance from Votrax, enables your computer to talk to you simply and clearly — with an unlimited vocabulary. You can enjoy the many features of Type-'N-Talk™, the new text-to-speech synthesizer, for just $525.00.
You operate Type-'N-Talk™ by simply typing English text and a talk command. Your typewritten words are automatically translated into electronic speech by the system's microprocessor-based text-to-speech algorithm.

The endless uses of speech synthesis.

Type-'N-Talk™ adds a whole new world of speaking roles to your computer. You can program verbal reminders to prompt you through a complex routine and make your computer announce events. In teaching, the computer with Type-'N-Talk™, can actually tell students when they're right or wrong — even praise a correct answer. And of course, Type-'N-Talk™ is great fun for computer games. Your games come to life with spoken threats of danger, reminders, and praise. Now all computers can speak. Make yours one of the first.

Text-to-speech is easy.

English text is automatically translated into electronically synthesized speech with Type-'N-Talk™. ASCII code from your computer's keyboard is fed to Type-'N-Talk™ through an RS-232C interface to generate synthesized speech. Just enter English text and hear the verbal response (electronic speech) through your audio loud speaker. For example: simply type the ASCII characters representing "h-e-l-l-o" to generate the spoken word "hello".

TYPE-'N-TALK™ has its own memory.

Type-'N-Talk™ has its own built-in microprocessor and a 750 character buffer to hold the words you've typed. Even the smallest computer can execute programs and speak simultaneously. Type-'N-Talk™ doesn't have to use your host computer's memory, or tie it up with time-consuming text translation.

Data switching capability allows for ONLINE usage.

Place Type-'N-Talk™ between a computer or modem and a terminal. Type-'N-Talk™ can speak all data sent to the terminal while online with a computer. Information randomly accessed from a data base cn be verbalized. Using the Type-'N-Talk™ data switching capability, the unit can be "de-selected" while data is sent to the terminal and vice-versa —permitting speech and visual data to be independently sent on a single data channel.

Selectable features make interfacing versatile.

Type-'N-Talk™ can be intefaced in several ways using special control characters. Connect it directly to a computer's serial interface. Then a terminal, line printer, or additional Type-'N-Talk™ units can be connected to the first Type-'N-Talk™, eliminating the need for additional RS-232C ports on your computer. Using unit assignment codes, multiple Type-'N-Talk™ units can be daisy-chained. Unit addressing codes allow independent control of Type-'N-Talk™ units and your printer.

Look what you get for $525.00. TYPE-'N-TALK™ comes with:

- Text-to-speech algorithm
- A one-watt audio amplifier
- SC-01 speech synthesizer chip (data rate: 70 to 100 bits per second)
- 750 character buffer
- Data switching capability
- Selectable data modes for versatile interfacing
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- Phoneme access modes
- RS-232C interface
- Complete programming and installation instructions

The Votrax Type-'N-Talk™ is one of the easiest-to-program speech synthesizers on the market. It uses the least amount of memory and it gives you the most flexible vocabulary available anywhere.

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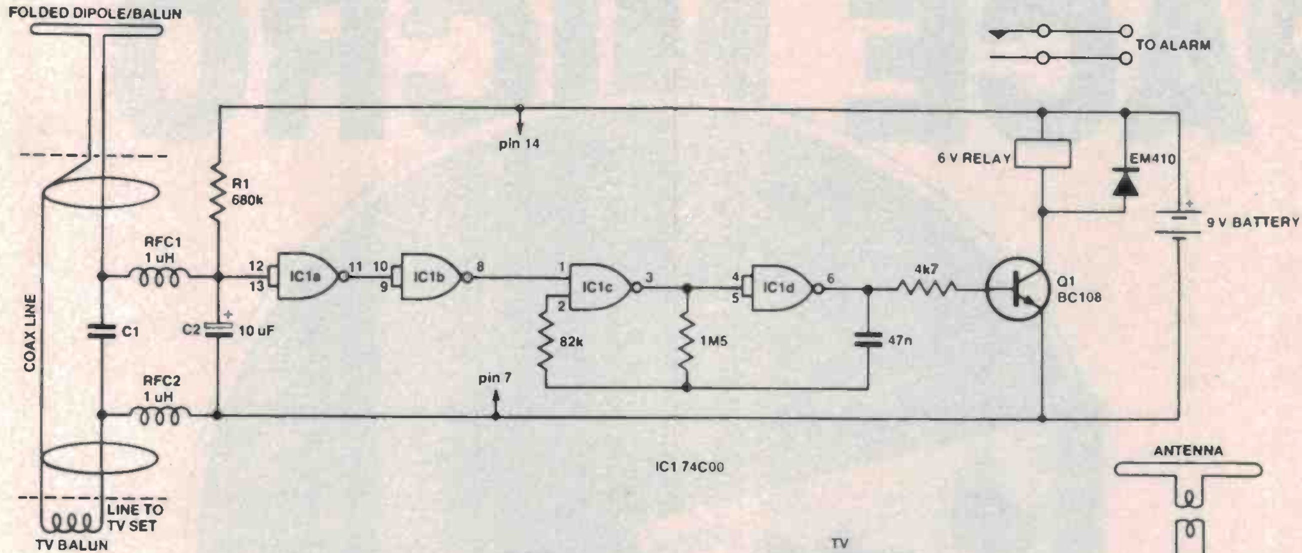
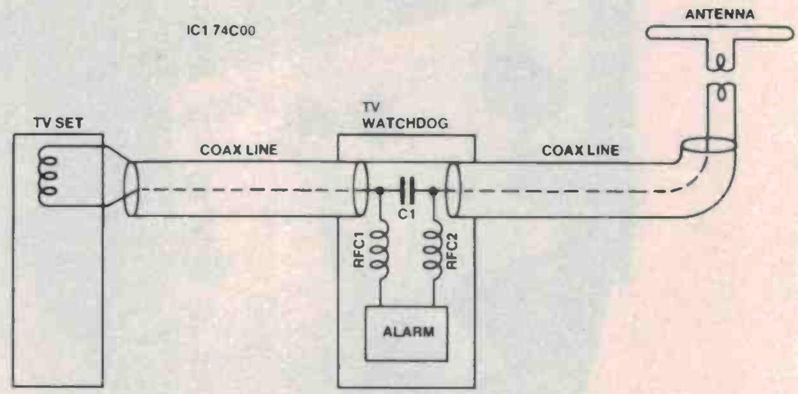
ANY TERMS OFFERED ARE TO APPROVED APPLICANTS ONLY.

DSE/A122/LM

Ideas for Experimenters





TV 'watchdog' alarm

If you don't want your TV set stolen from under your nose, then this simple alarm should do the trick. The idea comes from **G.N. Vayro of Broadmeadows in Victoria.**

The device is a simple supplementary burglar alarm. It is designed to awaken householders if a burglar strikes at night and to so shock a would-be thief that he/she flees in panic.

It operates on the basic closed wire loop principle, i.e: breaking the loop at any point activates the alarm. The TV antenna, coax or ribbon and the set's internal balun are used as the loop, therefore installation effort is practically nil.

The alarm is completely self-contained and all components including battery are mounted inside a small jiffy box. A standard Belling-Lee plug is mounted on the box so it plugs directly into the TV set. The antenna lead plugs into a socket on the opposite side of the jiffy box. The alarm is operated (after a delay) if the antenna is unplugged from the alarm or if the alarm is unplugged from the TV set.

The unit is isolated from the TV signals by RF chokes, and TV signals bypass the alarm via a capacitor. The antenna loop circuit holds C2 discharged and current flows in the loop via a 1M5 resistor.

When the loop is opened C2/R1 provide a ten-second delay before the alarm operates. This is so the would-be burglar does not know what activated the alarm. IC1b inverts the logic level and activates IC1c and IC1d, which oscillate at about 4 Hz. IC1d drives Q1 via a current-limiting resistor and Q1 pulses a relay to switch an alarm or a piezoelectric transducer direct.

Quiescent current is very low and a 9 V transistor battery should last almost to its shelf life.

When activated, the alarm draws only about 6 mA (average) and makes a very loud noise due to the efficiency of the piezoelectric transducer.

Winding metal detector coils

A highly novel approach to winding coils for home-made metal detector search heads has been suggested by **Malcolm Young of Dunedin, N.Z.**

As the coils consist of a number of turns wound to a large diameter, a suitable former can be obtained by using a party balloon! Just blow one up to the right size, carefully wind on the required number of turns and apply five-minute epoxy to secure the turns. After the epoxy has dried, pop the balloon — presto! a self-supporting search coil.

Any ideas?

Have you had a bright idea lately, or dicovered an interesting circuit modification? We are always looking for items for these pages, so naturally we'd like to hear from you.

We pay between $5 and $10 per item — depending on how much work we have to do on it before we publish it.

The sort of items we are seeking, and the ones which other readers would like to see, are novel applications of existing devices, new ways of tackling old problems, hints and tips.

Shoparound

THIS PAGE is to assist readers in the continual search for components, kits and printed circuit boards for ETI projects. If you are looking for a particular component or project – check with our advertisers if it is not mentioned here.

ETI-570 Infrared trip relay

Components for this project are widely available and readers should experience little difficulty. If, however, you can't locate a source for the CQY89A infrared LEDs and the BPW50 IR detector diode, then one or more of the following firms may be able to assist: in Melbourne – All Electronic Components, Rod Irving Electronics, Tasman Electronics, Magraths, Kalextronics and Raycross Electronics; in Sydney – Electronic Agencies, Radio Despatch Service and Jaycar; in Perth – Altronics (. . . and they're cheap!). Note that Dick Smith carries the CQY89A, but not the BPW50. You could substitute a BPW34 (which D.S. does carry) but the BPW50 is recommended for better sensitivity.

We understand All Electronic Components and Rod Irving Electronics will be carrying kits of this project. If you have most of the parts but require the pc board, suppliers are listed at the end of this column.

ETI-333 Reversing alarm

This project will be widely stocked as a kit, we believe. Ask for it at your local Dick Smith store, or try All Electronic Components or Rod Irving Electronics. Parts and pc board will be available from Radio Despatch Service, also. Note that piezo alarms are widely stocked. For pc board, see the suppliers listed at the end of the column.

ETI-259 Incremental timer

Same story on this one. There's nothing particularly special about any of the components. Kit suppliers as for the ETI-333.

ETI-726 6 & 10 metre RF P.A.

This 70 watt power amplifier for the 28 and 52 MHz amateur bands has enjoyed a resurgence in popularity recently, probably owing to the increased activity on these bands. However, we have been receiving quite a few enquiries as to where to get the parts, as our original Shoparound advice no longer holds. The last sole supplier (so far as we know) is 'old reliable' All Electronic Components of 118 Lonsdale St, Melbourne 3000, (03)662-3506. If you want a kit, or just the DX542CF transistor, they're the people!

PC Boards, panels etc.

Almost every pc board ever published by ETI may be obtained from the following firms:

RCS Radio
651 Forest Rd
Bexley NSW 2207

All Electronic Components
118 Lonsdale St
Melbourne Vic. 3000

In addition, many of our boards are stocked by Radio Despatch Service or, if they haven't got your requirements in stock, can have them made to order for you. Here they are:

Radio Despatch Service
869 George St
Sydney NSW 2000

The same three firms can provide front panels for our projects, too.

For the projects we've done over the past three or four years, many (if not most) pc boards and panels may be obtained through the following firms:

Mini Tech
P.O. Box 9194
Auckland N.Z.

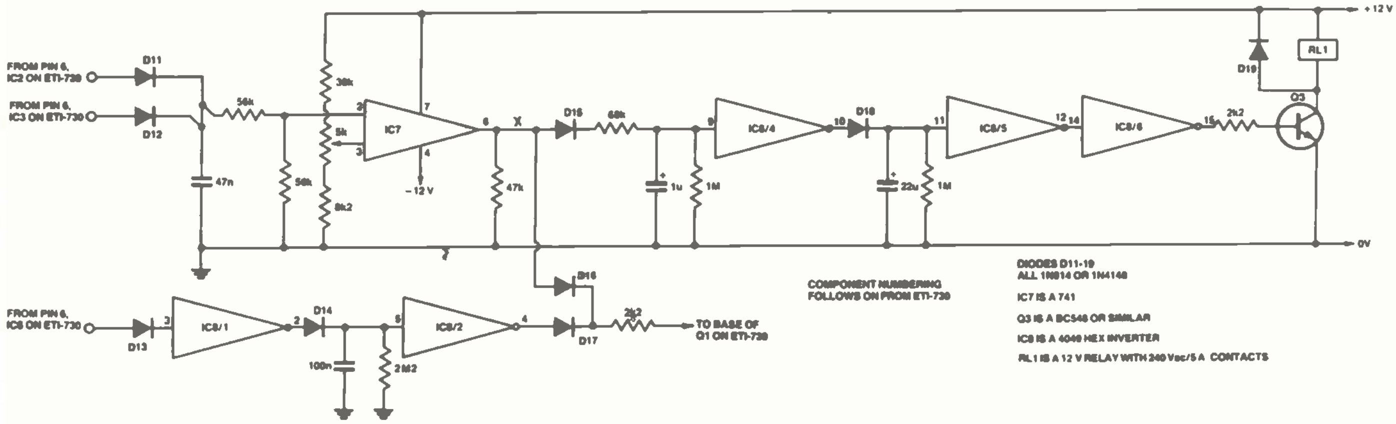
James Phototronics
522 Grange Rd
Fulham Gardens S.A. 5024

Sunbury Printed Circuits
10 Counihan St
Sunbury Vic. 3429

Jemal Products
P.O. Box 168
Victoria Park W.A. 6100

Rod Irving Electronics
425 High St
Northcote Vic. 3070

Auto-start and anti-space for the ETI-730 RTTY decoder



AUTO-STARTS are used by many amateurs for unattended monitoring of a radioteletype (RTTY) channel. When a 'mark' or 'space' tone is received for approximately one second, this circuit will close a relay which can supply power to the teleprinter's motor and loop supply. When the tones disappear for about 22 seconds, the relay removes power from the machine until further RTTY signals are received.

In addition, this circuit contains 'anti-space', which will simulate a mark signal if a space tone is received for longer than 220 ms. Mark is also simulated when no signal is received or when voice is received. The design of this circuit prevents voice from activating the auto-start and, in about 98% of cases, will prevent 'phone signals from printing garbage. (This is controlled by RV1. A compromise must be chosen between introducing distortion and totally eliminating 'phone from printing garbage).

Point X can be used to monitor the signal with a CRO or meter and facilitate tuning SSB signals (for those who do not have a CRO with X-Y facilities).

Input from the two CRO test point outputs of the ETI-730 go to IC7, a comparator, whose output is low when an RTTY tone (mark or space) is received. When no RTTY signal is present, driver transistor Q1 is saturated and a mark-hold condition is created. Combined with anti-space (IC8/1, IC8/2 and components), which simulates a mark tone after 220 ms of space tone is received, the teleprinter never chatters away for any length of time. The delay of 220 ms is chosen as at 45.45 baud; the longest space tone that is ever sent is about 132 ms.

Auto-start operation is controlled by the remaining gates of IC8. When an RTTY tone is received, the 1 uF capacitor from pin 9 to 0 V discharges via the 1M resistor in parallel with it. In about one second, the output of IC8/4 goes high, charging the 22 uF capacitor on the input of IC8/5 and saturating Q3 via IC8/6. When the tone is removed, the 22 uF capacitor discharges via the 1M resistor in parallel with it and in approximately 22 s, the output of IC8/6 goes low and RL1 is turned off, removing power from the teleprinter.

The trimpot RV1 is adjusted to give a high output on IC7 with no signal, and a low output when a tone is received. A CRO placed at point X will show a steady −12 volts on an accurately tuned signal. If the signal is not tuned correctly, or noise is received, the trace is no longer a straight line at −12 volts, but spikes to +12 volts are obtained.

Ralph Youie VK3YRY

DICK SMITH

presents the transceiver you've all been waiting for

Chosen by Dr David Lewis for the 1982 Antarctic Scientific Expedition

look at these features

- ALL mode – even FM* – so you can 'go anywhere' – on its own, or teamed up with a transverter. It's brilliant!
- ALL band – it receives from 150kHz to 30MHz continuous, with resolution down to 10Hz! And the transmitter includes all the new WARC bands.
- ALL microprocessor controlled – which makes operation nice and easy for you (including keeping track of the FT-ONE's 10 VFO's!)
- ALL area operation: run it from 100 – 120 or 200 – 240V AC in the shack, or 13.5V DC when mobile!
- ALL solid state (of course!) with a massive complement of 659 semiconductor devices, including over 70 IC's!
- ALL performance – with better than 0.3uV sensitivity and more than 100W PEP output (SSB).

be quick- first shipment stocks limited

You've dreamed of owning a transceiver like this Now your dreams can come true!

No longer in the 'luxury' category, Yaesu's new FT-ONE is very affordable – especially when you compare it to other general coverage transceivers.

If you want a transceiver that commands the bands, you won't do better than the FT-ONE.

And you won't do better than buying your Yaesu from Dick Smith Electronics: Australia's leading factory-approved Yaesu agent . . after all, we're the ones who give you a full 12 month guarantee AND guarantee to match or better any genuine Yaesu price offered by other suppliers!

all this for only $1795

** FM board optional at extra cost*

Cat. D-2852

DICK SMITH Electronics

Sydney : Canberra : Melbourne : Adelaide : Perth : Brisbane : Newcastle : Wollongong

DSE/A127/LM

Russian Satellites to sport 'robot' transponder!

Three new Russian amateur satellites were due for launch December/January, according to European reports, each to include 'Mode A' transponders (as per the OSCARs) plus a unique 'robot' transponder.

The robot transponder is said to respond to an appropriate call by sending back the caller's callsign, a signal report and possibly a serial number for the contact.

Input/output frequencies for the robot transponders are reported as 145.82/29.32 MHz, 145.83/29.33 MHz and 145.84/29.34 MHz for each of the three satellites. Mode A transponders are reported to have bandpasses that start 40 kHz above the two robot frequencies. (Thanks to HR Report).

Communications and the micro

A new concept in radio communications techniques has been developed by Philips by effectively 'marrying' sophisticated two-way radio and microprocessor technologies, they say.

The DS 1002 Data Radio System enables data as well as voice to be transmitted at high speed to and from any equipped fleet delivery and freight vehicles, service vans, mining trucks, police emergency and other authority vehicles, boats — in fact, any mobile.

Exhibited at IREECON, the DS 1002 frees the radio operator from verbally transmitting every message and allows greater concentration on actual fleet deployment. This efficiency can in turn lead to considerable savings being enjoyed in time, distance and fuel with a parallel increase in service, Philips claim.

Whilst several basic modules make up the system, these may be configured in the optimum fashion for the chosen application. The DS 1002 Mobile Data Processor Unit (MDPU) is fully software controlled and can be programmed to operate with a number of vehicle peripherals, including a mobile printer, 14-digit alphanumeric keyboard control unit and dash-mounted mobile data control heads.

Further information on system elements and example application notes are available from Philips-TMC (Radio Division).

It's on again!

The VK amateur's Mecca, otherwise known as the Central Coast Amateur Radio Club Field Day, will be held this year on Sunday 25 February.

Venue, as usual (does Mecca ever move?; does a camel drink water?) is the Gosford Showground, Showground Rd, Gosford (and that's easy to remember as it's almost a palindrome). The fun starts at 8 am and registration is a mere $4 for men, $2 for women and $1 for harmonics.

As it's the club's 25th annual bash, they'll no doubt excel themselves. Going to Gosford? . . . you're mad if you don't!

HALF PRICE COMPUTER!

it had to happen!

Are you fed up with 'built up' projects? Why not build this very high quality kit computer and save over 50% on equivalent built up units!

A FULL SIZE COMPUTER KIT

You are supplied with a full board including power-on EPROM monitor, 16K of RAM, cassette interface (relay activated) for universal control of any tape recorder, TV modulator and direct video output PLUS full size professional keyboard – not a 'feel less' toy.

ALL THIS FOR ONLY $295

Cat. K-3600

OUR MOST POPULAR KIT EVER!

Any extra parts shown in illustration are sold as separate, chargeable items.

OPTIONAL EXTRAS

Transformer (M-2325)	$23.00
BASIC interpreter (tape) (K-3602)	$24.50
IC socket set (K-3603)	$12.50
BASIC in EPROM (K-3604)	$99.50
S-100 Expansion (K-3606)	$19.50

Yes, this would make the fully assembled computer with above options.

ONLY $355.00

THE FANTASTIC SUPER 80

Construction details and a full copy of the EA article is supplied with each kit. We also have available two very comprehensive manuals to assist in construction and programming:

SUPER 80 Technical Manual (B-3600) ... $12.50
SUPER 80 BASIC Handbook (B-3602) ... $14.50
This book has over 50 separate versatile commands. Features arithmetic and integer functions, user-defined functions, machine language routines, text editing, string operations. Also contains 25 error codes to assist you in programming.

DICK SMITH ELECTRONICS

See our other advertisements in this publication for store addresses, phone numbers, post and packing, etc.

DSE/935M/LM

The ZX Printer is here!

Sinclair Research has introduced a printer exclusively for use with the ZX-81 personal computer, and the ZX-80 with retrofit 8K ROM. The new printer features full alphanumerics and sophisticated high-resolution graphics. Cost is only $175 tax paid!

ZX users who write and edit their own programs will find the printer of special value. They will be able to obtain hard copy of their listings and a permanent record of their computations and results.

Special features include COPY, which prints out exactly what is on the TV screen without further instructions. L LIST instructs the printer to produce an entire completed program, and L PRINT to print copy out on the printer and not the screen.

The ZX printer has 32 characters to the line, nine lines to the vertical inch (25.4 mm) and a printing speed of 50 characters per second. For operation it is attached to the rear of the computer by a stackable connector which allows the 16K RAM pack to be used at the same time.

The printer is supplied with a 20 m roll of special aluminised paper, enough for over 250 full screens of text. Additional rolls are available from Sinclair in packs of five for $25 the pack.

For further information contact Sinclair Equipment (Australia) P/L, 86-88 Nicholson St, Abbotsford Vic. 3067. (03)419-3033.

Computer satellite links

A powerful new technique for the high bandwidth transmission of data between computers is being established by a consortium involving the British Government, universities and industry. It comprises the combination of ground based Cambridge rings with satellite links and will cost some STG£3 million over a period of three years.

This scheme was devised at the Science and Engineering Research Council's Rutherford and Appleton Laboratories, and was initially proposed as a joint research project with Cambridge University and University College, London. The project is known as UNIVERSE (UNIVersities Expanded Ring and Satellite Experiment) and was quickly extended when GEC-Marconi Electronics, Logica and British Telecom agreed to join in the work. The cost will be shared between these industrial concerns, the Department of Industry (of the British Government) and the Science and Engineering Research Council.

At each of six sites in the UK a cluster of computer devices will be connected into a network directly coupled to an earth station at that site. Thus each computer at every site will be able to communicate with any other computer at the same site through the local site network and also will be able to communicate with any computer at any of the five remote sites through a satellite link.

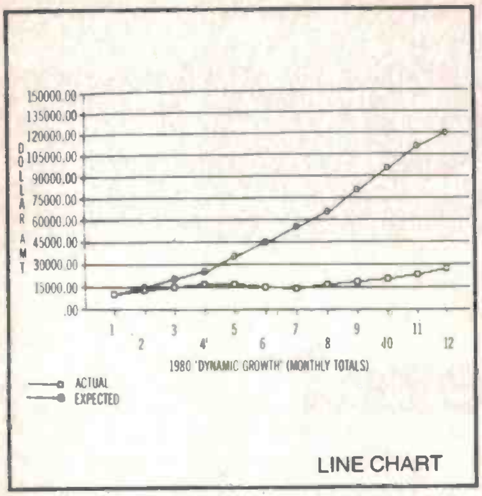
Each of the six sites will be equipped with an earth station comprising a 3 m diameter dish antenna, a 14 GHz transmitter for the up link and a 11 GHz receiver for the down link. These earth stations will operate with the Orbital Test Satellite (OTS), which is positioned in geostationary orbit above the equator over Gabon. The operational life of this satellite is expected to extend until at least early 1984, so that there will be time for the equipment for project Universe to be obtained and installed by early 1982 and to enable two full years of operational experience with the system at the very minimum.

This type of system could be expanded to cover many more sites (possibly up to about 30) for some commercial applications. It is anticipated that Britain will greatly benefit by the experience obtained through the operation of this complex system, and there will be a national demonstration facility to show potential overseas customers. The industrial companies participating in the scheme obviously hope for export orders and UK sales as a result of the work.

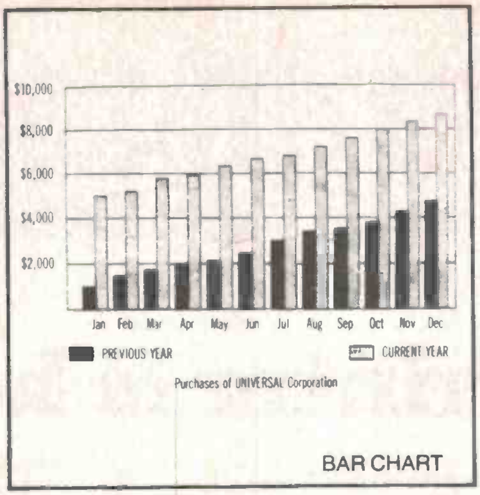
At distances of up to about 2 km, local data ring networks can provide high-speed data links between computers, packets of data flowing as signals with address labels defining the destination of each digital packet. For distances of up to about 100 m, twisted pairs of copper wires can be used to provide the connections, but at somewhat longer distances optical fibres are required to prevent signal degradation. At still longer distances terrestrial microwave or satellite links are required to connect the data rings.

In underdeveloped countries satellite links are likely to be the only economic way of achieving high data rates, since they will have no existing complex telecommunications systems. The basic rate of digital data transfer from any station on the ring is 1 Megabit per second, but within a few years this will be increased to 10 Megabits per second.

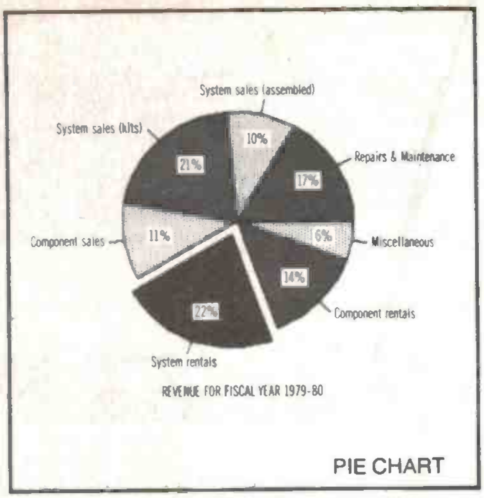
Brian Dance



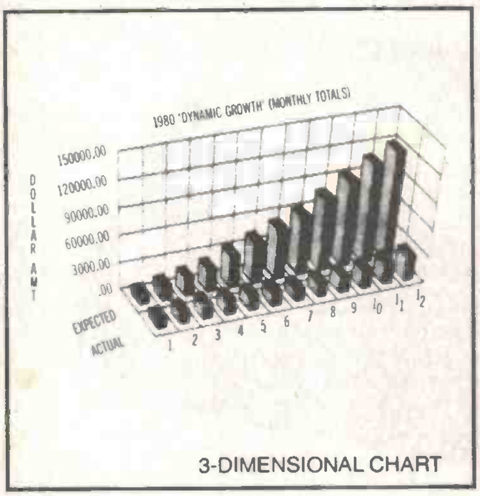
LINE CHART



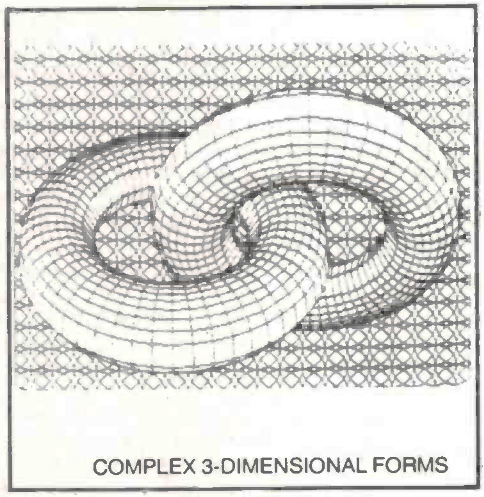
BAR CHART



PIE CHART



3-DIMENSIONAL CHART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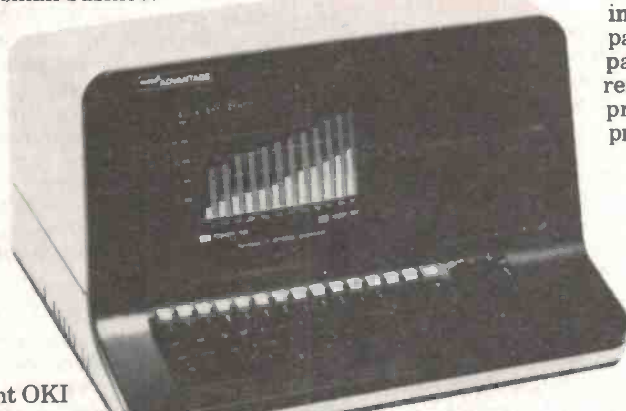
The Advantage's features include two integrated double-sides, double-density floppy disk drives, an 87 key Selectric® style keyboard which includes 15 programmable function keys, a 12-inch green graphics display, business graphics software and self-diagnostic capabilities. The A.D.E. Advantage package is completed with the excellent OKI Microline 82A Serial Dot Matrix Printer.



The small business computer user will be able to integrate graphics into everyday business without paying a premium. The Advantage package is available for a remarkable $5,595. At that sort of price, and with the ability to produce everything from a 3-dimensional visual to a pie chart, the Advantage will give businessmen a chance to grab a bigger slice of the profit pie. Talk to your A.D.E. Representative now.

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Printout

CP/M Bulletin Board operating in Sydney

Trevor Marshall's CP/M Bulletin Board and Remote Computer has moved from Perth to Sydney and is currently operating from 6 pm to 9 pm most evenings. All programs from the CP/M Users' Group (51 disks) and SIG/M Users Group (25 disks) are available by request. Directories and abstracts of these disks are available on-line and may be transferred or searched.

The Bulletin Board software supports directed or unrestricted messages and is essentially the same as the RBBS systems currently operating in the USA.

The remote computer has full HELP facilities (more than 260K of helpfiles) so if you have never used a CP/M-like computer before, type:

HELP CPM and
HELP THIS-SYS

after logging in and leaving the Bulletin Board program. A program called CHAT is available if you still need assistance.

Trevor's computer runs IOS, an enhanced version of CP/M. The CPU is a Z80 running at 5 MHz with 64K of user RAM. It has 2 Mbytes of files on-line on 8-inch floppies and uses an extra 48K of RAM purely for disk cache buffers (it's fast).

Anyone interested may log in by calling Sydney 95-5715. Connection is performed manually. A terminal and modem operating in the ANSWER mode at 300 or 110 baud is necessary in order to use the system.

Software exchange is performed (with handshaking) by the CP/M Users' Group MODEM7 protocol. If you do not have a copy of that program, type:

HELP SOFTWARE

after logging in.

File 'squeezing' utilities are available which reduce transfer time of large files by up to 40%.

Trevor receives new programs and information regularly from Kelly Smith (the operator of the CP/M-NET in the USA), and currently has copies of Kelly's newsletters on Disk B:.

All contributions are welcome (even if not fully finished) and selected gems will be sent to Kelly for raising on the US remote computer network. Contributed programs are left on B: for at least a month before archiving.

The SIG/M users' group disks include five disks of PASCAL-Z source as well as various useful hints about and programs for CP/M, together with the usual games. There are IBM to CP/M and DEC to CP/M file transfer programs.

Volume 11, a 241K ADVENTURE volume, is not available for modem transfer (it would take all day!) but enquiries from groups who wish to sub-distribute it (non-commercially) are welcomed.

Contact Trevor Marshall, c/o Nucleus Ltd, 14 Mars Rd, Lane Cove NSW 2066. Work: (02)428-1011; home: 95-5715.

VIC Centre

To coincide with the release of Commodore's low-priced home computer with sound and colour capabilities, Computerware have announced their establishment of 'The VIC Centre'.

The VIC Centre aims to provide a one-stop source for the VIC-20, VIC-20 hardware and VIC-20 software.

If you want to know what the VIC-20 system is all about, contact the VIC Centre at 305 La Trobe Street, Melbourne Vic. 3000. (03) 602-1006.

Motorola Memory System

A general purpose memory system which can accommodate up to 32 megabytes has just been announced by Motorola.

System 3000, as it is known, uses array boards mounting 288 64K dynamic ROM chips. An effective data transfer rate of 64 megabytes per second can be established through the use of parallel read with sequential addressing. At the memory buss level, the system can have an access time of 350 ns with error correction, or 275 ns without.

The standard package includes a card cage, power supply module, motherboard, two terminator boards, address-control card, error correction card, interconnect cables, interface card and two megabytes of RAM.

For more information, contact David Ednie of Rank Electronics on (03)541-8444.

Printer graphics pack for Apples

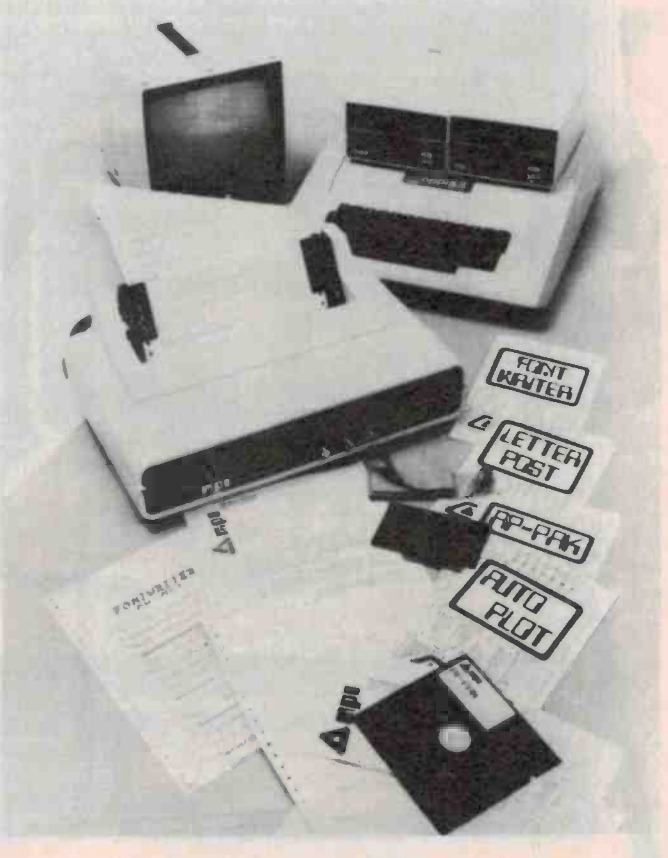
Datatel Pty Ltd have released a hardware and software package that allows Apple owners to use all the graphic capabilities of the 88G and 99G printers manufactured by Micro Peripherals Incorporated.

Called the Apple Ap-Pak, the system includes a printer control card, interface cable, graphics and word processing software, and instruction manuals. Price in Australia will be around $150 plus tax.

The hardware part of the Ap-Pak consists of an Auto Plot printer control card that plugs into the Apple II peripherals slot and drives an MPI graphics printer through a parallel I/O cable. In addition to the usual functions of a printer control card, the Auto Plot can transmit a picture from any Apple Hi Res display to the printer with a single keystroke. If the control parameters are supplied, it can print the Hi Res display in any of three heights and twelve widths, indented, rotated through 90°, or with two separate graphic files side by side.

The Ap-Pak includes two software packages and a series of demonstration packages that show their versatility. Font Writer, used in conjunction with the Applewriter text editing system, allows users to select a printout in three different graphic fonts (text, bold or italic), with a choice of three heights and six widths, in addition to the standard ASCII fonts resident in the printer. Letter Post is a software package that prints individual letters to selected names from a mailing list. Prewritten paragraphs can be chained together and printed out in any typestyle available with Font Writer, and letters may be livened up by the insertion of graphics in the middle of the text.

For more information, contact the distributors, Datatel Pty Ltd, at 3 Raglan St, Sth Melbourne Vic. 3205. (03)690-4000, or 80 Chandos St, St Leonards NSW 2065. (02) 439-4211.



NOW IN STOCK!

GALACTIC TRADER

The objective of this fantastic program is to make a fortune by trading commodities throughout the galaxy. Has 10 levels of difficulty. Playing time from 20 minutes to 5 hours. 16K required, cassette based. X-3678.

ONLY $19.95

GALACTIC EMPIRE

A sophisticated game of strategy & tactics. Your object is to unify the galaxy. Superb graphics and detailed manual supplied. Hours and hours of fun. 16K of RAM required, cassette based. X-3679.

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Diplomacy, social manipulation and ruthlessness must be be combined to bring the major power blocs of the galaxy together to serve your needs to lead the revolution. A fascinating game. 16K required, cassette based. X-3677.

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Put yourself in the pilot seat as you approach the city on a high speed bomb run. Your mission is to destroy the enemy's ground installations. Naturally, they will respond with ground fire and can mount a formidable air attack. Incredibly fast, real time graphics, make this a very exciting package. Cassette based. X-3683

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NEW! ready to go DISK DRIVES & still cheaper per byte!

Superb new model disk drives - now with power supply inbuilt for added reliability and less connecting! Ideal for all System 80 & TRS-80 computers - and many others... and they're still $$$ cheaper than Tandy drives.

Now two models - one configured for drive 0 (Cat. X-4060) and the other configured for drive 1 (Cat. X-4061). It couldn't be easier!

Features: ● 40 Track - store up to 100K bytes per disk, ● High quality - uses MPI mechanism, ● Suits soft sector disks.

ONLY $419

GALAXY INVASION

The idea of this game is to destroy the 'invaders' and save Earth - but beware of the roving flagships. Cassette based, 16K required. X-3693.

ONLY $19.50

LUNAR LANDER

SYSTEM 80 & TRS 80 with 16K & Level 11 BASIC.

One of the most incredibly executed games ever! The program features a real time LUNAR LANDER which you attempt to manoeuvre across a rugged lunar landscape to a safe landing site. With approximately 10 landing sites to choose from, you select the one that suits your skill. Also included in a hidden ravine is a refueling station and for the grand master a special 900 point landing site. Requires 16K, cassette based. Great sound effects!

ONLY $19.50 X-3691

METEOR MISSION

The objective of this graphical game is to rescue the stranded astronauts from the planet below. You must manoeuvre your craft through the meteor belt. Absolutely brilliant! X-3697.

ONLY $19.50

COSMIC FIGHTER

Similar to Space Invaders, but this time alien destruction requires two hits, then three hits . . . it becomes exceedingly difficult and fast. X-3695.

$19.50

NEW Depth Charge

Depth Charge is another brilliant addition to our large range of exciting software. Picture yourself as a captain of a subdestroyer, it is your duty to track down & destroy as many enemy submarines as possible. You're able to drop depth charges, but beware: the enemy sub can fire torpedoes, plus a heat-seeking missile that you can't dodge. Simply superb! Requires 16K, cassette based. X-3686

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DSE A123RB

Printout

New line isolating transformer

Arlec Pty Ltd has just introduced a printed circuit board mounting audio transformer which has been designed specifically to provide the isolation necessary between Telecom Australia lines and mains operated equipment likely to be used on them. It is equally suitable for switched network and private line applications.

Officially approved by Telecom Australia (Engineering Approval No. RA81/144), Arlec Transformer No. 45035 conforms to the relevant clauses of Telecom Australia specifications 1053 and 1054.

The 45035 is a 600 ohm transformer with a turns ratio of 1:1. At zero dBm, frequency response covers the range 300 Hz—10 kHz and return loss is better than 15 dB, 300 Hz-5 kHz.

It will carry up to 60 mA dc in one winding without any appreciable variation in performance, and up to 200 mA dc continuously without suffering any damage.

Mounting is via the pc board mounting pins, which are spaced at 25 mm. Overall dimensions of the transformer are 41 mm x 33 mm x 31 mm, and it weighs a mere 150 g.

Further information is available from Arlec Pty Ltd, 30 Lexton Road, Box Hill Vic. 3128. (03)840-1222.

New TCG releases

US-based Novell Data Systems recently released a new, fully programmable dot matrix printer onto the Australian market, to be distributed by the TCG group.

The printer features 30 programmable functions including six sizes of condensed and expanded print, variable line spacing, subscripting and superscripting, selection of two character sets and a programmable VFU (Vertical Format Unit). Interfaces are available for RS232 or Centronics.

The Novell 800 prints 150 characters per second, bi-directional, with logic-seeking intelligence. The printhead is designed for an average of 200 000 000 characters.

The cost of the Novell Image 800 is under $1700.

Also newly released from TCG is the Hendrix Micro HS40 Series, designed to meet the complete electronic text editing and production needs of small to medium newspapers.

The Micro HS40 is a full-capacity system, providing up to eight complete Edit III VDTs. It will support up to eight I/O devices, including low and high-speed newswires, an on-line phototypesetter with 4/SIGHT soft copy terminals, remote input terminals, display ad terminals, printers, and interfaces with other Hastech systems. The system's TPS/4 software system can handle editorial functions, classified ad functions and composition functions.

Micro HS40 Series systems are available in three cluster configurations, which, in conjunction with the modular product line, should make future system upgrading or expansion simple. A remote configuration for newspapers with bureaus or for small newspapers sharing production facilities is also offered.

A package including three terminals, a console printer, news wire and typesetter interface is priced at under $50 000.

For further information contact Mr. Mike Barraclough, The TCG Group, 31-33 Hume St, Crows Nest NSW 2065. (02)439-6477.

Programming without tears — or expense

Many small businesses could do with the help of a pocket computer to help them save time and overcome problems, yet they are put off by the daunting task of programming. To overcome this problem, Powerchip Software have just announced the first release of a series of books which have taken the United States by storm.

Specifically designed with the novice computer programmer in mind, these books provide a unique opportunity to learn what programming is all about without having to spend a lot of money.

Aimed at use with the Tandy TRS80 and the Sharp PC1211, these books provide an easy to follow, step by step guide to programming. Using BASIC language, the easiest computer language to follow, it is claimed they will guide even the most novice programmer along the path to successful programming.

The books currently available cover both business and entertainment applications for either the small businessman or student, and although they are specifically intended for use with the Sharp and Tandy models, with only minor changes to the programs they can be modified to operate on other, larger computers, thereby increasing their versatility.

Business programs include 'Profit Estimator', 'Invoice Totalling' and 'Wages and Overtime', to name but a few, all of which are ideal for the small merchant who can see his business growing but as yet cannot justify the use of a large computer. Each program clearly sets out the steps to follow and then gives a sample run so you can see for yourself what form the final program will take. This is a vitally important educational factor, as it teaches the user what programming is all about, enabling him to expand his own knowledge so that he will eventually be able to write his own programs.

This educational aspect has been one of the major concerns kept in mind during preparation of the books. There are twelve books in the current series, which may be bought either individually or as a package. Individual books carry a recommended retail of $9.95 each.

Some of the titles in the series include '101 Tips and Hints', which is a vital book in that it gives an outline of some of the shortcuts, 'Programming for the Home, School and Office', which covers many useful areas, and 'Murder in the Mansion', a superb new game which will have the entire family involved! Soon to follow will be software for the Casio FX-702P.

For further details Powerchip Software may be contacted at P.O. Box 32, South Caulfield Vic 3162. (03)529-2884.

Club Call

OMEGA (OSI Microcomputer User's Group Australia) is a club for users of the increasingly popular OSI micro, until recently relatively unknown in Australia. We are advised that the ACT sub-group meets on the third Wednesday of every second month, and membership costs $6 per year (overseas air mail $12). There is a bi-monthly newsletter produced for over 150 members in Australia, New Zealand and the USA. Contact Geoff Cohen, 72 Spofforth St, Holt ACT 2615, for more details. (062)49-2688 (bh) or 54-7608 (ah).

John Newman, of P.O. Box 4, Thornbury Vic. 3071, wrote asking us if we knew of people interested in forming a club for users of **6800 and 6809 microprocessors** — chips which are now being used by quite a number of people in Australia. If anyone is interested in forming such a group, contact John at the above address and take it from there!

RS232C data-communications analyser

The Hawk 4020 is designed for interactive troubleshooting and passive monitoring of serial data associated with the RS232C digital interface.

It can accommodate synchronous and asynchronous data rates up to 19 200 bits per second, capturing and storing up to 256 characters (including four EIA control lines) for later analysis. Data traffic is read out on a one-line, 20-character alphanumeric display, and there is also an optional teletypewriter interface.

Using the 4020, field service technicians can passively monitor and trap on-line data, perform error rate tests and simulate both data terminal and data communications equipment. It can also be configured to transmit or reply to polling messages, to generate or verify redundancy checks and to measure delays between related control signals.

For more information contact The Dindima Group Pty Ltd, P.O. Box 106, Vermont Vic. 3133. (03)873-4455.

RFI/EMC filter for computer applications

One of the problems that has arisen with computers and related equipment is 'electromagnetic compatibility', or EMC. A new filter-adaptor that fits between 25-pin D-subminiature plug/sockets helps overcome some of these EMC problems.

The problem arises because digital signals generate harmonics well beyond the frequency range required for reliable operation, and these spurious signals may interfere with other electronic equipment operating nearby.

STC-Cannon Components have released this new filter that deals with the problem. It is a plug/socket — 25-pin D-sub style — that you simply insert 'in the line'.

The filter employs a monolithic capacitor substrate that can handle a claimed 1 Adc (max.) at a working voltage of 100 Vdc (at sea level). Specified attenuation is around 10 db at 20 MHz, rising to more than 30 dB between 80 and 150 MHz, maintaining more than 20 dB attenuation at frequencies up to 500 MHz. Spec. sheet and further details from STC-Cannon Components.

Printout

OKI's Microline 80 rules, OK?

Anderson Digital have released a new printer from OKI, called the Microline 80, that features program-selectable fonts, graphics, 80 and 132-column printing, continuous duty operation, 96-character ASCII set and tractor, pin or friction feed.

The Microline 80 standard models include Centronics-compatible parallel and RS232C serial interfaces. It can handle all common types of paper — 80-column fanfold, rolls and letter or legal forms.

The printhead has seven pins 'fired' using energy stored in tension members claimed to provide excellent reliability. The head design permits continuous operation at 80 cps with no duty cycle limitations. The Microline 80 will print both double width and condensed characters in addition to the normal ones. Font selection, character spacing and line spacing are all under program control.

For further information, contact Anderson Digital Equipment, Unit 1, Pioneer Ave, Thornleigh NSW 2120.

News from Natsemi

National Semiconductor has introduced the first LSI circuits for equipment using the IBM 3270 Information Display System standard. Two chips now replace the 40 chips previously required to perform the encoding, transmitting, receiving and decoding functions in these systems.

Housed in 24-pin dual-in-line packages, the DP8340N transmitter/encoder and the DP8341N receiver/decoder are priced at $21.50 each in 100-piece quantities.

Also available from Natsemi is a high-speed, 256-word by 4-bit Emitter Couple Logic (ECL) RAM, designated the DM10422, claimed to be ideal for use in scratch pad, buffer and control store applications.

Synertek Inc (a division of Honeywell) and Natsemi have signed a co-operative agreement to second source the NS16000 family of microprocessor devices. The agreement, which is effective immediately, calls for the exchange of mask-making data for National's proprietary NS16032 CPU and all peripheral devices, in exchange for which Synertek will design additional peripheral circuits for the NS16000 family.

Naltsemi has also reached an agreement with Monolithic Memories Inc, in which Natsemi's projected advanced error correction device and family of dynamic RAM (DRAM) controllers will also be manufactured and marketed by Monolithic Memories. These devices are the first members of National's DP84XX memory interface family.

National Advanced Systems in the US has acquired Itel Corporation's remaining inventory of Advanced System computers, peripheral equipment, spares, tools and test equipment, as well as certain leasehold improvements, a US Government lease base, and the residual interest in Advanced System computer equipment already leased to customers.

Book Review

K2FDOS, a Floppy Disk Operating System for the 8080

By Kenneth B. Welles

There are substantial advantages in using disks to provide bulk storage on a computer system. Compared to other forms of bulk storage, such as the audio cassette, programs can be located in a fraction of the time previously needed, loaded into the computer memory in seconds rather than minutes, and it becomes feasible for one program to find and load any data required, or even another program, without operator intervention.

The most common type of disk in small computers is the so-called floppy disk, which is of modest capacity and speed as compared with hard disks such as the Winchester type, but also of modest cost in comparison.

Any disk system comprises three parts: the disk drive or drives, the hardware interface between the drive and the computer, and a software program that organises the system to perform a useful function. Such a program is known as a 'Floppy Disk Operating System' (FDOS).

The work area on the surface of a disk is divided into tracks (concentric rings), which are themselves divided into short sections called sectors. In order to read and write to or from the sectors and tracks, the disk drive requires quite a degree of low-level control — pulses to move the head, a signal to control the direction in which the head moves, pulses to lower the head down into contact with the magnetic surface, some detection system to recognise the index mark and count secrots, and so on. The FDOS issues such necessary commands, which are then turned into electrical signals by the interface in order to operate the disk drive.

This brief description of the components and operation of a disk system should help to make clear what 'K2FDOS, a Floppy Disk Operating System for the 8080' is about. In fact there is more to the book than just an FDOS; it contains four other pieces of software, one of them a general disk utility program of comparable magnitude and complexity, and a circuit diagram and reasonably detailed explanation of a hardware interface (reprinted from Byte Magazine).

The book is written in the form of a teaching manual, with ten chapters and fifteen appendices. The chapters, which make up about a third of the book, start with how to use the FDOS commands and those supported by the disk utility program, and slowly go deeper and deeper into how FDOS works internally and how to use its facilities from your program rather than by commands from the keyboard. There are plentiful examples and useful summaries at the end of each chapter. The appendices contain fully commented listings of all the software, details on how to use the other three pieces of software supplied, and information about the hardware interface.

The FDOS itself is quite a small program, designed to fit into a 4K RAM area. Only six commands are available from the keyboard, as most of FDOS consists of subroutines for other programs to use.

Up to eight disk drives can be supported, and the commands are sufficient to save a named and dated file on the drive of your choice; the file may be built up from the contents of any number of contiguous or non-contiguous sections of memory. A file can be located and loaded by name, and will begin execution immediately if it was so specified on saving, or may be executed through another command if not.

FDOS is always resident in memory (apart from the 1K buffer area, which may be placed in ROM if you wish), and when it is kept on disk rather than in RAM a short bootstrap program (given in appendix F) must be run to bring FDOS itself from the disk into memory.

Chapters three to ten inclusive and appendices A, B and I deal with the question of how to use FDOS's many subroutines in your own programs. The explanation is given in a most readable way, with superb detail and many examples. Why can't all program documentation be as good and clear as this book?

There is of course more to the use and maintenance of a disk full of programs than just loading and saving them. A large program called PIP (1¾K bytes long plus up to 3K of buffer area) is provided, which when run in conjunction with FDOS unlocks some of the power hidden in FDOS's subroutines so that it may be used directly from the keyboard. With PIP you can do the following (the name of the command is given in brackets):

- Find out what files are on a disk (DIRECTORY)
- Find out how much space is left on a disk (FREE)
- Remove a file no longer wanted (DELETE)
- Change the name of a file (RENAME)
- Make a new file which is a concatenation of existing files (COPY)
- Print a copy of a file on the terminal or a printer (LIST)
- Transfer information from an input device to disk (READ)
- Transfer information from the disk to any output device (PUNCH)
- Leave PIP and return to the control of FDOS (EXIT).

These commands allow the user to perform all the normal operator-initiated file manipulation necessary.

In order to initialise a disk and get FDOS and PIP onto it, two programs called FORMAT and SYSGEN are used. These are also fully documented in appendices D and E respectively.

As there is no standard hardware configuration, any program that is hardware-dependent will be of little use unless it can be tailored to any reasonable hardware situation. These programs are very well served in this respect. A very detailed explanation of the construction and operation, together with the fully documented source listings, eases any customising that has to be done, and to help further three appendices are provided specifically for this purpose: 'Patching your own I/O devices to FDOS', 'Interfacing to other disk interfaces', and 'Interfacing to a 5-inch floppy disk drive'.

To sum up, this is a very well detailed software package, written for the 8080 but also suitable for the 8085 and the Z80. For this latter a rewrite using some of the more powerful opcodes would shrink the program quite substantially. Physically the book is soft-covered and professionally produced on good-quality paper by Byte Books, a division of Byte Publications Inc, USA. The price, US$20, seems reasonable for the contents.

It is inevitable that K2FDOS will be compared with the most common 8080 disk operating system, CP/M. K2FDOS is smaller and runs in far less memory, but is a little less powerful. It does provide a fully commented source listing, essential to customisers and software tinkerers, whereas CP/M does not provide a listing and likes to dine on at least 16K of RAM. However, as far as I know only one firm, Intersystems, has produced K2FDOS-compatible software, whereas a vast mountain of software has been written to run in conjunction with CP/M, and it will probably remain the 8080/Z80 user's first choice.

So while not everyone will find this book useful, it is nevertheless a goldmine of information for any enthusiast or tinkerer. Thank goodness for personal computer enthusiasts like K.B. Welles.

Reviewed by Dr. Tim Hendtlass
Applied Physics Department
Royal Melbourne Institute of Technology

Intel handbook for E²PROM

A 96-page handbook describes the operation and several application possibilities of Intel's new 16-kilobit electrically erasable programmable read-only memory (E²PROM).

Following an overview of the implications of E²PROMs and a technical discussion of the 2816's operation, the handbook shows ways to interface it to a microprocessor and program it from a 5-volt power supply.

Also included are several application notes, ranging from use of the 2816 to remotely update microcomputer-based in-field equipment, to E²PROM storage of changeable programs in CRT and POS terminals.

A free copy of the E²PROM Family Applications Handbook may be obtained by writing to AJF Systems & Components, 310 Queen St, Melbourne Vic. 3000. (03)67-9306.

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The PASCAL/M product is implemented using a pseudo machine P-code (Portable Pascal code). The P-code instructions generated by the compiler were chosen to optimize instruction execution and code space of Pascal programs. The execution of the P-code is accomplished by an interpreter (PRUN) which performs the programmed operations on the target machine. The choice of using an interpreter vs. generating target machine code was critically examined during the design of PASCAL/M with the conclusion favoring the memory compactness of P-code.

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PASCAL/M does all input/output and file manipulation through calls to the host operating system, giving immediate and uniform access to the entire spectrum of devices supported. The PASCAL/M file interface intrinsics were chosen to promote Pascal program portability and to provide a bridge between specific operating system capabilities and the Pascal language definition.

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Real-World Extensions

PASCAL/M has been carefully extended to provide the capabilities that are useful or necessary for developing actual application programs. These extensions have been carefully selected and defined with heavy emphasis on compatibility with other existing Pascal implementations. Many special features of PASCAL/M not provided by the standard language are implemented in terms of additional predefined procedures and functions and do not conflict with standard Pascal. PASCAL/M extensions include STRING data types, non-decimal radix constants, greatly expanded I/O facilities and a large number of SEGMENT memory partitions.

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PASCAL/M fully supports all CP/M devices and provides an interface for you to define the capabilities of your console (cursor controls). All runtime input/output requests are directed to the host operating system. This results in files that are portable between other products running under the host system.

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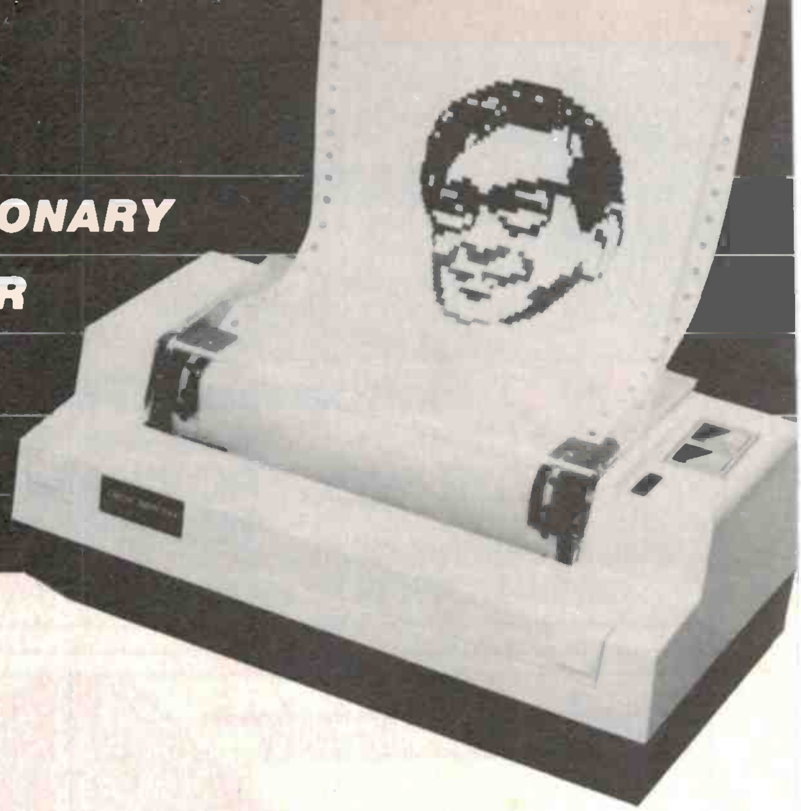

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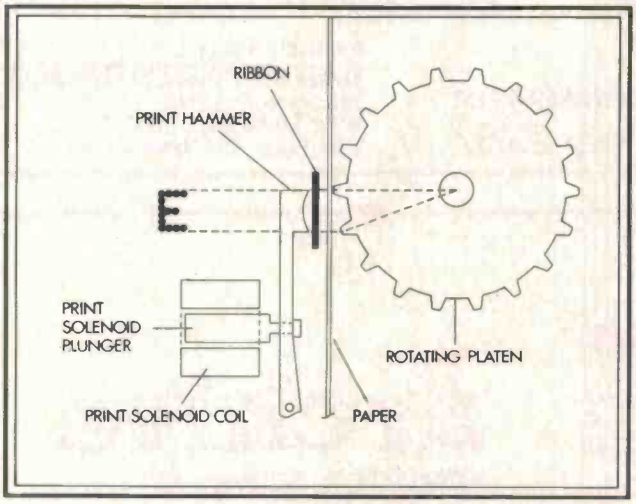

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The X-3252, which prints both graphics and alphanumerics, uses a rotating platen with protruding splines positioned behind the paper (see diagram). The character or graphics image is created by multiple hammer strikes in rapid succession as the print head advances across the paper. The precision gear train assures exact positioning of the print hammer relative to the splines on the platen, to provide excellent print quality.

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The X-3252 has features comparable to printers selling for thousands of dollars. These include upper/lower ASCII character sets, ribbon cartridge, 80 columns at 12 characters per inch, adjustable tractor feed, original and 2 copies, 30 characters per second, and full graphics with a resolution of better than 60 dots per inch in both horizontal and vertical axes.

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I. Soutar

THE OBJECT of the game is to avoid getting trapped by the computer. You move by inputting '5' to move left, '6' to move down, '7' to move up or '8' to move right (in the directions indicated by the arrow above those numbers). When you have moved, the computer will place a black square on one of the four sides of your position. If you move onto a black square the game ends and the computer tells you how many moves you managed to stay free for (about 100 is quite good).

Program Listing

```
1   RANDOMISE
2   LET B=16
4   LET A=6
6   LET M=0
8   LET P=0
10  LET W=0
12  LET D=0
14  LET C=0
20  LET Z=-1
25  GOSUB 700
30  FOR I=1 TO 9
40  PRINT , , , ,
50  NEXT I
52  GOSUB 700
60  GOSUB 500
70  POKE W + 181, 20
80  LET Z = Z + 1
90  INPUT C
100 GOSUB 500
110 GOSUB 600
120 POKE M,0
130 IF C=6 AND A<10 OR C=7 AND A>1
    THEN LET A=A-2*C + 13
140 IF C=5 THEN LET B=B-1
150 IF C=8 THEN LET B=B+1
160 GOSUB 600
170 IF PEEK (M)=128 THEN GOTO 400
180 POKE M, 20
190 LET D=RND(4)
195 IF A=10 AND D=4 OR A=1 AND
    D=3 THEN GOTO 190
200 LET D=(D=1)-1*(D=2)+33*
    (D=3)-33*(D=4)
210 GOSUB 500
220 GOSUB 600
230 POKE M + D, 128
240 GOTO 80
400 CLS
410 PRINT "YOU LASTED FOR";
    Z;"MOVES"
499 STOP
500 LET P=PEEK(16397)
510 IF P>127 THEN LET P=P-256
520 LET W=PEEK(16396)+P*256
530 RETURN
600 LET M=W+(A-1)*33+B
610 RETURN
700 FOR I=1 TO 32
710 PRINT CHR$ (128);
720 NEXT I
730 RETURN
```

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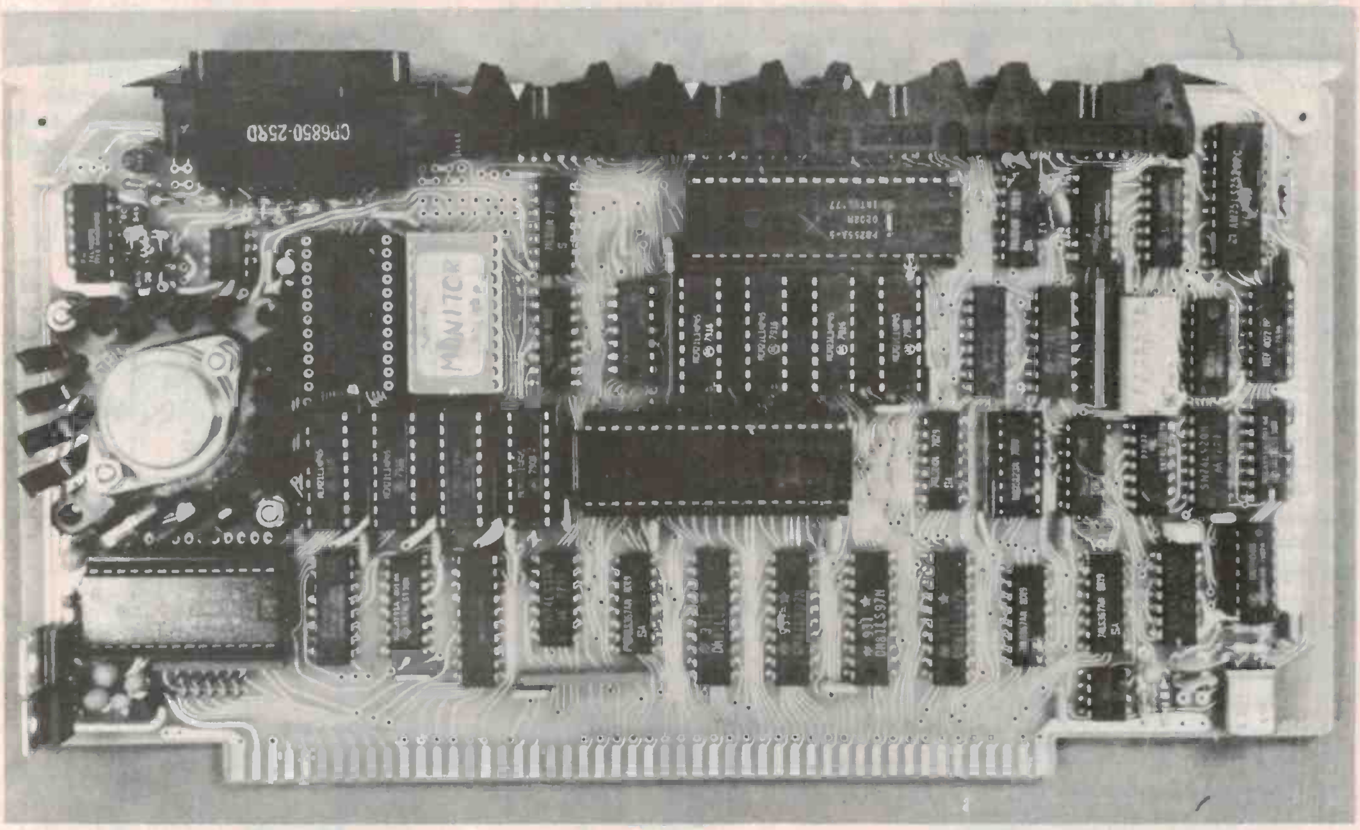
Interfacing with the ETI-685 2650 S100 computer board



Five ports have been supplied on the ETI-685 processor board to provide the user with a wide variety of input-output interface possibilities. Two of these ports are fixed in format, one is serial for interface to a printer, serial VDU or modem, and the other is a parallel-in port for use with a keyboard. The other three ports, A, B and C, supported by the PPI, are user-programmable.

Ron Koenig

PROGRAMMABLE peripheral interface devices (PPIs) are being used extensively these days in microcomputer-based equipment because of their relatively low cost and interface flexibility. Several standard TTL integrated circuits (such as latches and tristate buffers) can be used for I/O interface, but when they have been designed into a piece of equipment there is no way that the interface function that they provide can be altered. The use of programmable devices, such as PPIs, can reduce this problem and, as more ports are concentrated in the one device, circuit complexity and chip count is reduced with a resulting reduction in cost.

The PPI was included on the ETI-685 to provide the user with valuable hands-on experience in the use of these modern devices. The purpose of this article is to provide the user with a basic understanding in the use of the 8255 PPI and to illustrate, with a few simple experiments, its use on the ETI-685 processor board. These experiments will require the construction of a few 'basic' interface circuits. ▶

8255 PPI description

The 8255 PPI is a 40 pin, large-scale-integrated circuit (LSI) device which was designed to interface between the 8080 eight-bit microcomputer and an external input or output peripheral device. The PPI is a general purpose programmable I/O device with 24 I/O pins supported by three 8-bit ports, and these 24 pins can be programmed to operate in a large variety of interface configurations.

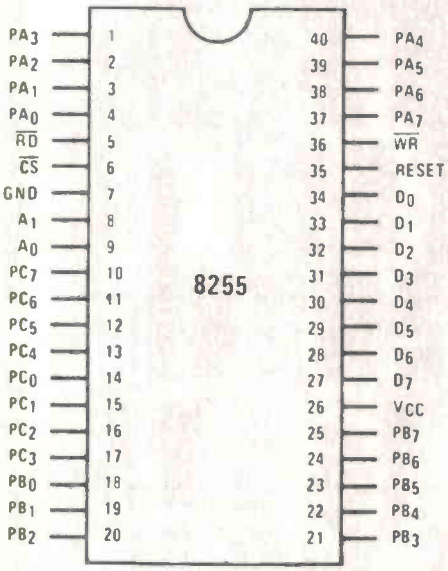


Figure 1. 8255 PPI Pin Configuration.

Each of the three ports of the PPI (A, B and C) has been manufactured with special features to enhance the PPI's interface capabilities.

Port A contains one 8-bit data latch-buffer and one 8-bit data input latch.

Port B contains one 8-bit input and output latch-buffer and one 8-bit data input buffer.

Port C contains one 8-bit data output latch-buffer and one 8-bit data input buffer (no latch). This port can be programmed into two 4-bit ports, where each port contains a 4-bit latch. These 4-bit ports can be used in conjunction with Port A and B for control signal outputs and status signal inputs. Also, special command words can be used to set or reset any of the eight Port C bits independently.

Any of the eight Port B and C output buffers can source 1 mA at 1.5 V to directly drive Darlington-type power transistors. No output should be shorted directly to 0 V (ground) or +5 V (Vcc).

Programming the PPI

The functional configuration of each port is programmed by the system software writing a control word into the control resistor. This command word sets up the PPI's internal data buss, and the read/write control logic issues the appropriate commands to the Group A and Group B control blocks. The Group A control sets up Port A and Port C upper, and Group B Control sets up Port B and Port C lower.

There are three basic modes of operation of the PPI, which are selected by writing a control word into the control resistor.

Mode 0: This is the basic I/O mode in which each control group of 12 I/O pins can be programmed in sets of four and eight to be inputs or outputs.

Mode 1: This is the strobed I/O mode in which each group of 12 I/O pins may be programmed to have eight lines of input or output, with the remaining four pins in each group being used for handshaking and interrupt control signals.

Mode 2: This is a strobed bidirectional buss I/O mode where the eight

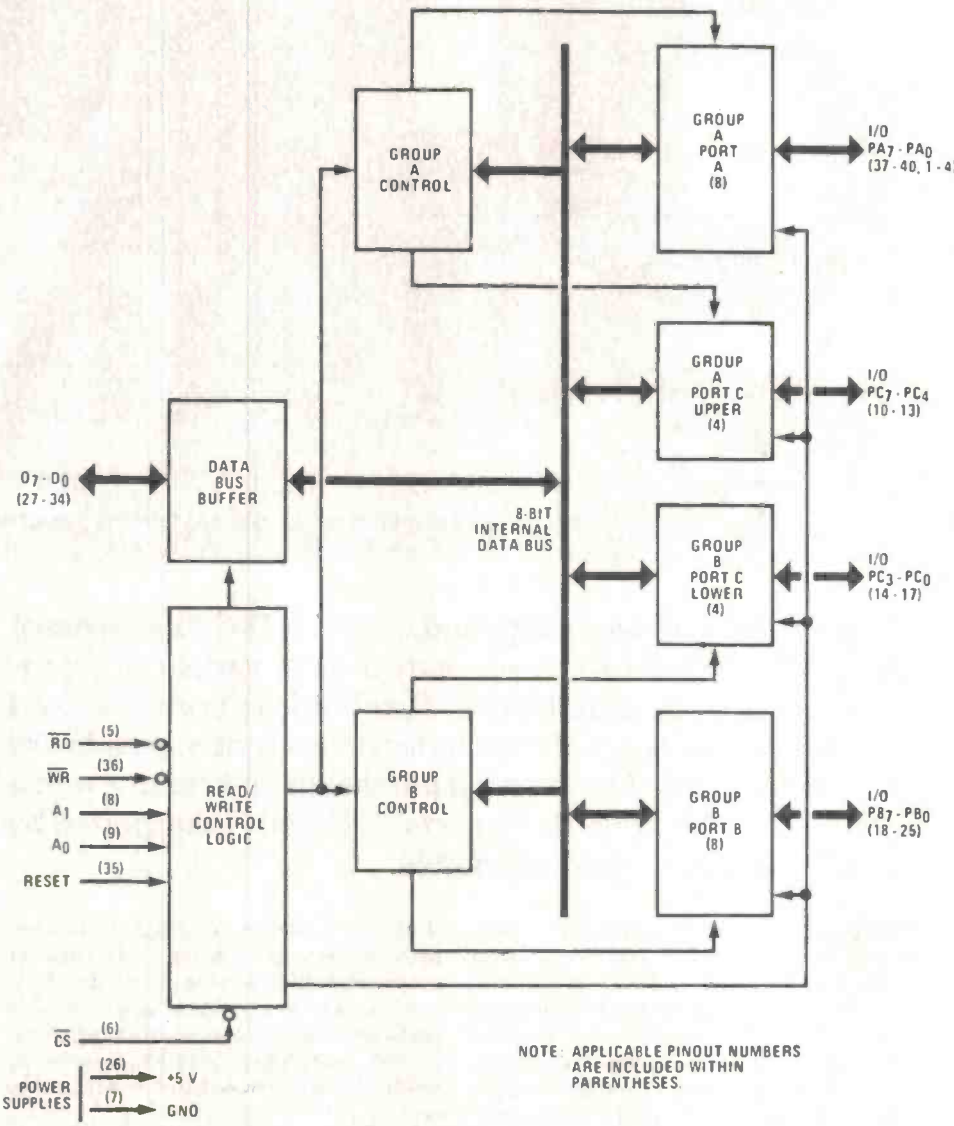


Figure 2. 8255 PPI Block Diagram.

Port Bits	Mode 0		Mode 1		Mode 2
	IN	OUT	IN	OUT	Group A Only
PA_0	IN	OUT	IN	OUT	Bidirectional
PA_1	IN	OUT	IN	OUT	
PA_2	IN	OUT	IN	OUT	
PA_3	IN	OUT	IN	OUT	
PA_4	IN	OUT	IN	OUT	
PA_5	IN	OUT	IN	OUT	
PA_6	IN	OUT	IN	OUT	
PA_7	IN	OUT	IN	OUT	Bidirectional
PB_0	IN	OUT	IN	OUT	
PB_1	IN	OUT	IN	OUT	
PB_2	IN	OUT	IN	OUT	
PB_3	IN	OUT	IN	OUT	(Mode 0 or Mode 1 only)
PB_4	IN	OUT	IN	OUT	
PB_5	IN	OUT	IN	OUT	
PB_6	IN	OUT	IN	OUT	
PB_7	IN	OUT	IN	OUT	
PC_0	IN	OUT	$INTR_B$	$INTR_B$	I/O
PC_1	IN	OUT	IBF_B	$\overline{OBF}_B$	I/O
PC_2	IN	OUT	$\overline{STB}_B$	$\overline{ACK}_B$	I/O
PC_3	IN	OUT	$INTR_A$	$INTR_A$	$INTR_A$
PC_4	IN	OUT	$\overline{STB}_A$	I/O	$\overline{STB}_A$
PC_5	IN	OUT	IBF_A	I/O	IBF_A
PC_6	IN	OUT	I/O	$\overline{ACK}_A$	$\overline{ACK}_A$
PC_7	IN	OUT	I/O	$\overline{OBF}_A$	$\overline{OBF}_A$

Figure 3. **Mode Definition Summary Table.**

Control word		Port C bit affected
Reset	Set	
00	01	0
02	03	1
04	05	2
06	07	3
08	09	4
0A	0B	5
0C	0D	6
0E	0F	7

Mode definition control word format.

pins of Port A form a bidirectional I/O buss and five pins from Port C are used for handshaking. The remaining three Port C pins can be used with bit-set/reset commands, and Port B can be configured as either Mode 0 or Mode 1.

The mode definition control word is generated from the chart at the bottom of this page.

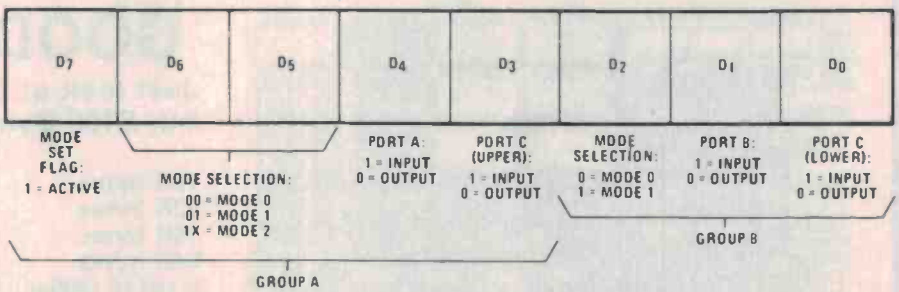


Figure 4. **Bit Set/Reset Control Word Table.**

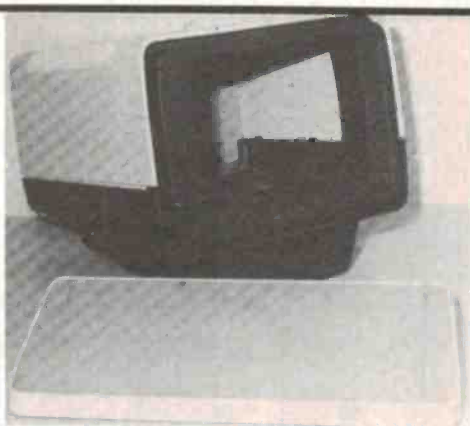
Interrupt control facilities

When the PPI is programmed to operate in Mode 1 or Mode 2, control signals are generated that can be used as interrupt request inputs to the CPU. These interrupt request signals are provided at the Port C PC0 and PC3 pins and can be enabled or inhibited by resetting or setting the appropriate INTE flip-flops with bit-set/reset commands. These 'mask' flip-flops are automatically reset when a new control word is loaded into the PPI, and following a device reset. Alternatively, the condition of these signals can be determined by software (polled mode) by reading Port C and testing the appropriate bits.

On the ETI-685 the two Port C interrupt request bits (PC0 and PC3) appear at the wire link field W4 as 'A' and 'B' respectively. These signals can be wired to any of the eight vectored interrupt lines V10 to V17 of the vectored interrupt controller, IC7. Full interrupt status between the PPI and the CPU can be established by the appropriate initialisation and programming of the programmable interrupt controller (IC7).

Single bit set/reset

Any of the eight bits of Port C can be set or reset independently using the bit set/reset feature. The table above provides a list of the ASCII words to be written into the control register to set or reset the appropriate Port C bit. When Port C is being used to provide status and control signals for Port A and Port B during Mode 1 or Mode 2 operation, the bit set/reset feature can be used to provide software control of these hardware interface signals. ●



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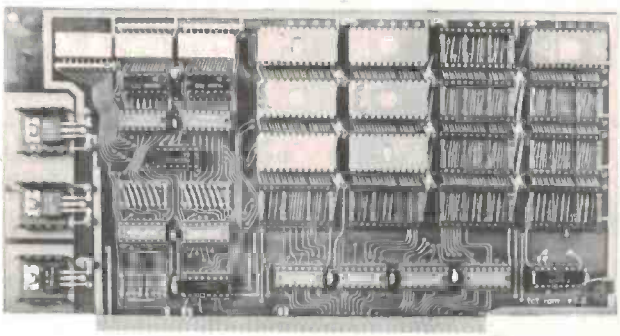

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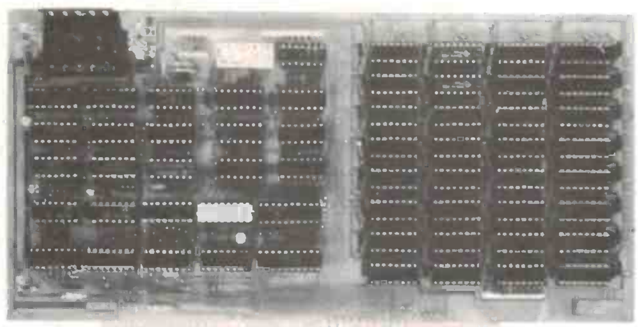

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** USE KEYS 0-9 TO ENTER YOUR GUESS **

MASTERMIND

```
0600  6E 00  VE=00
0602  A7 F0  I=07F0
0604  26 A0  DO 06A0
0606  26 A0  DO 06A0
0608  26 A0  DO 06A0
060A  65 00  V5=00
060C  60 00  V0=00
060E  61 00  V1=00
0610  62 00  V2=00
0612  F2 55  MI=V0:V2
0614  26 AE  DO 06AE
0616  65 34  V5=34
0618  26 D0  DO 06D0
061A  A7 F6  I=07F6
061C  26 E2  DO 06E2
061E  26 E2  DO 06E2
0620  26 E2  DO 06E2
0622  65 00  V5=00
0624  26 AE  DO 06AE
0626  A7 F6  I=07F6
0628  F2 65  V0:V2=MI
062A  A7 F3  I=07F3
062C  F2 55  MI=V0:V2
062E  65 00  V5=00
0630  26 AE  DO 06AE
0632  64 02  V4=02
0634  6D 00  VD=00
0636  A7 F3  I=07F3
0638  26 F4  DO 06F4
063A  A7 F3  I=07F3
063C  F2 55  MI=V0:V2
063E  85 00  V5=V0
0640  A7 F0  I=07F0
0642  26 F4  DO 06F4
0644  A7 F0  I=07F0
0646  F2 55  MI=V0:V2
0648  95 00  SKF V5≠V0
064A  17 00  GO TO 0700
064C  95 10  SKF V5≠V1
064E  16 52  GO TO 0652
0650  95 20  SKF V5≠V2
0652  7D 01  VD+01
0654  44 00  SKF V4≠00
0656  16 5C  GO TO 065C
0658  74 FF  V4+FF
065A  16 36  GO TO 0636
065C  65 08  V5=08
065E  26 D0  DO 06D0
0660  65 34  V5=34
0662  26 D0  DO 06D0
0664  7E 01  VE+01
0666  65 34  V5=34
0668  26 D0  DO 06D0
066A  4D 06  SKF VD≠06
066C  16 88  GO TO 0688
066E  4E 63  SKF VE≠63
0670  16 82  GO TO 0682
0672  61 C0  V1=C0
0674  F1 15  TIME=V1
0676  F1 07  V1=TIME
0678  31 00  SKF V1=00
067A  16 76  GO TO 0676
067C  65 08  V5=08
067E  26 D0  DO 06D0
0680  16 1A  GO TO 061A
0682  A7 F0  I=07F0
0684  65 2C  V5=2C
0686  26 AE  DO 06AE
0688  61 08  V1=08
068A  60 02  V0=02
068C  F0 18  TONE=V0
068E  6F 10  VF=10
0690  71 FF  V1+FF
0692  FF 15  TIME=VF
0694  FF 07  VF=TIME
0696  3F 00  SKF VF=00
0698  16 94  GO TO 0694
069A  31 00  SKF V1=00
069C  16 8A  GO TO 068A
069E  16 9E  GO TO 069E
06A0  64 09  V4=09
06A2  C0 0F  V0=RND
06A4  84 05  V4=V4-V0
06A6  4F 00  SKF VF≠00
06A8  16 A0  GO TO 06A0
06AA  F0 55  MI=V0:V0
06AC  00 EE  RET
06AE  66 00  V6=00
06B0  35 00  SKF V5=00
06B2  16 C6  GO TO 06C6
06B4  A7 F3  I=07F3
06B6  F2 65  V0:V2=MI
06B8  F0 29  I=DSP,V0
06BA  26 CA  DO 06CA
06BC  F1 29  I=DSP,V1
06BE  26 CA  DO 06CA
06C0  F2 29  I=DSP,V2
06C2  26 CA  DO 06CA
06C4  00 EE  RET
06C6  A7 F0  I=07F0
06C8  16 B6  GO TO 06B6
06CA  D5 65  SHOW 5MI@V5V6
06CC  75 08  V5+08
06CE  00 EE  RET
06D0  66 18  V6=18
06D2  35 08  SKF V5=08
06D4  16 DA  GO TO 06DA
06D6  FD 29  I=DSP,VD
06D8  16 CA  GO TO 06CA
06DA  A7 F6  I=07F6
06DC  FE 33  MI=VE(3DD)
06DE  F2 65  V0:V2=MI
06E0  16 BC  GO TO 06BC
06E2  F0 0A  V0=KEY
06E4  40 0F  SKF V0≠0F
06E6  16 82  GO TO 0682
06E8  61 09  V1=09
06EA  81 05  V1=V1-V0
06EC  4F 00  SKF VF≠00
06EE  16 E2  GO TO 06E2
06F0  F0 55  MI=V0:V0
06F2  00 EE  RET
06F4  F2 65  V0:V2=MI
06F6  83 00  V3=V0
06F8  80 10  V0=V1
06FA  81 20  V1=V2
06FC  82 30  V2=V3
06FE  00 EE  RET
0700  7D 02  VD+02
0702  16 54  GO TO 0654
```

This computer will do anything!

— Limited only by your imagination

Graham Wideman on the experience of buying (or selling) computers.

"WHAT IS a computer . . . really?" asks the potential computer customer of a salesman. This seems to be one of those questions of such innocent simplicity that it rivals "What is life?" in degree of difficulty to answer. A computer is not adequately described by saying merely that it is something which computes. The browsing consumer usually must be initially contented with the explanation that a computer is something that you can "program" to do "whatever" you want it to do, usually with the added qualification that this is limited only by your imagination. The computer can balance your cheque book, store recipes, do word processing, more sophisticated accounting such as general ledger, receivables and payables, payroll, it can control your home appliances, send and receive information over the telephone and perform a host of other exciting, work-saving or entertaining functions. All because you can program it.

And so the customer, caught up in the excitement, leaves the store with a computer he or she can program. And program and program and program. For it takes a huge amount of programming to actually *get* anywhere. Friends and relatives start to forget what you look like. Spouses and lovers take up other interests. And you realise you got what you paid for: something you can program.

So what is a computer?

It's time to come to terms with what a computer really is, or at least why it can be a great tool. When is a computer great? When it's doing a lot of work that someone else would otherwise have to do. The virtue of a computer lies not in the fact that you or I can program it, but in the fact that, thanks to programmability (yours, mine or preferably someone else's), a computer can act like any of a number of very useful specific-purpose machines. My computer at the moment is acting as a word processor machine, allowing me to be relaxed as I write while it does the work. At other times it acts as a pay-cheque figuring-out machine, or a cheque book balancing machine.

This being the case, it is important to look at or present a computer (whether you are in the buyer's or seller's shoes) from the perspective of being a collection of useful machines. There are of course those people who buy computers for the fun of buying a sophisticated electronic gadget that is great fun to tinker with. This was particularly so in the beginning years of the personal computer. But a comparison can be drawn between this situation and that of the automobile and its first appearance. The first automobile owners were the real enthusiasts, who bought a car for the thrills of driving, and of being master of an often temperamental machine. And the horseless carriage owner of the very early days was likely to contribute as much to the construction and health of his vehicle as the manufacturer. These are our present-day computer 'hardware' enthusiasts, and I suspect the 'software' enthusiasts also fall into the same category. The people to whom the computer will ultimately prove itself to be most useful are the same kind of people who now take the car for granted.

What about software?

After buying a new car you wouldn't expect to hear the salesman say as you leave the showroom, "Oh yes, and we can also supply wheels and an engine, should you happen to be needing them . . .". Yet we do hear the computer salesman say that software is also available at his store, software which I consider *essential* to doing anything truly useful with the computer. Retailers and manufacturers must (I hope) be realising this; it is software — i.e: the programs — that makes a computer truly the tool that benefits a business.

For example, anyone who must normally do a lot of composition and typing instantly sees the benefits of a word processor, or a computer acting like a word processor. And I have frequently heard tales from computer store personnel about how programs such as VisiCalc (from Personal Software) have so impressed a businessman that he's immediately ordered a computer. What's astounding about these stories is not that the program sold the computer, but that the salesman, the computer store and the manufacturer seem *surprised* that this should happen. In fact the customer was not buying a program and a computer to run it on, he was buying a particular visual calculating machine, one of many machines any computer can imitate.

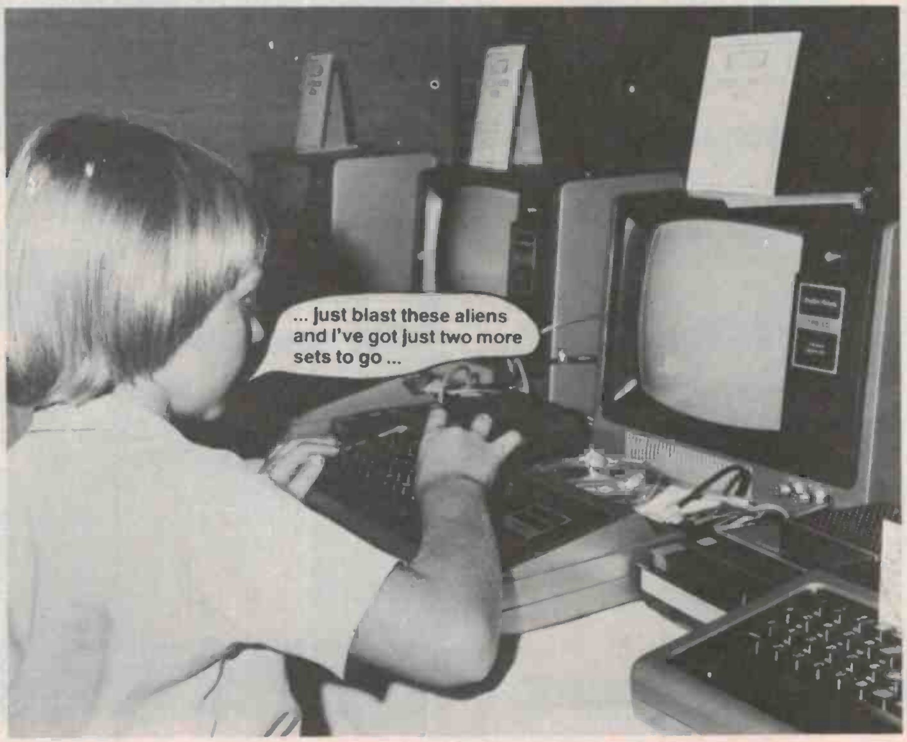
Unfortunately software is presently 'expensive', which is to say that the average computer owner today perceives it to be expensive. Is it? Is $200 to $500 a large amount to pay for a disk which will turn your not-terribly-useful $2000 system into a word processor, for example? It certainly is if you consider that it would only cost you $3 for a disk if you could copy the program from someone; this has become a rampant crime. But the price is not so unreasonable compared to attempting to produce the same program yourself. The health of the better software houses attests to the fact that many computer owners are realising this, but it is often not something that the new computer buyer is exposed to or aware of.

The future

It is pretty obvious that the personal computer is catching on. As it does we will see efforts at software standardisation, which allows the same program to run on different computers, such as we already see with the CP/M disk operating system. This standardisation gives a software author a wider market for his product and more competition, which should lead to reduced software prices. Higher volume sales of computers themselves will contribute to lower prices and yet higher volume all around. This is the trend which most would predict, but to me this process looks like it might take some time. There is an alternative possibility which we might see, and which could heat up the action more effectively.

It's no big secret that giant Tandy-Radio Shack were very surprised at the popularity of their home computer line. We then should not be surprised if the computer manufacturers are still finding their way in determining what computer package it is that the public will just gobble up. As I have mentioned, my hypothesis is that the average consumer is just not interested in a box that he can program, no matter how expandable, how many K of RAM you can stick in it, or how much imagination he is limited by; in other words, very few people are interested in the machine itself. But Mr. and Mrs. A. Consumer are dead interested in many of the machines that the computer can pretend to be. Why then should we not expect the manufacturers to get into the software act and make sure their computers are demonstrated and sold with a comprehensive gallery of software, or should I say demonstrated as and sold as a package of useful machines?

Manufacturers are starting to recognise that a minimum useful hardware configuration includes disk drives, as demonstrated by the Apple III and TRS-80 Model III. My expectation is ▶



that it won't be long before that minimum configuration includes software as well — personal word processing software, personal accounting software, perhaps personal telephone communication software, personal 'information management' software (storage and retrieval of information like recipes), personal mathematics software (like VisiCalc), and so on. It would sure make a computer easier to sell, and a lot more attractive to buy.

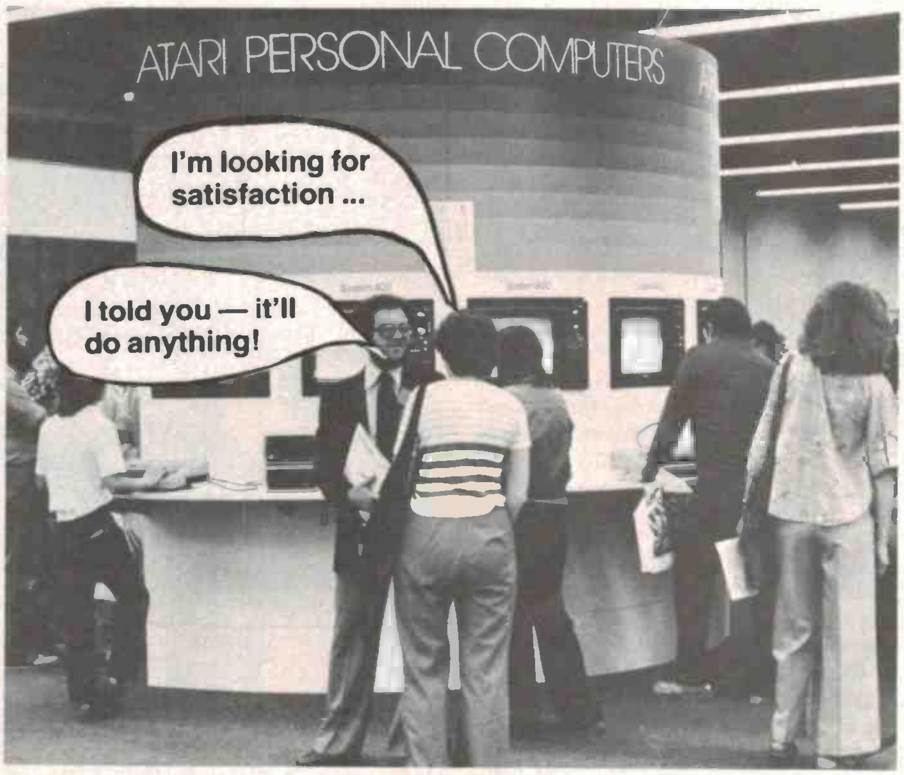
Advice for now

This marketing transformation is not going to happen overnight. If you are interested in getting a computer now, then consider what you really want to get out of the system. Don't be fooled into thinking you are going to do all the programming. Many people buy computers expecting to learn about them as they go along, adding a piece at a time. Unfortunately, although very interesting, this means that your computer spends many months not able to do very much useful. This is hardly any way to convince yourself to plunge in and go for the disk drives and printer that'll really make your computer a tool worth using. And worse still, a computer that doesn't really do very much, and consumes a large amount of your time, is even less well accepted by those associates or other members of the family who might have some say in further expenditures.

When comparing features and prices of different computers don't just go for the cheapest starter outfit. Pay attention to the overall cost of a system expanded to the point at which it is going to be most useful, which inevitably includes software. If you have a particular application in mind, go to a computer store and get a demonstration of a computer pretending to be that machine. All are far from equal for different tasks.

And if you are in the business of selling computers, be aware that there are a lot of people who have heard that computers can be useful, but don't want to know about the computer itself. If you can immediately demonstrate the computer as the machine of the customer's needs — word processor, financial forecasting tool, or what-have-you — and have the customer sitting at the console actually using that dreamed-about tool within minutes, you've probably made the sale. There's nothing more off-putting for a customer than walking into a store and having a salesman try unsuccessfully to demonstrate a program.

By the way, this word processing machine was worth every penny it cost. And to think I got a computer thrown in for free! ●



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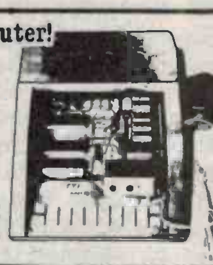

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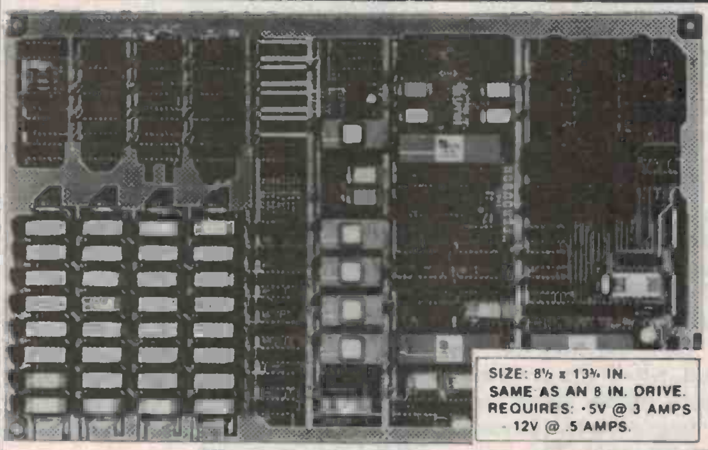

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Get there faster — with speedy BASIC

Grow your fingernails again — stop waiting for that program to run — avoid the rigours of machine code. Here are some useful hints on how to make things go faster, BASICally, that is!

Malcolm Banthorpe

THE FLEXIBILITY of BASIC as a programming language allows the programmer considerable freedom in choosing the exact manner in which a particular task will be tackled. There will often be a number of different approaches available for the writing of even a simple routine, all of which achieve the same end result but via different sequences of instructions. The readability of the program, the amount of memory used, the accuracy of the result, the ease of use of the program, its ability to deal with 'rogue' data and its speed of execution will all vary according to which approach has been adopted.

Programmer's criteria

Generally the most important criteria of good programming are ease of use, accuracy of result, ability to deal with rogue data and user errors, and readability. By readability we mean the degree to which the program listing can be understood by someone other than its author. This factor is important even in home computing where a program listing may be intended only for the eyes of its writer. Most programmers will have experienced the frustration of trying to decode one of their own programs several months or even weeks after it was written.

In graphics programs where animation is involved, such as in games and simulations, the situation is rather different, and in order to achieve an effective display it is often necessary to program for speed at the expense of other considerations, readability in particular. Games such as 'Breakout', 'Space Invaders', Pinball, etc, which rely heavily on animated graphics, are ideally programmed at least partially in machine code to give the necessary speed. Many home programmers are happier working with BASIC and good results can often be achieved if care is taken in writing those parts of the program where speed is most critical. Real time control is another area where the execution time of a routine can be of paramount importance.

Time-saving techniques

This article describes a number of techniques which may be applied to BASIC programs to minimise processing time. Their use is by no means restricted to games and control applications, but it should be borne in mind that the speed is often won at the expense of readability.

A graphics animation routine typically employs one or more loops to achieve the illusion of movement of a graphic character on the VDU screen. The symbol is repeatedly written on to the screen, erased and rewritten into an adjacent location. If this can be done quickly enough there is a reasonably good illusion of movement. If the program loop is too slow the sequence of events will be seen for what it really is, namely a symbol constantly appearing and then disappearing to reappear slightly shifted, and the illusion is lost. It is the way in which the program instructions within these loops are written that will determine the success or failure of the animation. The loops will contain the rules which apply to the movement and will also test for collisions, etc, and modify the movement accordingly. In all the following programming examples, FOR . . . NEXT loops are used to compare the execution times of pairs of routines which achieve the same results by different means.

Number one

The first technique is a fairly obvious one which is often neglected by beginners. This is not purely a speed-up technique but should be applied to all programming. The rule is simply to avoid placing in a loop any instruction which only needs to be carried out once. Consider the following routine:

```
a) 10 FOR Y = 1 TO 32
   20 FOR X = 1 TO 64
   30 Q = SQR (X↑2 + Y↑2)
   40 NEXT X
   50 NEXT Y
  (execution time 298 S)
```

In this rather slow routine (the SQR and ↑ functions tend to slow down any routine, as will be shown later), Y↑2 is evaluated 2048 times in line 30 when it only need be evaluated 32 times if placed outside the inner loop, since the value of Y only changes 32 times during the execution of the routine.

```
b) 10 FOR Y = 1 TO 32
   15 Y2 = Y↑2
   20 FOR X = 1 TO 64
   30 Q = SQR (Y2 + X↑ 2)
   40 NEXT X
   50 NEXT Y
  (execution time 202 S)
```

The addition of line 15 and the modification to line 30 has reduced the execution time by nearly one third. The value of X↑2 must still be calculated 2048 times because the value of X changes 64 times for each of the 32 times that Y changes.

Timed twice

Where a constant is to be used several times, such as in a loop, set a variable to be equal to the constant before the loop, and thereafter use the variable.

```
c) 10 FOR X = 1 TO 30
   20 P = P + 1
   30 NEXT X
  (execution time 12.4 S)

d)  5 A = 1
   10 FOR X = 1 TO 3000
   20 P = P + A
   30 NEXT X
  (execution time 11.3 S)
```

Simply by setting A to be equal to 1 in line 5 and modifying line 20, a significant reduction in the execution time has been made. The BASIC interpreter takes less time to look up the value of A in its variable table than it does to convert one or any other number from the floating point decimal form to the binary form which it uses internally. So in this case the conversion is only required once in line 5 instead of 3000 times as in example (c). The technique can give significant speed gains, especially where several such constants are involved in a loop.

Technique three

In NEXT statements it is generally permissible to omit the index variable. This does tend to degrade program readability somewhat but can be useful where speed is critical.

```
e) 10 FOR X = 1 TO 5000
   20 NEXT X
  (execution time 6.6 S)
```

```
f) 10 FOR X
   20 NEXT
  (execution time 5.5 S)
```

The omission of the index variable, X, from line 20 gives a speed gain of nearly 20%. NEXT is faster than NEXT X because in the former case the computer does not check that X was variable specified in the last FOR . . . TO statement. This information is already stored on the stack and even where several FOR . . . NEXT loops are nested, the computer will execute them in the correct sequence without the variable being specified in each NEXT statement. A few dialects of BASIC will not accept this form of statement and will indicate a syntax error. Check that it is compatible with your computer by running example (f).

More on FOR

Addition and subtraction are performed more quickly than multiplication and division and these in turn are performed faster than functions such as ↑, SQR, SIN, LOG, etc. Often alternative functions can be implemented to achieve the same result but with a saving of time.

```
g) 10 B = 2
   20 FOR A = 1 TO 3000
   30 C = A*B
   40 NEXT
  (execution time 12.6 S)
```

```
h) 20 FOR A = 1 TO = 3000
   30 C = A + A
   40 NEXT
  (execution time 9.7 S)
```

Both routines are involved with the doubling of the value of A but (h) is faster because it uses addition instead of multiplication to achieve this end. If B is set to 3 in line 10 of (g) and line 30 of (h) is changed to C = A+A+A, then the run time becomes 12.6 seconds in each case, showing that the extra addition operation cancels the previous advantage and that the technique is only beneficial where doubling is involved.

The fifth amendment

As mentioned previously, BASIC is particularly slow in evaluating powers of numbers when the ↑ function is used. Where the power in question is an integer, it is often advantageous to use multiplication instead.

```
i) 10 FOR X = 1 TO 1000
   20 A = X↑2
   30 NEXT
  (execution time 52.9 S)
```

```
j) 10 FOR X = 1 TO 1000
   20 A = X*X
   30 NEXT
  (execution time 4.5 S)
```

The time difference here is very large and would make an obvious improvement to the speed of an animation. The squaring of numbers is of use in such a program for the calculation of distances using Pythagoras' Theorem (C = SQR(A*A + B*B)). Even higher powers can profitably be calculated by multiplication. If line 20 in the above examples is changed as follows,

```
i) 20 A = X↑5

j) 20 A = X*X*X*X*X
```

then the execution times are 52.0 and 10.7 s respectively, showing that multiplication still has the clear advantage despite the extra arithmetic operations.

The SQR function, which is also slow, is unfortunately not so easy to deal with. There is no straightforward alternative to the SQR function. Where it has to be used and is seriously affecting the success of a program, the one possible solution may be to use a look-up table for the values of the square roots. Those required can be evaluated at the start of the program and stored in an array:

```
k) 10 DIM S (200)
   20 FOR X = 1 TO 200
   30 S (X) = SQR (X)
   40 NEXT
```

This routine, although slow, can be run once and for all at the start of the program. Subsequently, the value of a square root of an integer in the range 1 to 200 can be looked up directly in the array in the time-critical part of the program, e.g:

```
l) 50 FOR X = 1 TO 200
   60 A = S(X)
   70 NEXT
  (execution time 1.0 S)
```

Compare this with the execution time of 10.5 seconds when line 60 is changed to A = SQR(X).

This technique is useful where a limited range of roots is required, but is extravagant in its use of memory because of the array space required. It may be possible to reduce this requirement by the use of an integer array instead of a real array, if available on your computer.

If this technique were to be applied to program example (a) then it could most simply be implemented by using a two-dimensional array. The routine to set up the table of roots would be of the form:

```
m) 1 DIM S (64,32)
   2 FOR X = 1 TO 64
   3 X2 = X*X
   4 FOR Y = 1 TO 32
   5 S(X,Y) = SQR( X2 + Y*Y)
   6 NEXT
   7 NEXT
```

Program (a) can now be rewritten to incorporate all the speed-up techniques mentioned so far which are relevant to it.

```
n) 10 FOR Y = 1 TO 32
   20 FOR X = 1 TO 64
   30 Q = S(X,Y)
   40 NEXT
   50 NEXT
  (execution time 14.1 S)
```

The big improvement in execution time over the previous 202 seconds is mainly due to the use of the array to eliminate the need for the ↑ and SQR functions.

Added extras

There are a number of further techniques which will have a lesser effect on speed but which may however be useful in fine-tuning a program. Variables are stored in a variable table by the BASIC interpreter in the order which they are first encountered in a program. Hence if the first line of a program is: ▶

```
10 A = 5: B = 7
```

then A becomes the first variable in the table and however often its value changes as the program is run it remains at the top of the table. Similarly B will be the second variable in the table. Each time a particular value is specified during a program the interpreter will search through its table, starting at the top until it is found. Some time can therefore be saved by declaring near to the start of a program any variables which are later to be specified frequently. Then each time the variable is encountered the search is minimised.

In very long programs it may be worthwhile to place any subroutines which are to be called frequently near the beginning. This is contrary to normal practice, where subroutines are normally placed after the main body of the program. When the interpreter encounters an instruction such as GOSUB 1000 it will look at every line number from the start of the program until line 1000 is found. Therefore the nearer to the start of a program a subroutine is placed, the less the search time on each occasion that it is called.

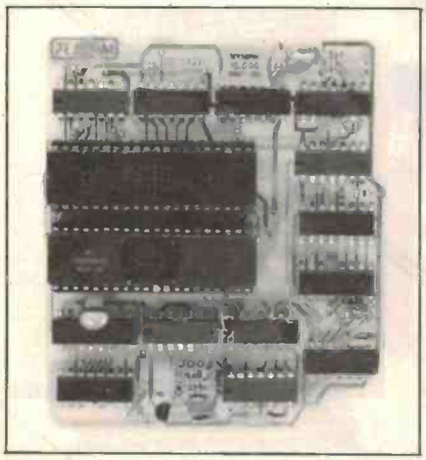
The use of multiple statements instead of one statement per line will have a very minimal effect on run time and is not generally worthwhile for speed considerations alone.

Any of the above techniques can be applied to reduce the running time of critical parts of your programs. Individually some procedures will have very little effect, but used in combination they can improve a program considerably.

SYSTEM 80 AND TRS-80 COMPUTING

The Percom Peripheral

Percom's DOUBLER II™ tolerates wide variations in media, drives



The Revolutionary PERCOM DOUBLER™

GARLAND, TEXAS — Harold Mauch, president of Percom Data Company, announced here today that an improved version of the Company's innovative DOUBLER™ adapter, a double density plug-in module for SYSTEM 80 and TRS-80 computers, is now available.

Reflecting design refinements based on both theoretical analyses and field testing, the DOUBLER II plugs into the drive controller IC socket of a SYSTEM 80 or TRS-80 Expansion Interface and permits a user to run either single or double density diskettes.

With a DOUBLER II installed, over four times more formatted data — as much as 364K bytes — can be stored on one side of a five inch diskette that can be stored using a standard drive system.

The critical clock-data separation circuitry of the DOUBLER II is a proprietary design called a ROM-programmed digital phase-lock data separator.

According to Mauch, this design is more tolerant of differences from diskette to diskette and drive to drive, and also provides immunity to performance degradation caused by circuit component aging.

Mauch said "A DOUBLER II will operate just as reliably two years after installed as it will two days after installation."

The digital phase-lock loop also eliminates the need for trimmer adjustments typical of analog phase-lock loop circuits.

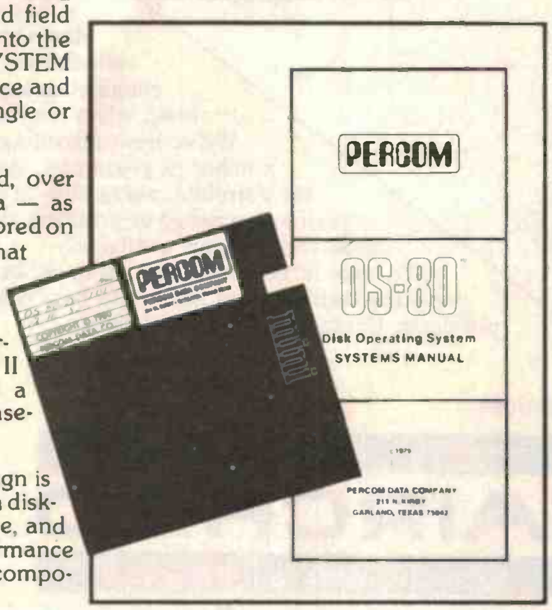
"You plug in a Percom DOUBLER II and then forget it," he said.

The DOUBLER II also features a refined Write Precompensation circuit that more effectively minimises the phenomena of bit and peak-shifting, a reliability-impairing characteristic of magnetic data recording.

The DOUBLER II, which is fully software compatible with the previous DOUBLER, is supplied with DBLDOS™, a TRSDOS compatible disk operating system.

The DOUBLER II (Cat. X-3540) sells for **$229.00,** including the DBLDOS™ diskette and a comprehensive user manual, at all Dick Smith stores.

Note: The System 80 Expansion Unit's external data separator must be disabled when using the Doubler. Technical details are available — ask to see Technical Bulletin No. 44.



OS-80 Disk Operating System now available in Double Density

GARLAND, TEXAS — Percom's OS-80 Disk Operating System, formerly called MicroDos, is now available in a double density form as well as the original single density version. This means that the users of Percom's new Doubler II can now retain all of the features of OS-80, combining these with the higher speed and efficiency of double density operation.

Those who have already been using OS-80 for single density operation will know that its prime features are speed, the small amount of memory required for the DOS itself (less than 7K bytes), and extreme simplicity of operation. The last of these is due to the fact that OS-80 uses Level II BASIC commands for both DOS and Disk BASIC functions, giving the programmer complete and explicit control over all disk operations — whether they involve programs or data. This makes OS-80 very suitable for use by the newcomer to programming, as all disk operations can be achieved using simple BASIC programming.

These advantages have made the original single-density version of OS-80 particularly good value for money at only **$35.00,** and a great many people have purchased them in Australia through the many branches of Dick Smith Electronics (who sell it as Cat. X- 3555).

The new double-density version is known as OS-80D, and sells in Dick Smith Electronics stores at Cat. X-3545 for **$72.50.** It offers all of the features of the original product, converted for double-density operation. As a result, users of the Doubler II recording adapter now have a choice of two different disk operating systems for their double-density operation: the DBLDOS supplied with the Doubler II itself, or OS-80D.

STOP PRESS . . . The Percom "Patch-Pak" is still available, for those who want to convert their TRS-DOS operating system for use with 40-track disk drives. It's available from all Dick Smith stores as Cat. X-3550, and costs only $20.0Q.

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DSE/A121/LM

A review of the Epson MX80 printer

This low-cost machine has upturned the printer market in every country in which it has been introduced. Australia has proved no exception. But why? Let's find out . . .

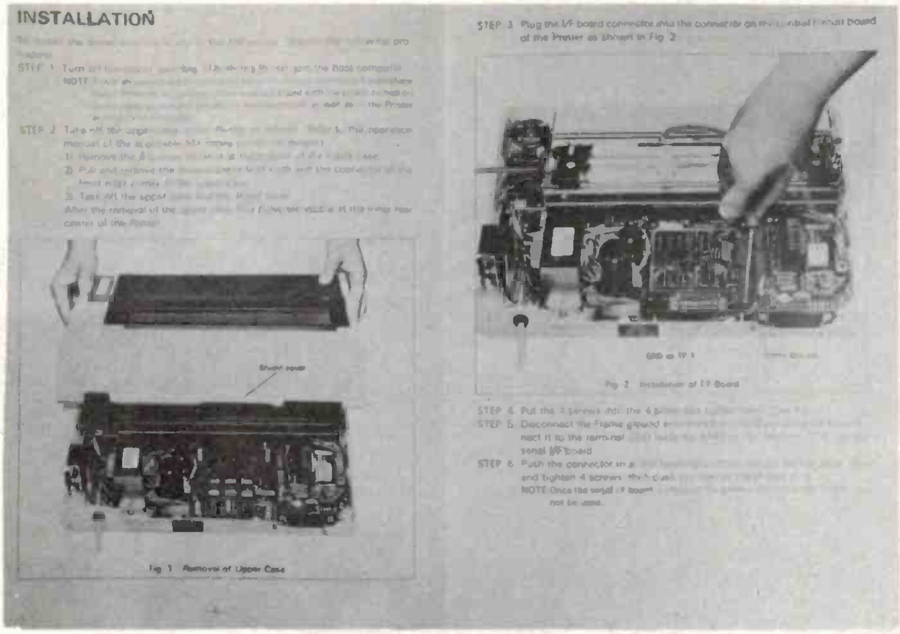
Michael Olsson

MOST personal computer users place a high priority on the purchase of a printer for their system, but for a long time such a purchase has been put out of the question for one reason only — they have been very expensive. In fact the price of a halfway decent printer has been as high as, if not higher than, the price of a good CPU.

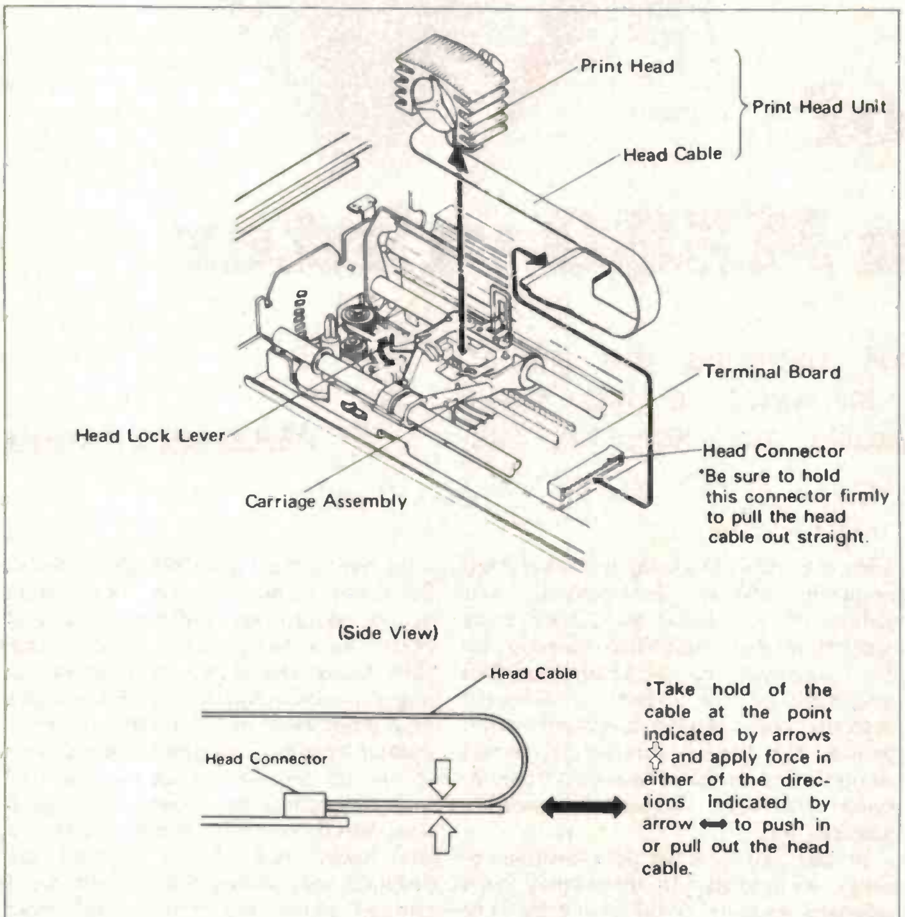
Those people who have been able to purchase a printer will argue that they are indispensable. The ability to produce program listings, correspondence and hard copy records makes their computer much more useful. The process of documenting software and all the vital 'housekeeping' functions become less difficult and tedious if you have good hard copy records of past activities to refer to. The presence of a printer makes available to you a host of software systems which require a system with a printer to run on. Using your personal computer in various business applications suddenly becomes a viable proposition.

In the last year or so a number of fairly inexpensive printers have been released on the Australian market, but many of them have been what can only be described as 'cheap and nasty', with the emphasis definitely on 'nasty'. Of these recent releases one stands out as being more useful and versatile than the others, while at the same time being one of the cheapest on the market — the Epson MX80, marketed and supported in Australia by Warburton Franki. This printer has proved to be so popular in Australia that many personal computer stores report that the demand for other printers in the lower end of the market has dropped very dramatically; in fact one Sydney store has dropped all other low-cost printers altogether.

So why are so many people opting ▶



Documentation with the MX80 is clearly written, well set out and copiously illustrated. The picture above is just an example. The removable print head is one of the great advantages of the MX80, and it's simple to do, as the illustration below, taken from the manual, shows.



Replacement of Print Head

for the MX80 when evaluating printers for their system? The answer seems quite simple: the MX80 offers very good value for money. It has features which have never before been available on a relatively cheap printer, such as dot graphics and some 12 different print types, and comes with either friction or tractor paper feed mechanism on the slightly more expensive models.

The MX80 is a dot matrix impact printer using a 9 x 9 dot matrix. In other words, the MX80 uses a movable print head which consists of a series of small tubes, each of which contains a needle, fired individually by electrical solenoids to produce printed images. In its basic form the MX80 has a standard 96-character ASCII character set as well as 64 graphic patterns, in addition to some French and German characters. In normal usage the MX80 prints at 80 characters per second, but the print speed drops dramatically when you use the other print functions, sometimes well below 40 cps.

It uses a parallel interface as standard but is available with interfaces to suit most personal computers in Australia. The printer reviewed for this article was equipped with an RS-232C interface, the installation of which was quite simple, and it worked first time.

The print

It does not produce the best quality print in the world, nor is it terrifically fast, but it is certainly adequate for the average computer user in both respects. If you use the emphasised print capability the characters are quite solid, not letter quality but near enough. It's a matter of 'horses for courses'.

The MX80 can print four different character sizes: normal, double width, condensed and double width condensed. The type size is selected by standard ASCII control codes, usually a two-digit sequence but in some cases more than two. It recognises 64 programmable vertical tab positions and 112 horizontal tab stops. In the normal print mode the MX80 has, as the name suggests, 80 columns per line, but in the condensed print mode the data capacity of the print buffer is expanded to 132 columns, a feature which enables you to run software packages designed for use with larger printers with only minor or no modifications.

Also software-selectable are the three different types of print emphasis:

Font Tests

There are twelve (count them!) different styles of printing available with the MX-80. Here they all are:

This is the Standard Font.

This is Double-Width Standard Font.

This is Emphasized Standard Font.

This is Emphasized D/W Standard Font.

This is Double-Strike Standard Font.

This is D/S D/W Standard Font.

This is Double-Strike Emphasized Standard Font.

This is D/S Emphasized D/W Font.

GRAPHICS

The MX-80 can print 2 by 3 dot graphics characters. The MX: Driver maps printing ASCII characters into the graphics characters when the mode is enabled with ESCAPE T. The graphics mode is disabled with ESCAPE U or when a channel is opened to the Driver. The mapping is as follows:

! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ?

@ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\ ] ^ _

PRINT SAMPLE — from the test sheet supplied by Warburton Frankl.

normal or single strike, emphasised print and double strike with a displacement of 1/216 inch between the two strikes (0.12 mm). These three modes of print emphasis can be used in conjunction with the four different character sizes, which makes for very versatile printing.

Graphics

If you need a printer for scientific work or wish to present your business reports in graphic form, the dot graphics capability may come in useful. At the time of testing I had no graphics software available to me, nor was the test printer provided with the dot graphics capability, so I could not put the MX80 through its graphics paces, but I was unable to find any reason why the MX80 should not perform to specification in that regard. You do, however, sacrifice some of the other print functions if you choose the dot graphics capability, as there is not enough ROM for all the print functions and the dot graphics.

Self-test

Another useful feature is the preprogrammed self-test mode, which allows you to test the general operation of the print head operation and the print quality and other print mechanisms simply by turning the power on while depressing the linefeed switch. This will enable you to diagnose any problem with a minimum of fuss and determine if any problem you are having is in the printer itself or in the interfacing, or is due to a software malfunction. You can thus avoid embarrassing, costly and time-consuming calls to your local dealer for something which is not a printer problem.

Documentation

Unlike many Japanese products the MX80 does not come with a set of difficult to understand 'Japanese English' manuals. It has clear and precise instructions on all aspects of installation, interfacing, operation and care of the printer, something which is absolutely essential to inexperienced or nontechnical computer users.

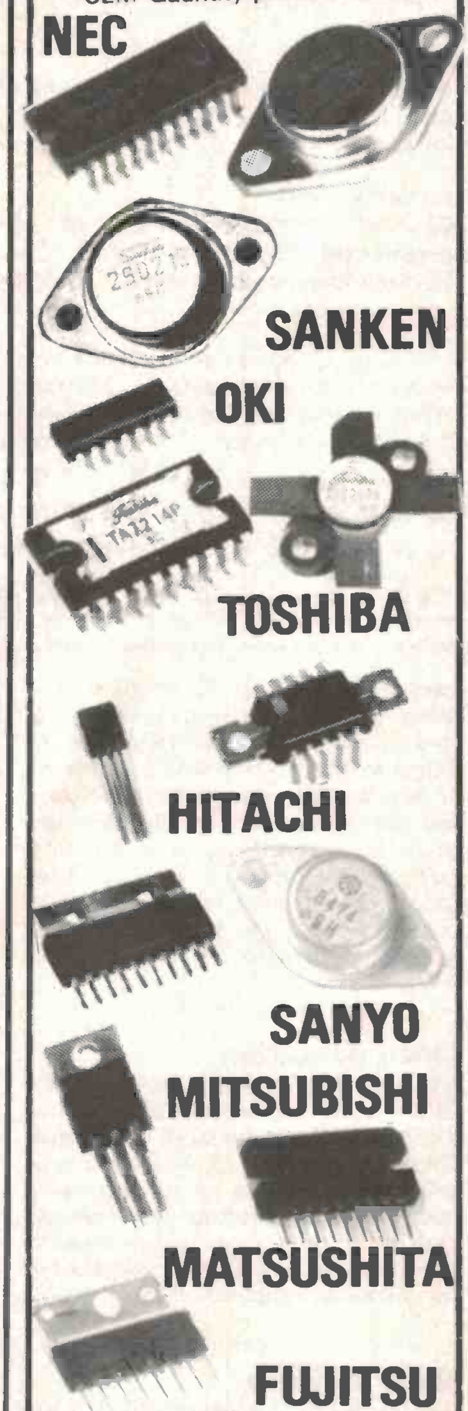
Wear and tear

An interesting aspect of the MX80's design is the approach taken to the problem of wear and tear of the print head. Of all the mechanical parts of any printer the print head is the one subjected to most punishment and thus the most likely to wear out. The manual does not specify an expected life span for the print head but it is likely to be many millions of characters. Rather than providing an expensive and more durable print head the designers have chosen to use a fairly cheap one (around $50 or so) which you simply replace when (indeed, if) the need arises. This is not to say that the print head used is in any way of inferior quality; it is a reliable print head in the experience of MX80 users, both here and overseas, and the design approach is a practical way around a problem which on many other printers can be very costly.

The crunch

An MX80 will set you back around $1000 for the cheapest models or about $1100 for the more expensive models with tractor and friction feed and dot graphics capabilities. An RS-232C interface board or an interface board to suit anything other than a parallel interface costs around $90, so you are not faced with a huge outlay if you decide to purchase one of them (they cost under $500 in the US).

The MX80 is a neat little printer which will do a pretty good job if you do not expect too much of it (don't hold your breath while it does a formfeed), and one which manages to suit most of the small computer user's needs. It is definitely a product which deserves a good look before you buy a printer for your personal computer. ●



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SIGHT & SOUND

PCM — hold on, it's coming!

The PCM compact disc is set for a big launch late this year. PCM disc players were on show in all shapes and sizes at the Tokyo All Japan Hi-Fi Show last October. You name it and it was there: square ones, flat ones, round ones, and upright ones.

While all the companies had PCM (pulse code modulation) disc players, several have even developed PCM cassette decks (many using the compact cassette format).

The disc players come in a variety of styles. Some stood upright and you posted the disc in from the top, others had front-loading systems similar to a cassette deck. Denon had a flat model where the disc posted in from the front, which gave one an idea of what a car PCM player will look like.

Sanyo showed a matching upright twinset combination. The disc player had a slot in the top and through this you posted the disc much as you put a slice of bread in a toaster. The disc is visible through a glass panel.

There are two main thrusts for the PCM cassette. Sharp took most of the limelight with its compact digital cassette player, but they weren't alone with the concept. Alpine showed a PCM compact cassette for recording digital sound, but didn't promote it as well as Sharp.

Technics re-launched their SV-P100 audio digital cassette recorder that uses a VHS tape. They showed it last year and promised a production run by April. This time, the production run was guaranteed to be by the end of 1981. The SV-P100 is expected to be aimed at the semi-professional market, like radio stations. The SV-P100 is huge and doesn't really lend itself to the home market where everything else is getting smaller and smaller.

But Sony might have the answer for that. It showed a 'mini' PCM decoder that matches its portable F-1 video recorder and which will convert that or any other video recorder into a PCM audio recorder. It will cost around $1000.

The idea is that the audio buff who is also a videophile will be able to buy this as an add-on to his hi-fi/video system and use some of his Beta tapes for recording audio off his PCM records.

There appears little doubt that the compact digital disc will hit the market this year. All the Japanese manufacturers I spoke to were super-confident of the launch; in fact one wonders why they are all hanging back for 'CD Day'. My guess is that Philips has everyone on a tight rein for an international launch.

One of the interesting aspects of the digital disc is the opportunity it has for displaying text on a digital alphanumeric display, and doing search exercises. Sanyo's unit showed the title of the music and/or song, and the name of the artist or group. This was displayed on the front panel automatically.

One of the chief technicians in Philips' Eindhoven headquarters earlier last year said that in fact there is enough room to store up to 50 words every half a second. So if they want to put a full-scale display screen onto the system the record manufacturers could encode the complete libretto from an opera or lyrics from a pop song so the audience could read it on the screen while they listened to the music.

The record producers could also encode signals onto the disc so that should you want to have all slow numbers the record player would seek these out, automatically skipping the fast dancing numbers. And likewise, the player, on request, could seek out the fast dance records, ignoring the romantic numbers to keep a party swinging.

But even with all this technology the vinyl disc won't pass away overnight. When Mr. Thorens was in Australia recently he said that the new digital records and conventional records will live side by side for another ten or fifteen years. He pointed out that there are vast musical works on the old vinyl system, and in comparison, only a limited number of works recorded ready for the digital release.

Philips estimates that there will be around 150 titles available on the one-hour, one-sided compact digital discs on release day, so it would appear that the new digital age will have a slow start and then gain momentum.

And if you think this new technology is going to be aimed at the audiophile, think again. After the initial release, the industry anticipates that the move will be to cheaper, mass-production players using 10-bit processing instead of the 16-bit standard settled on by the industry.

The discs will all have 16-bit information but the cheaper machines will only have 10-bit processing capability, which will mean increased quantisation noise, poorer signal-to-noise ratio than the more expensive players, and far less dynamic range. But even with 10-bit processing these machines are expected to rival the best we have in vinyl discs now.

The Japanese industry can't wait to get started. One gets the feeling the manufacturers are like over-fit horses fighting the bit behind the starter's gate, ready to leap into the new technology race that promises to give them a new lease of life.

Dennis Lingane

Marantz Gold.
Your New Recording Standard.

For over twentyfive years the name Marantz has stood for the ultimate in audio engineering brilliance and fidelity.

In keeping with this standard of technical excellence, the new Marantz Gold range of Cassette Decks with stunning designer element of brushed-gold finish now includes a recorder incorporating the latest in noise reduction processing.

The Marantz SD3030 Cassette Deck features the new Dolby C system to provide recordings with far less tape hiss than those made using standard Dolby B.

Unlike some other noise reduction systems, Dolby C recordings can be played back on a deck equipped with standard Dolby only without audible distortion or pumping effects.

Recording enthusiasts will be delighted by the other models in the new range.

Marantz Gold decks offer a variety of advanced features such as LED peak level meters on the SD1030, fine bias adjustment on the SD2030, and a motorized linear skating loading system on the SD5010.

All feature Dolby B noise reduction, compatibility with metal tapes, soft touch controls and DC Servo motors to ensure constant tape speed and silent operation.

So, set your standards high. And your recording standards higher.

See your local stockist and listen to the future. Listen to Marantz.

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Now you're listening.

Decks shown in stack (from top): SD1030, SD3510, SD2030, SD3030 and SD5010.
All decks shown with TDK Metal tapes.

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Akai's new video tape recorder

Akai's VS-5 VHS video tape recorder has been designed with the user very much in mind; using the tagline 'you can't miss', Akai hopes to preach to the unconverted that video tape recording is both uncomplicated and relatively inexpensive.

With 'you can't miss' in mind, the VS-5 has been designed for super-simple operation, and has a fault detection system which allows correction before recording time is lost.

The VS-5 offers fast channel selection; pause/still frame-by-frame playback which allows close scrutiny of single or consecutive frames — useful for sportspersons analysing their movements, for example; a quick-finder system that runs at about nine times normal playing speed; and complete remote control operation with a handheld infrared controller.

The VS-5's timer covers 14 days and offers nine different programs, subdivided into three different common programming situations. Five programs are reserved for one-time purposes, two for recording a program every day of the week at the same time, and the remaining two to tape a program each week on the same day. A supplementary timer feature is the 'sleep' function, which allows the user to drop off to sleep by automatically powering-down after the preset time!

The VS-5 is designed with a sloping front panel to make for easy reading and operation at normal heights, and features in addition many other quality facilities.

You can find out more about the VS-5 from Akai Electric Co Ltd, P.O. Box 21, Tokyo Airport, Japan. Phone: Tokyo (742)5111; telex: J26261, J28674.

Yamaha cassette deck with dbx

Yamaha's new cassette deck, the K-960, incorporates dbx tape noise reduction circuitry, which can reduce noise on cassette tapes by as much as 30 dB with the push of a button during taping.

The deck also features Sendust record/play heads for better frequency response and reduced dropout and modulation noise, a double gap ferrite erase head and metal tape capability.

The K-960's independent two-motor drive is said to reduce wow and flutter to only 0.028% W RMS, comparable to the drive stability of a quartz-locked turntable. The core/coil design and silver wires used in the K-960 substantially lower head impedance, providing improved square-wave response, better linear-phase response at higher frequencies, superior channel separation and increased dynamic range.

Features include: dbx noise reduction, Yamaha's low-impedance pure plasma process Sendust Rec/Play head, double-gap ferrite erase head, metal tape capability, two-motor separate drive tape transport, IC logic control, fluorescent bar-graph peak meter, continuously adjustable bias control, timer recording switch, subsonic and MPX filters, Dolby noise reduction, low-noise equaliser amp, and a focus switch to extend high-end frequency response or improved phase coherence. All this comes for a suggested retail price of $500.

For more details contact the Public Relations Manager, Yamaha/Rose Music, 17-33 Market St, South Melbourne Vic. 3205. (03)699-2388.

Another VCR from Sanyo!

There's obviously no holding Sanyo on the video scene — they've just released another Betacord video cassette recorder, the VTC 5300P, said to be easy to use, compact and attractively styled.

Its tape will record up to three hours 40 minutes, so that, using the inbuilt programmable recording timer, a 30-minute programme may be recorded every day of the week on the same tape, the whole sequence being preset in advance.

The VTC 5300P also features electronic microprocessor controls for fast, silent mode switching, and functions may be selected without the need first to press 'stop'. The model also has an auto rewind function and 'one touch recording', plus a record lock to safeguard against accidental over-recording.

VTC 5300P is available now, selling at around $899. For further information contact Mr. W. Christie, Sanyo Australia Pty Ltd, 225 Miller St, North Sydney NSW 2060. (02)436-1122.

National video search controller

National's automatic search controller for VHS recorders divides up recorded videotape into segments for automatic search and playback. In this way it can find information very quickly at the touch of a button.

The NV-A850 Automatic Search Controller has been developed with sales and product demonstrations, classroom situations and government departments in mind. It can, for example, recall from different cassettes a series of maps or drawings in sequence for quick reference, exhibit a set of illustrations to coincide with a speaker's comments, or display products or services at random for advertising or demonstrations.

The NV-A850 is distributed in Australia by the Electronics Division of GEC, and more information may be obtained by contacting David Rose on (02)212-5488.

New audio systems from Sanyo ▲

Sanyo recently released five new packaged sound systems. The 'Otto' series systems feature teak timber-look cabinets with brushed silver and black trim, glass panels and high performance components.

Recommended retail prices range from $629 up to $2320 in a choice of features and power output from 20 to 60 watts RMS per channel. All systems comprise a turntable, amplifier, tuner, tape deck, speaker system and matching cabinet.

Sanyo's 'Otto' systems 200, 300 and 400 are available from the end of November; availability of the other systems will be announced.

For further information contact Mr. R. Hopwood, Sanyo Australia Pty Ltd, 225 Miller St, North Sydney NSW 2060. (02)436-1122.

New SA5103 AM/FM receiver

The new SA5103 AM/FM receiver from Sharp Optonica is a high performance unit especially designed for sale at budget prices. Its output end will deliver 28 W per channel (RMS) into 8 ohm loads at a maximum distortion level of 0.8% total harmonic.

This tuner incorporates a five-digit fluorescent frequency readout which provides a bright display for easy and accurate tuning. In addition the receiver includes a signal strength meter incorporating a five-LED display.

This new receiver is expected to be available about the end of 1981.

Brian Dance

German Hi-Fi has new Korting models

German Hi-Fi of North Sydney recently introduced a range of Korting hi-fi models, claimed to be top quality value for money.

Korting's C.220 cassette recorder features built-in High-Com noise reduction system and separate fine bias control for metal tape. It is a two-motor system and offers Dolby replay and limiter, and retails at $596.

The tuner has preprogramming for 16 stations and automatic search on FM, and is claimed to give extremely good separation. The amplifiers are 50 or 60 watts per channel and feature the Korting patent loudspeaker recording system and Duo-Programme, which allows recording to continue unaffected while all other functions of the amp remain in operation.

The components are all housed in well styled, German designed and manufactured modular units, yet are still said to offer an economically priced hi-fi system.

Another new release from German Hi-Fi is a new range of direct drive turntables from Elac. These are claimed to be of unique design and extremely high quality, but remain competitively priced.

Around Christmas German Hi-Fi will be offering specials on Uher hi-fi components, so anyone wanting to own really top quality hi-fi equipment for a reasonable price should take a look at what is available.

You can contact German Hi-Fi International Pty Ltd at 5 McLaren St, North Sydney NSW 2060. (02)92-4177.

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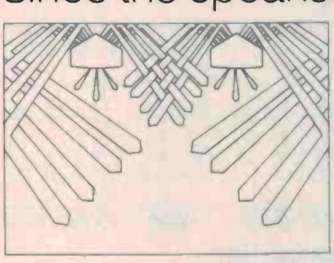

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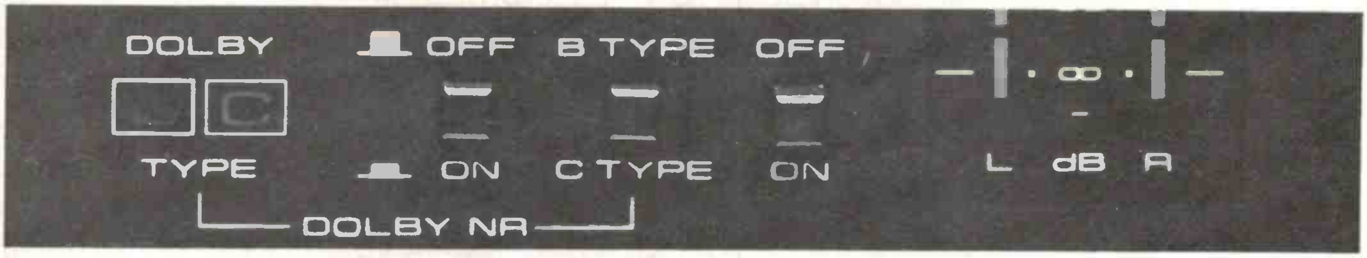


Dolby C — new weapon in the war against tape noise

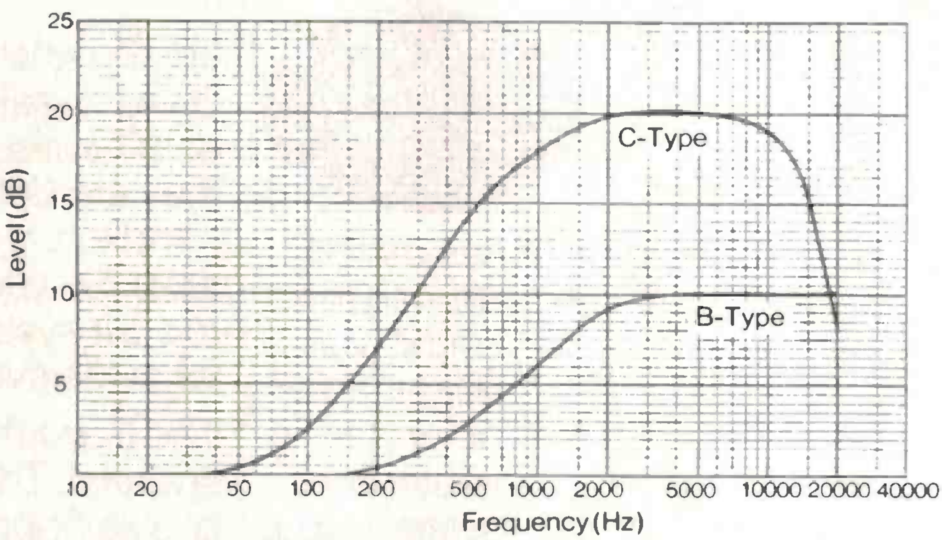
The Dolby B-type noise reduction system was introduced to the consumer in 1968, and the first cassette decks employing it appeared in 1970. The Dolby technique is the most widely used noise reduction system employed in domestic and commercial recording today, the number of products carrying the Dolby 'double-D' logo probably numbering in the hundreds of millions. Recently, Dolby laboratories came up with an improvement based on cascading B-type circuitry. Here's how it works.

William Fisher

THE DOLBY C noise reduction system for domestic tape recorders has been developed from the well-established Dolby B system. Essentially, Dolby C comprises two Dolby B-type stages in cascade, giving an overall 20 dB reduction in noise instead of the 10 dB achieved with a single Dolby stage. The two stages of the Dolby C system have slightly different characteristics from Dolby B, and there are two additional signal processing networks, but a Dolby C system can still be based on two Dolby B integrated circuits, which helps to keep the cost down.

First, Dolby B

Before going into the details of Dolby C, a quick review of the Dolby B circuit will be useful. Like all noise reduction systems, Dolby B is a compander (compressor/expander) system, where compression of the dynamic range before recording keeps the recorded



Dolby low-level encoding frequency response. Note that the maximum amount of compression in the C-type system diminishes above 10 kHz and crosses the B-type curve at 20 kHz. The 'spectral-skewing' circuit reduces the high frequency compression, preventing high frequency tape overload and intermodulation distortion.

levels above the noise floor of the tape and below its saturation ceiling; expansion before playback restores the original dynamic range. Dolby B gives a maximum compression and expansion of 10 dB, with a consequent maximum reduction in noise of 10 dB.

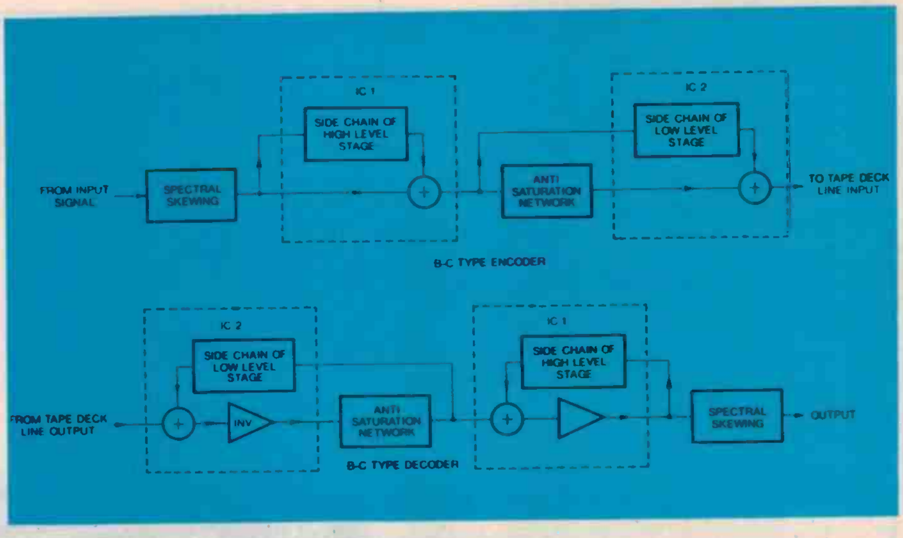
Simple companders, which apply the same amount of compression and expansion to all levels, have a number of unpleasant side-effects, most notably the expansion of tape hiss when the system reproduces loud bass notes. The Dolby B system avoids this problem by varying the amount of compansion (i.e: compression and expansion) according to the signal level. Low-level signals are companded (i.e: compressed and expanded) more than high levels. Also, the frequency range which is companded depends on the signal level. High frequencies are always companded more than low frequencies, and frequencies below about 300 Hz are never companded. As the signal level is increased, the lower cutoff frequency is raised. Dolby call this the 'sliding band' technique. It's overall effect is to minimise the 'noise modulation' effects produced by simple compansion, and to give a subjectively acceptable spectral distribution to whatever noise still remains after compansion.

Two B, or C

The Dolby C system has two signal processing stages which are both similar to the Dolby B-type circuit. The first, or 'high level' stage responds to signals in roughly the same way as a Dolby B circuit, reducing the amount of compansion at relatively high levels. The second stage is called a 'low level' stage, because it only applies full compansion to signals 20 dB or more below the highest levels that are fully companded in the first stage. Roughly, the first stage applies 10 dB of compansion to signals between −15 dB and −35 dB (referred to the standard 0 dB recording level), and the second stage applies an additional 10 dB of compansion to signals between −35 dB and −55 dB. At low signal levels, the system acts only as a fixed gain amplifier with no compansion.

In both stages of the Dolby C system the variation of compansion with frequency is different from that of the Dolby B system. Dolby B begins to take effect in the 300 Hz region and increases its compansion with frequency until a maximum of 10 dB noise reduction is achieved at around 4 kHz. Each stage of the Dolby C system takes effect nearly two octaves lower, around 100 Hz, and gives maximum (10 dB) compansion at and above 2 kHz.

The different frequency/compansion characteristic of Dolby C has two advantages. First, it produces a subjectively even spectral distribution of what little noise remains. Second, *it is better adjusted to cope with half-speed microcassette recorders,* where the spectral distribution of tape noise is shifted down one octave compared to that from compact cassettes.

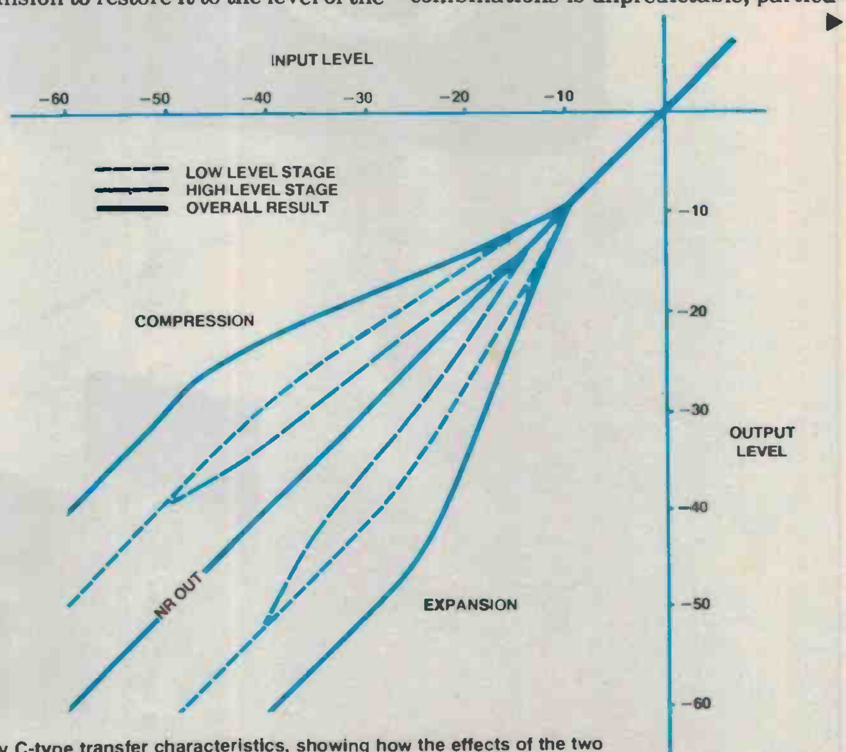


Block diagram of the Dolby B-C type noise reduction system.

Tracking

In any noise reduction system, it is important that the expander tracks the compressor precisely. In other words, the decoder must read the level of the encoded signal and apply just enough expansion to restore it to the level of the original, uncoded signal. Unfortunately, the signal is encoded on magnetic tape, and there's many a slip twixt the head and the tape (. . . so to speak).

The signal that the decoder reads from the tape may not be exactly the same as the signal that the encoder tried to impress on the tape. Inaccurate encoding of signal levels on the tape is really only a problem at certain levels and frequencies. If the level is higher than the saturation level of the tape, then obviously the tape magnetisation won't be an accurate record of the magnetising signal. Above about 10 kHz, the response of many head/tape combinations is unpredictable, particu- ▶



Dolby C-type transfer characteristics, showing how the effects of the two stages combine to produce 20 dB of compansion.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larly if the tape is not exactly suitable for the recorder or the heads are worn or dirty. At low frequencies, also, different recorders produce different variations in the magnetisation level. Any anomalies in magnetisation are exaggerated by expansion, so the Dolby C system restricts its operation to the range of frequencies and levels where the performance of a cassette recorder is accurately predictable.

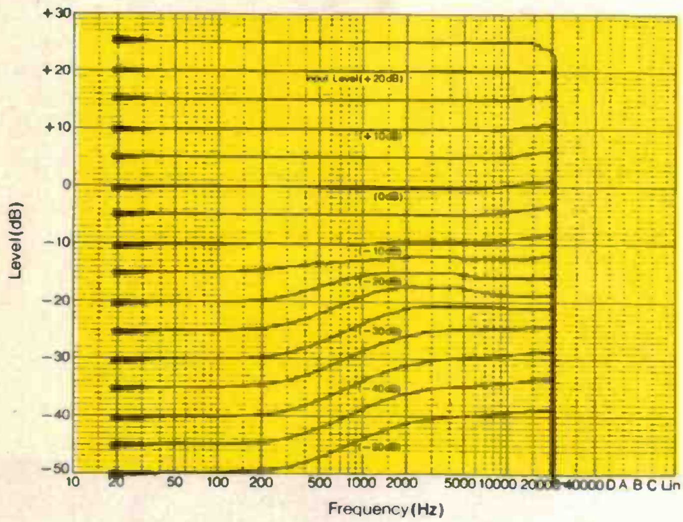
Tracking problems at low frequencies are avoided by sharply curtailing the action of the Dolby C system at frequencies below 100 Hz, where the human ear is in any case relatively insensitive to noise. Dolby C also includes two pairs of networks designed to prevent mistracking at high frequencies and high levels. These are called *spectral skewing* and *anti-saturation* circuits.

Spectral skewing is a high frequency rolloff introduced before the first stage of compression. To avoid errors caused by unpredictable tape response at high frequencies, the spectral skewing network gradually reduces the effectiveness of the noise reduction above 10 kHz, so that the overall noise reduction above 15 kHz is only about 10 dB. A complementary boost of high frequencies is applied after expansion on playback to maintain a flat frequency response. Spectral skewing obviously leaves a disproportionate amount of residual noise above 10 kHz, but this is not noticeable because the amount of noise reduction falls off more slowly with frequency than the natural sensitivity of the human ear. There *is* more noise at high frequencies, but it *sounds* like less.

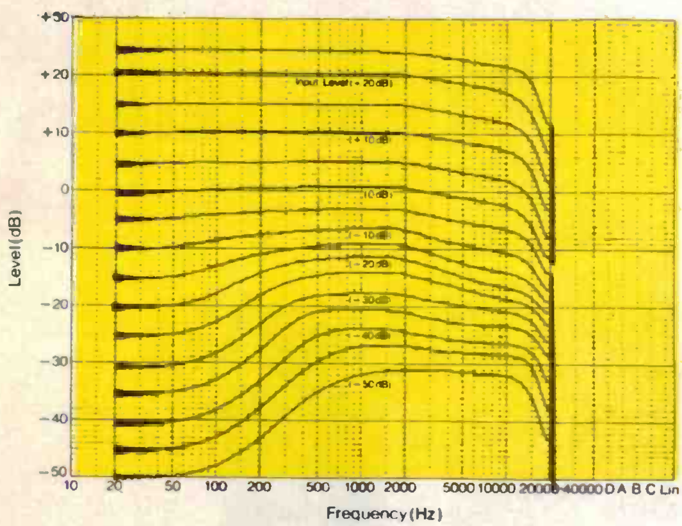
Anti-saturation, as its name implies, helps to keep the tape magnetisation below its saturation level. This is desirable not only to prevent the expander mistracking the compressor, but also to minimise the intermodulation distortion which always accompanies saturation. The anti-saturation network is placed between the two stages of compression. It measures the level of the signal after the first stage of compression and splits high-level signals into two parts, one part going to the second compression stage and the second part being rolled off gently above 1.5 kHz. The two parts are then summed before recording. There is a complementary network in the replay stage to maintain a flat frequency response.

Because the Dolby C system is based on two companion networks which are very similar to the Dolby B networks, it can easily be reconfigured as a Dolby B system for replaying Dolby B-processed recordings, or for making tapes to be replayed on equipment (car cassette players, for instance) that can only decode Dolby B-processed recordings. Conversion from Dolby C to Dolby B operation can be accomplished with a single multipole switch which bypasses the second stage of compression (as well as the spectral skewing and anti-saturation networks) and selects different components for the first compression network to give it the characteristic Dolby B compression bandwidth. It's worth noting here that the Dolby C system is so designed that recordings encoded with it sound *acceptable* (but obviously not perfect) when replayed through Dolby B decoders or even without any decoding at all.

The structural similarities of Dolby B and Dolby C result in some cost savings for manufacturers installing the Dolby C system, since they can make use of ICs already developed for Dolby B (and Dolby do not require any extra royalties from Dolby B licensees who also make Dolby C systems). However, any system that provides an overall noise reduction of 20 dB demands a superior performance from the equipment in which it is installed. Noise levels of all amplifier stages in cassette recorders must now be *some 10 dB lower* than was necessary before, because noise which would once have been masked by tape noise may be exposed by Dolby C. ●



Dolby B-type encode characteristics (level versus frequency).

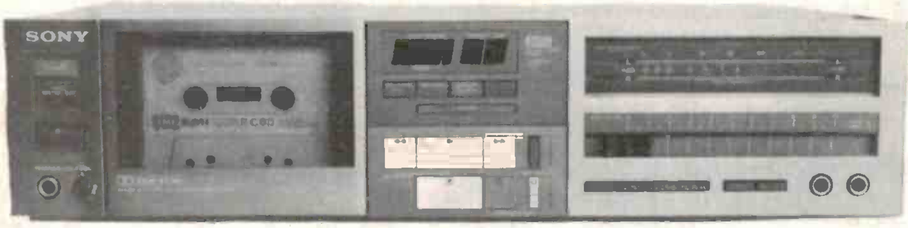


Dolby C-type encode characteristics (level versus frequency).

Sony TC-FX6C cassette deck

The Sony TC-FX6C cassette player is a new design incorporating the recently developed Dolby C noise reduction system, and was found by Louis Challis to hold its place excellently in a very crowded market.

Louis Challis



SONY TC-FX6C CASSETTE DECK

Dimensions:	*430 mm wide, 105 mm high, 275 mm deep*
Weight:	*6.5 kg*
Price:	*$449 rrp.*
Manufactured:	*In Japan by Sony Corporation*
Distributed by:	*Sony (Australia) Pty Ltd.*

THE RELEASE of Dolby C tape recorder systems has created, and will continue to create, as many new models as the release some two years ago of the 'Type 4' or metal-type tape formulations. Here is the opportunity to redesign and release a wide new range of cassette decks with all the frills and thrills that the marketplace calls for, whilst simultaneously providing enhanced user capabilities and operational flexibility.

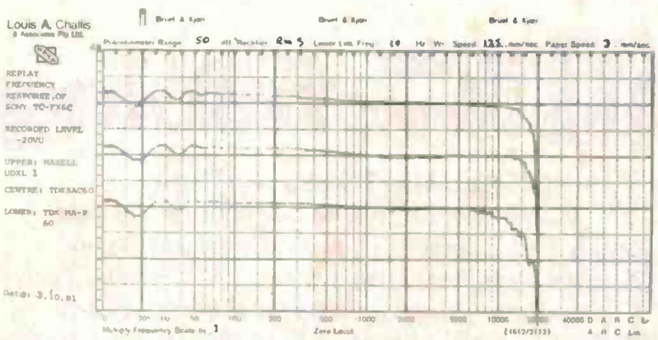
This particular cassette deck offers a number of new and innovative features which place it in the upper bracket of the best machines available. As well as having Dolby B and C noise reduction facilities, it offers an automatic music sensor system (AMS) supplemented by a convenient touch control system for both the AMS and normal mechanical controls.

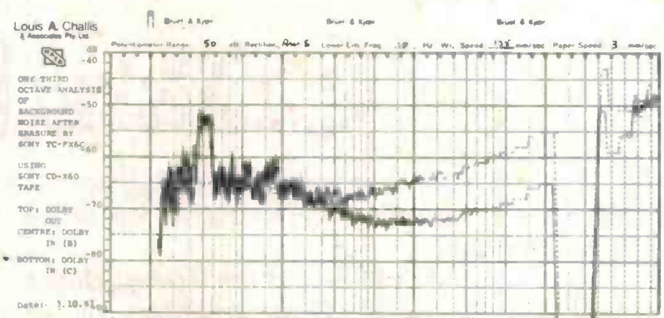
The appearance of the TC-FX6C is subdued yet pleasing, and the designers have taken a lot of trouble to provide a frontal appearance, which is a positive step forward over the design philosophy practised by Sony in the past.

The front panel features a satin-brushed aluminium fascia with three main sections of controls. On the left side is a power switch with a supplementary slider switch for selecting record timer, play and off position, to accommodate an external timer. The eject button controls the damped front panel in front of the cassette well. Below this is a stereo headphone socket with its own individual level control.

The central section is the digitally controlled heart of the cassette recorder and is divided into two primary sections. The upper section contains the automatic music sensor with digital fluorescent display, and the five controls to facilitate its programming.

The counter section at the top left hand side uses four blue-white fluorescent digits and uses a true *linear* counter to provide very fine resolution, which is only limited by tape stretching. If the memory switch is activated, a small flashing dot appears at the right hand side of this display. To the right of the counter are two separate fluorescent displays associated with the repeat programme button and the automatic music sensor (AMS) button respectively. Below these fluorescent displays are four controls for the counter reset for the memory activate, the repeat numerical sequence programme setting and the AMS programme selector control. By pressing the counter reset button at any point during the playing or recording of a tape the linear counter is reset to zero, and this zero point can be used for homing on either end of the sequence for replaying a tape. By pressing the memory button after the counter reset button a playing cycle can be reset in which an early part of the





tape, commencing at the very start, can be cycled to play up to a point which is determined by the counter zero. Conversely, by setting the zero at an intermediate point and utilising the programme repeat button, a starting point other than at the very start of the tape can be set and the tape can be recycled up to nine times (the exact number depending on how many times the memory button is keystroked).

The most complex function that the system provides is to set the linear counter to zero at the start of a sequence, activate the memory, keystroke the number of times the programme is to be repeated (up to a maximum of nine), and to set the automatic music sensor at any level from zero to nine, to indicate the number of sequences which the recorder is to play before recycling. The fifth control, a long touch bar, is a clear button which clears the counter, memory, repeat and AMS functions in much the same way as the clear button does on a small calculator.

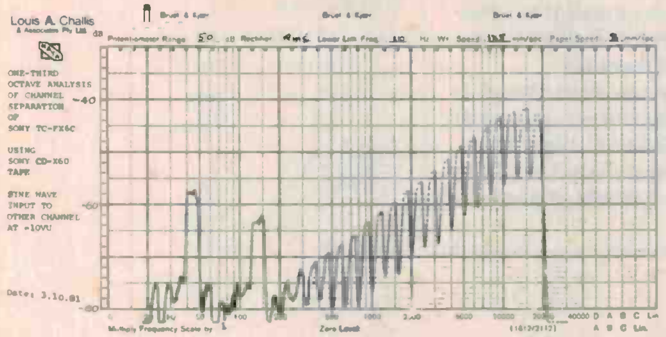
All the mechanical controls are light touch buttons with a large central button for 'play' with its own integral LED flanked on either side by 'fast rewind' and 'fast forward' sensors.

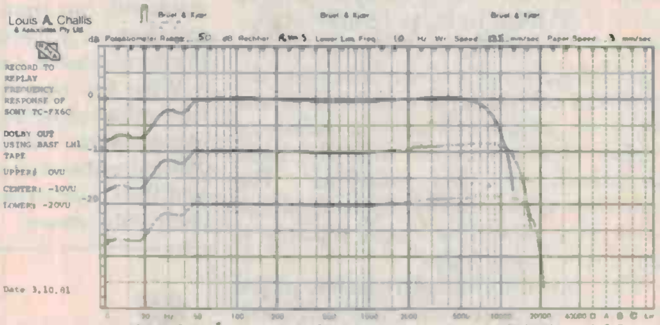
The 'record' button, which also contains its own LED, has been made smaller than the other main controls, so as to be less likely to be accidentally touched. It has to be activated simultaneously with the 'play' button to initiate a recording sequence. The 'stop' button is as large as the 'play' button and is sensibly located at the extreme bottom of the panel right under the play button. The 'pause' button, which is coloured yellow and contains a double segment light, is located between the 'stop' button and the 'record muting' button. When the 'record muting' button is activated a four-second blank section of tape is automatically created, during which time the pause button flashes on and off cyclically to indicate that this function is activated. These controls may sound complex but *are delightfully easy to use and the layout is ergonomically superior to the conventional in-line array* used by most other machines. The AMS function searches for the four-second blank sections of tape created by the 'record muting' button. This may be inserted whilst the original programme content is being recorded or at any time subsequent to the creation of the tape.

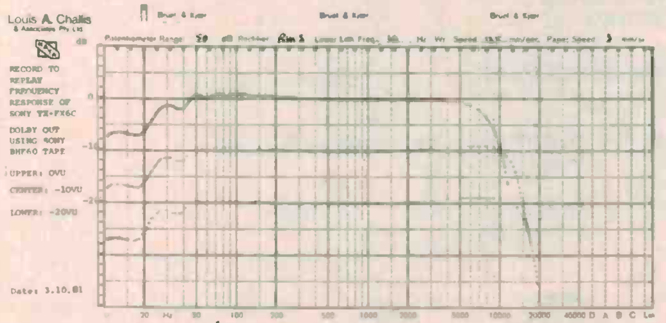
The right hand side of the fascia contains the fluorescent display peak programme meter at the top with an effective −30 VU to +8 VU dynamic range, with yellow segments up to 0 VU and red segments from 0 to +8 VU. This display indicates the proper maximum limit of peak recording signal, which is +2 VU for type 1 and 2 tapes, +4 VU for type 3 tape, and +6 VU for type 4 (metal) tape. The display is a compound type in that it indicates the instantaneous VU level whilst simultaneously holding the peak level reached during the previous five seconds of playing. This is an excellent feature and avoids the need to provide the option of one or the other. Immediately below the fluorescent display are a pair of recording level slide attenuators, which may be operated independently or together.

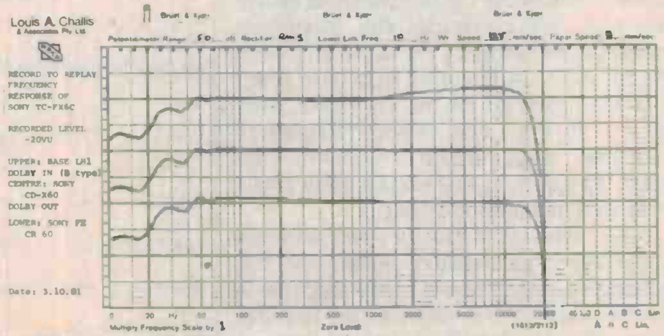
The bottom row of controls contains four selector switches for tape types 1 to 4, i.e: normal gamma ferric-oxide, chromium dioxide, ferrichrome and metal tapes. Two additional push-buttons are provided for 'Dolby off' and 'Dolby B' or 'Dolby C'. Last but not least, two microphone sockets are provided for direct recording of stereo programmes.

The rear of the cabinet contains two pairs of coaxial sockets for 'line in' and 'line out', a filter switch for removing the 19 kHz pilot tone signal from FM stereo broadcasts, and a socket for a remote control unit for which other details have not been provided. The inside of the unit contains one large motherboard for the normal functional ▶









operation of the cassette deck, a separate large board immediately above it on which the Dolby B and Dolby C processors are mounted, and a very large board on which the microprocessor controls are located on the rear left hand side of the chassis. There are numerous other small boards provided for the fluorescent display, the linear counter display, for measuring the tape motion, and the headphone amplifier board, which is located immediately behind the headphone socket. The designers have made extensive use of ribbon cables and the neatness of appearance and detail provided by way of circuit designations creates a feeling of confidence in the design. The back of the space inside the chassis is effectively utilised and the design has apparently been properly researched and carefully proven as there are virtually no add-on components contained on any of the cards.

On test

The Sony cassette machines which we have reviewed over the last few years have, without exception, been remarkably well documented and faithful in terms of compliance with the catalogue figures quoted. The TC-FX6C was no exception. The first and one of the most notable features that we liked about this machine was the excellence of the replay response, which was ±3 dB from 10 Hz to 17 kHz on type 1 tapes, ±3 dB from 10 Hz to 17 kHz on type 2 tapes and ±3 dB from 10 Hz to 13 kHz on type 4 tapes. This lower performance on the type 4 tapes is not a condemnation of the machine but rather a difference in the absolute alignment of our reference replay tape compared with the head alignment of this machine. The machine would reasonably be expected to perform as well on metal tapes as it does on ordinary tapes.

The record-to-replay response of the machine is not quite as good at the low frequency end but is generally equal to or superior to the replay response at the top end. We measured the frequency response as being 24 Hz to 16 kHz with BASF LH1, 24 Hz to 17 kHz with Sony CD-X60 and 23 Hz to 16.5 kHz with Sony FE CX. The overall frequency response is particularly smooth with each type of tape and on the Sony tapes it is almost a straight line.

The wow and flutter performance figures are particularly good, and the harmonic distortion at recording levels lower than 0 VU is remarkably low and *typically amongst the lowest we have yet seen.* The dynamic range with Dolby 'out' is −53 dB(A), with Dolby B is −61 dB(A) and with Dolby C is −66 dB(A), which is quite commendable. Notwithstanding these figures the graph of signal-to-noise performance with Dolby C activated provides a subjective performance which is better than indicated by the absolute A-weighted figures.

The channel separation is −42 dB at 20 kHz, but is typically −62 dB at 1 kHz and even less at lower frequencies. The objective test results show that the machine equals or exceeds all of the manufacturer's claims and provides a technical performance which would be expected to meet the most stringent requirements of a demanding audiophile.

To play

The subjective assessment of performance was a real pleasure, for the ergonomic design attributes of the central control area are superior to the straight-line touch switch facilities previously used by Sony and still used by most other manufacturers. Whilst the automatic music sensor does not offer all the fancy cycling and recycling sequence capabilities that some other machines do, it is my opinion that they go just far enough to satisfy the 'real world' requirements of the average user. I was only able to assess the performance of this machine over one weekend, but that was enough to show me that *on pre-recorded Dolby C tapes the performance is impeccable.*

With the best pre-recorded Dolby B tapes the subjective performance is still exceptional. With Dolby C tape, background noise was completely inaudible and the C system and its added cost was positively proven.

I found the AMS facility good, reliable and much easier to use than most other 'music locating systems' being offered.

The TC-FX6C is not a cheap machine but it provides practical performance, design features and operational flexibility which I must rate as being worthy of a 'five star' rating. ●

MEASURED PERFORMANCE OF SONY TC-FX6C
S.N. 300665

HARMONIC DISTORTION:

Tape: SONY CD X60

		100Hz	1kHz	6.3kHz
OVU:	2nd	-	-	-47.6dB
	3rd	-33.9	-36.7	-38.0dB
	4th	-62.7	-59.1	-61.4dB
	5th	-70.8	-	-dB
	T.H.D.	2.0	1.5	1.3%
-6VU:	2nd	-	-55.8	-dB
	3rd	-44.5	-49.3	-43.3dB
	4th	-67.1	-	-dB
	5th	-	-	-dB
	T.H.D	0.04	0.04	0.07%

MAXIMUM INPUT LEVEL:

(for 3% third harmonic distortion at 1kHz)

Tape: Sony CD-X60 + 2.0VU

DYNAMIC RANGE:

Tape: Sony CD- X60

Dolby Out	-48dB(Lin)	-53dB(A)
Dolby B In	-50dB(Lin)	-61dB(A)
Dolby C In	-51dB(Lin)	-66dB(A)

ERASURE RATIO:

(for 1kHz signal recorded at OVU)

Tape: Sony CD-X60 -86.5dB

Tape: Metal 85.4dB

MEASURED PERFORMANCE OF SONY TC-FX6C
S.N. 300665

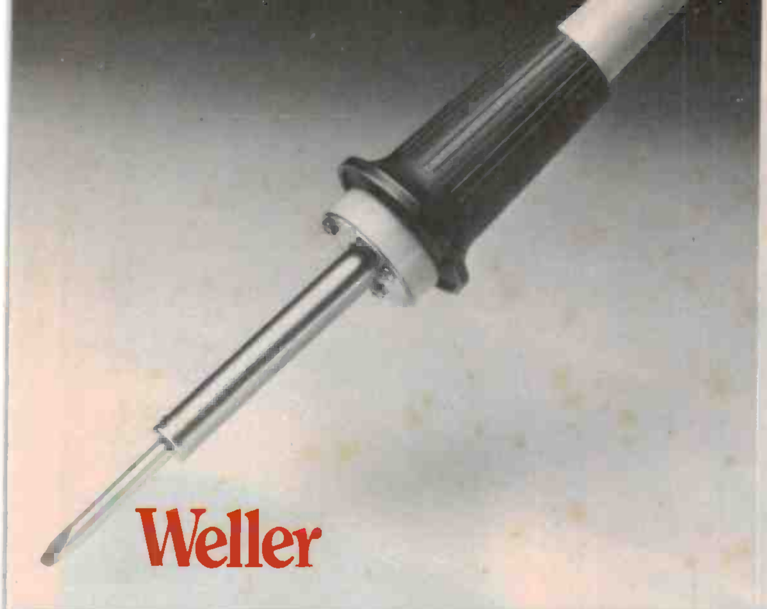
RECORD TO REPLAY FREQUENCY RESPONSE AT -20VU:

Tape	Dolby	Lower-3dB Point	Max. Point and Frequency	Upper - 3dB Point
BASF LH1	IN	24Hz	2dB @ 7kHz	16kHz
SONY CD-X60	OUT	24Hz	-	17kHz
SONY FE CX	OUT	23Hz	1dB @ 90Hz	16kHz

SPEED ACCURACY: 0.25%

WOW AND FLUTTER:

WOW:	Average	< 0.1% PP
FLUTTER:	Unweighted	0.13% RMS
	Weighted	0.035% RMS



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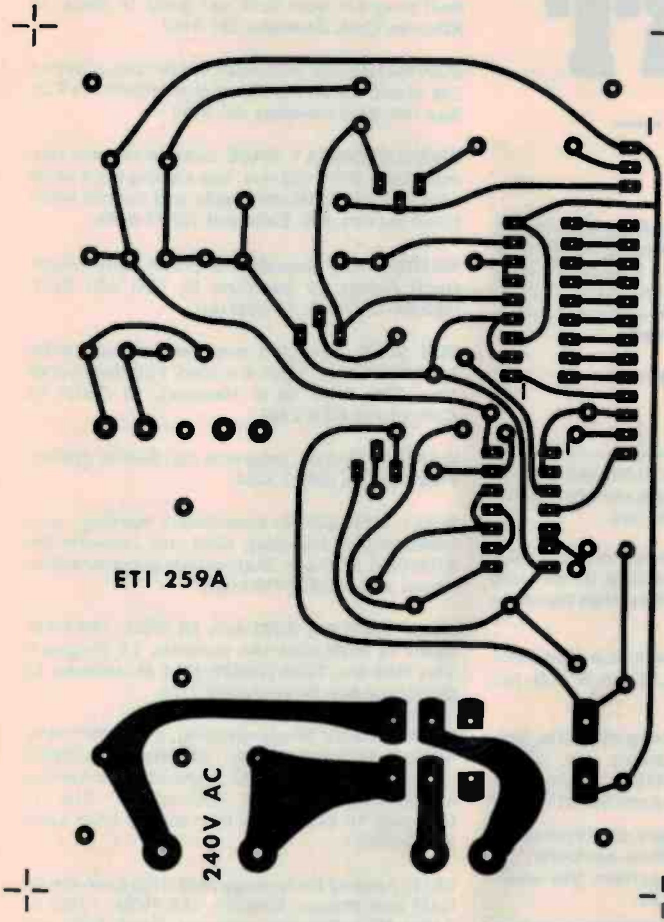
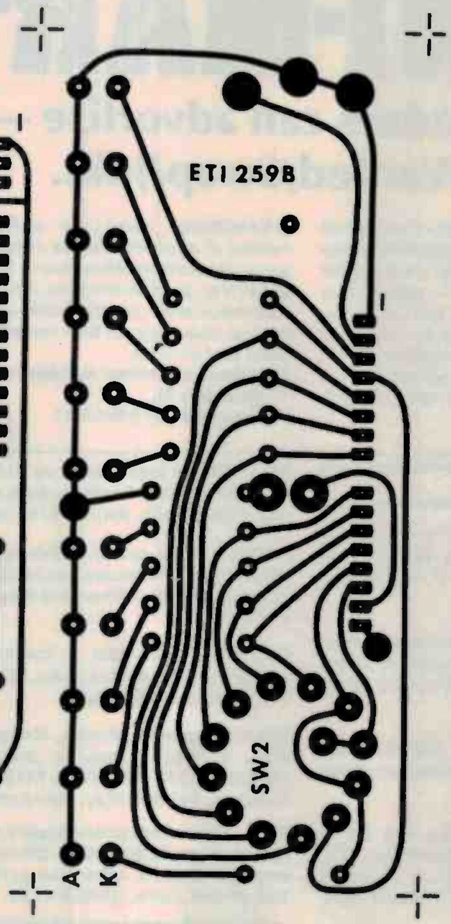
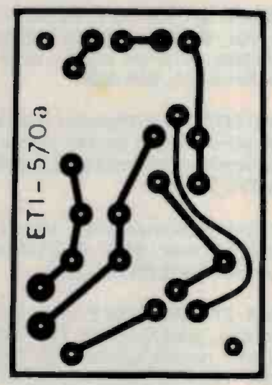
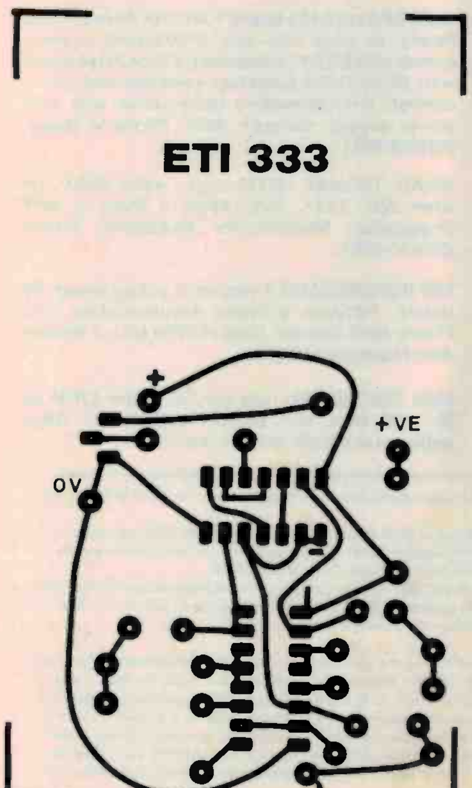
We got off to a
flying start with 2 pilots,
2 mechanics and 5 planes.









Using ETI PCB Artwork

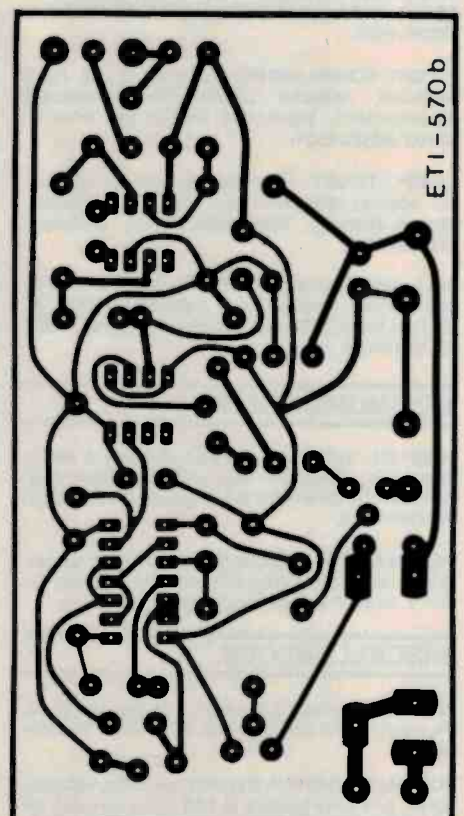
This method can be used to make negatives of ETI artwork from October 1977 on, provided the reverse of the page is printed in blue. The film used is Scotchcal 8007, which is UV sensitive and can be used under normal subdued light.

Cut a piece of film a little larger than the pc board and expose it to UV light through the magazine page. The non-emulsion side should be in contact with the page. This surface can be detected by picking the film up by one corner — it will curl towards the emulsion side. Exposures of about 20 minutes are normally necessary.

The film can now be developed by placing it emulsion side up on a table, pouring some Scotchcal 8500 developer on the surface and rubbing it with a clean tissue.

Further information on Scotchcal and pcb manufacture can be found in the September and December 1977 issues of ETI.

Please note that occasionally lack of space may prohibit the printing of blue type behind all pcbs. In this case the reader must resort to more conventional photographic techniques for pcb manufacture.



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HITACHI SR903 receiver, 160 W RMS/channel, black, as new, $400. DBX118 dynamic range expander, $250. (03)470-3171.

ARXB 77 TURNTABLE with Shure V15 Mk III cartridge; preamp (WW), Eric Taylor (Sept. '77), includes rumble cancellation filter, J. Macaulay (Sept. '79), and power supply, M. Oldfield (Nov. '72). John, (062)47-0491. $250 ono.

PHILIPS EL3548 open reel tape recorder, 2-speed, 4-track, with reel of 7-inch tape, $45. Drummoyne. (02)81-1005.

STUDIO SOUND MIXER: 24 x 3 in, 8 out. Fully balanced, modular construction. Broadcast specifications. Impressive unit at the price — $2400. (02)80-2601.

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COMMUNICATIONS

WANTED: Aus. Radio Service Manuals 6 and 9. Universal test speaker unit, universal valve tester. A. Goodwin, Goodwins Rd, Bagdad Sth, Tas. 7407. (002)68-6233.

SELL: EA 200 MHz frequency counter, $90. Q.max, G.D.O., $80. MIZUHO DX 555D marker/counter, 12-240 V, $180. P.O. Box 345, Yeppoon Qld. 4703.

MISCELLANEOUS

WANTED: Chess Challenger 7 or similar. Dr. E. Plunkett, 7 Hill St, Eugowra NSW 2806. (068)59-2472.

FOR SALE OR SWAP: Back issues of EA, volumes 33-38, and nine binders at half price, or swap for ETI 1979-1981. P.O. Box 754, Morwell Vic.

SELL: Digital logic trainer as published EA, July '77. This is a Dick Smith kit, built and working. $70 ono. Phone Keith, (08)264-3710 (ah).

FOR SALE: TV colour pattern generator, Philips PM5509, with manuals, price $500 or swap for home computer. 1 Albemarle Way, High Wycombe WA 6057.

FOR SALE: Lab gear — colour bar generator, condition as new, $160 ono. G. Birch, P.O. Box 590, Nambour Qld. 4560.

SELL: Capacitors, diodes, ICs, pots, LEDs, trim-pots, switches. Separate prices, e.g: 470 uF electro — 18¢; 7408, 7483, 74154 — 25¢ each. P. Catalano, 14 Lindy Way, Kelmscott WA 6111.

SELL: Benchmate power supply, 0-15 V/amp, 1 W (3 ICs to complete), $30. Chess computer, one segment broken, otherwise perfect, five levels, $80. Phone Jamie, (060)25-4130.

COMPUTERS

S100 CABINET, 12 slot with power supply, $150; DGZ80 CPU, $250; DG640 VDU, $125; QT 64K RAM, $500; or the lot, working, $1000. (002)23-6941.

SELL: DG680 CPU, DG640 VDU, TCT 64K RAM, monitor, keyboard, SME mainframe, BASIC, Assembler. All boards assembled/tested. Phone Chris (03)417-3419. $1200 ono.

THREE ASR 33s — two friction feed ($525 each) one pin feed, reconditioned ($550). Two Centronics 101 AL industrial line printers (up to 15½" wide). Good condition, $850 each. Circuits and service information available for all. Ring Errol (02)709-7646.

RAM, 8K, FORREST DUSTON (Ithaca Audio) S100 static board in good working condition. Fully socketed. Documentation. $75 plus postage. Phone (062)82-2496.

SELL: Sinclair ZX80 1K, old ROM, 9 Vdc power supply, four manuals, six newsletters, display hold program; cost $370, sell $260. G. Black, 27 Killarney Cres, Capalaba Qld. 4157.

JOIN the National Sinclair ZX Users' Group. Send a 24¢ stamp for an introductory newsletter to P.O. Box 148, Glen Waverley Vic. 3150.

PROFESSIONALLY MADE metal computer cabinet, 390 x 480 x 120 mm, has sloping front panel with keyboard mounting rails and cut-out ventilation louvres. $20. Earlwood, (02)78-6249.

WANTED: OSI Superboard, prefer early model. Geoff Cohen, 72 Spofforth St, Holt ACT 2615. (062)54-7608 (ah); 49-2688 (bh).

FOR SALE: Keyboard micro switch, solid-state type 72SW12-6. ASCII-encoded. Full documentation, $70. Write to S. Hessling, 48 Curtin St, Cabramatta NSW 2166.

WANTED: Games programs for DG680 system. Phone Steve, (02)72-3924.

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... SOUND review

Audiosound 'Motet' model 8023 speaker system

This review should be subtitled 'Australian manufacturer makes good'! Louis Challis thinks "The Motet . . . is the first shoebox-size system I have heard that does not really sound like a shoebox . . . one of the most commendable performances from a miniature speaker system that I have yet heard."

Louis Challis

THE DICTIONARY defines Motet as "a vocal composition in polyphonic style, on a Biblical or similar prose text, intended for use in a church service . . ."

Maybe Audiosound did intend these speakers for use in church services, but I really cannot be sure. Although there may be many things that these speakers are intended or designed for, only one may be presumed to be vocal compositions and prose text would be well down on the list of design criteria! The really important criteria bear absolutely no relationship to the title 'Motet', which is an unintentionally misplaced choice of name for what is otherwise a well designed 'bookshelf speaker system'.

The first miniature loudspeaker system I ever saw was a small, floor-standing one. Since that time various American and European manufacturers have released speaker systems under the general title of either a 'bookshelf speaker system' or 'a compact speaker system'. Very few of them have used the term 'compact monitor' or 'mini monitors' that Audiosound have used tc describe the 8023 Series Motets, which once again raises the question of what constitutes a monitor speaker system and if a monitor speaker system can ever be converted into a mini-monitor.

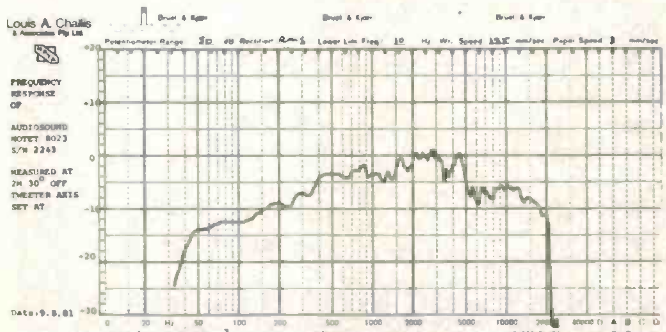
In the last couple of loudspeaker reviews I have been critical of some of the claims made by manufacturers and their advertising personnel. I have highlighted the difficulties they have in producing designs where the various competing problems of space, volume, selection, the positioning of the drivers and design of the crossover networks all interact so as to produce problems. Very few of the manufacturers have really adequately dealt with these problems and created speaker systems that can be regarded as 'state of the art' equipment.

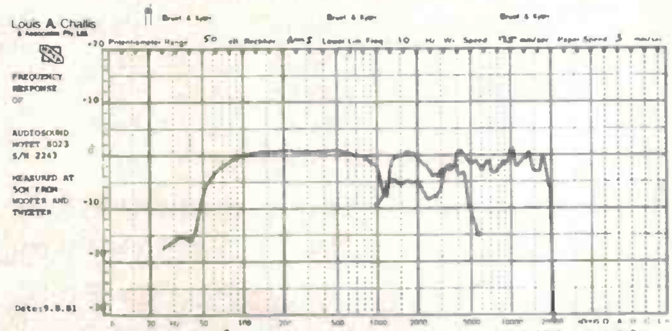
As if to underscore this point, in the last few months we have seen some of the top speaker designers from England and the USA appear briefly on the Australian scene. They have been actively engaged in lecturing to professionals and sub-professionals on the attributes of their latest analysis and design systems, which have been developed to produce better speakers. With such big brass as that loitering on the edges of the stage one could well ask what chance a small Australian manufacturer has in the big league.

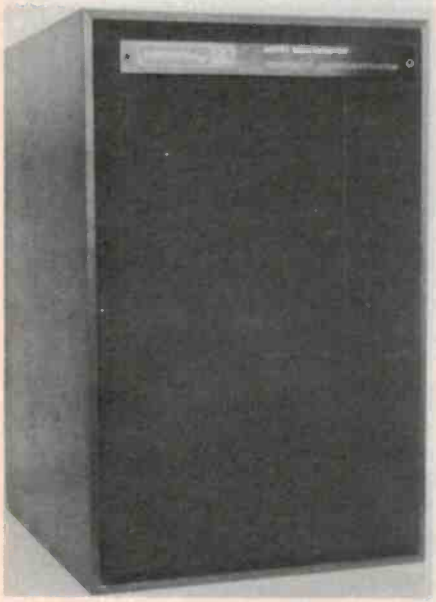
Conflicts and Thiele

The Audiosound 80 Series follows on from a series of very much larger speaker systems that Audiosound produced in the past (and may still be producing for all I know). The mini-monitor thus starts off with what appears to be a set of conflicting constraints, not the least of which is the size of the cabinet, which has a miniscule volume of only 24 litres. The speaker complement is based on a 100 mm (4 inch) driver, type MR5C, manufactured by Magnavox but modified by Audiosound, supplemented by a 25 mm (1") imported tweeter with an illegible designation. This is installed in a cabinet with a design based on recommendations by A. N. Thiele in his paper 'Loudspeakers — In Vented Boxes'. One could well be excused for thinking that with a complement of speakers as simple and as small as this, the performance would be disappointing and analagous to another system I once rudely described as being a 'shoebox' loudspeaker system.

The cabinet is fabricated from plastic-timber-veneered particle board with a 38 mm venting port and the low







frequency driver centrally located with the tweeter above and the port below. The front panel is similarly fabricated with a particle board frame covered in black open weave cloth and retained by Velcro fasteners at the four corners. The top of the frame features a white screen-printed escutcheon on satin black aluminium which extends right across the panel. The rear of the cabinet incorporates a recessed terminal block with spring loaded terminals to accept bared wires.

Measurement

The objective testing of the first of the speakers, Serial No. 2244, in the anechoic room, proved it at first to have a rather strange frequency response. It was only when we realised that the woofer and the tweeter had somehow been inadvertently misphased and corrected the problem that a surprisingly improved response was forthcoming.

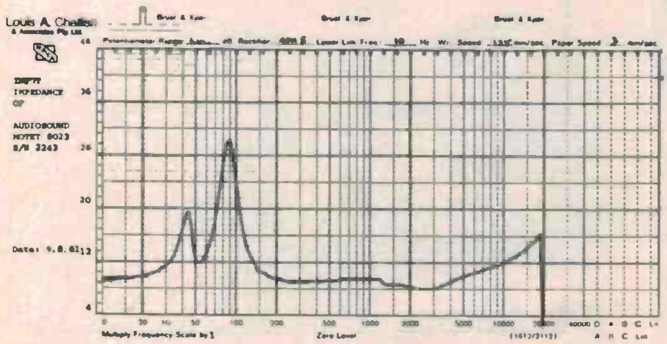
The on-axis response was then ±8 dB from 60 Hz to 20 kHz, and apart from a 5 dB rise between 3 kHz and 5 kHz would have been almost exactly within the manufacturer's specified frequency response. The off-axis response was, if anything, better than quoted, being within ± 6 dB from 60 Hz to 20kHz. This performance seemed rather surprising, as we are usually sceptical of such claims on frequency response of any small speaker system, but we had to accept the fact that the people at Audiosound really have put their act together. By religiously following Thiele's paper they have developed a system using relatively simple drivers and a good crossover network to achieve what is an excellent frequency response — quite outstanding for such a small enclosure.

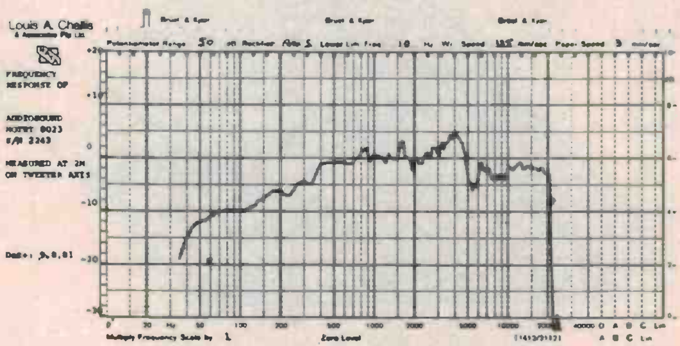
If the frequency response was good, the phase response was even better, and this system achieves one of the flattest phase responses I have yet seen from any speaker system. The impedance curve is a trifle unusual as it features two peaks in the response curve, one centred at 45 Hz and the second at 90 Hz. The higher curve reaches 30 ohms and the smaller peak 19 ohms.

The overall impedance curve in the critical region extending from 150 Hz to 20 kHz does not drop below 8 ohms, and so this speaker system can be readily paralleled with any other 8 ohm speaker system without adverse effects on your amplifier.

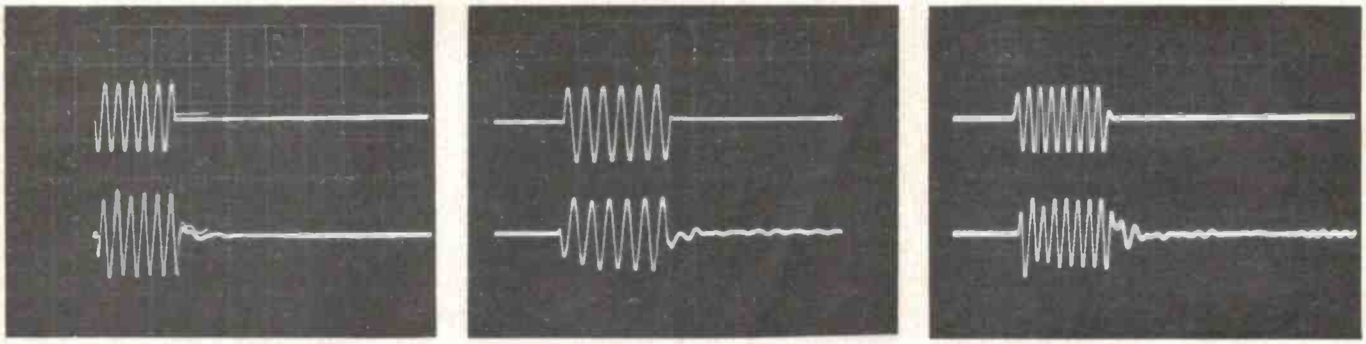
The distortion characteristics are, as one would really expect, moderately high at low frequencies, but particularly low in the frequency region from 1 kHz upwards. Here it features distortions of less than half a per cent, which are by and large inaudible. The tone burst testing that we carried out in the anechoic room showed that the speaker does have some trace of jitter and does generate some readily measurable resonance characteristics. The decay response analysis curves presented an even more direct and incisive picture of the overall characteristics of the system. Apart from two significant peaks in the 2 kHz and 5 kHz region, the treble and general tweeter response is remarkably smooth and equal to that provided by far more expensive systems costing many times the price; many much more expensive units cannot equal the treble response of this unit. The fundamental resonance in the decay response spectrum occurs at approximately 2.5 kHz, with an important supplementary peak occurring at approximately 5 kHz. The treble response above 5 kHz is remarkably clean, showing little or no trace of natural decay resonance characteristics, although some low-level natural resonances do occur at very low level all the way up to 23 kHz.

It is clear that some slight improvements in the woofer performance and in the vicinity of the crossover frequency could most probably be achieved. Nevertheless the overall response is much better than would be expected ▶





100 Hz (20 ms/div.) | 1 kHz (2 ms/div.) | 6.3 kHz (0.5 ms/div.)



Tone burst response of Audiosound Motet 8023, Serial No. 2243 (for 90 dB steady state SPL at 2 m on axis). Upper trace is electrical input, lower trace is loudspeaker output.

from either the size of the speakers or from their basic cost. It is clear that the designers have achieved a commendable result without spending a fortune on drivers and without resorting to an unusually large enclosure.

Subjectively

The objective testing produced overall results vastly different from what either you or I may well have imagined from seeing the enclosure. Consequently it was clear that the subjective testing of these speakers would be likely to offer some unusual surprises. Surprises they were, for the system performed admirably in almost all the critical areas. The first and most surprising feature was their ability to handle low frequency sounds, not necessarily faithfully, but without cone breakup as I would have expected from such a small woofer. The worst test that I know, leaving aside hard rock music, is a special test band on the Swedish High Fidelity Institute's test record. This is on the record SHF1, Track 10, which is entitled 'Elbas Bak Grund Ha mtad Fran Piter Holm'skiva'. Quite apart from the Swedish this is one of the nastiest and most unpleasant tests that any loudspeaker system could be subjected to. Yet, much to my surprise, this Motet 80 Series took the programme content in its stride, and although not reproducing it as well as the reference monitor system nonetheless gave one of the most commendable performances I have yet heard from any bookcase system.

The general transient performance of the system was outstanding, for although I could hear the resonance characteristics in the 2-5 kHz region coming through on certain pieces of music, particularly on woodwind, clarinet and flute, on most other programme content the performance of the system closely mirrored that of my reference monitor system. There were small subjective differences in the sound but the performance was good and on much of the classical music, remarkable.

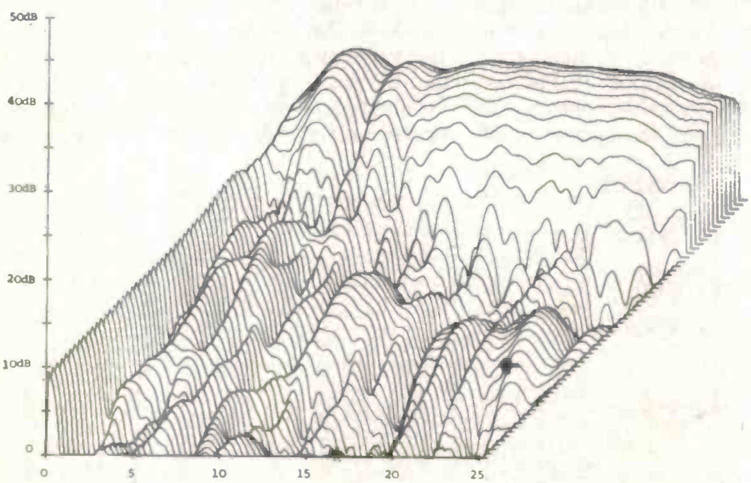
On violins the response was particularly good and on voice, which is one of the most critical tests of all, the performance was clean and the majority of the voices really sounded like voices.

In a word . . .

The Motet Mini-Monitor is the first shoebox-size system I have heard that does not really sound like a shoebox, and whilst not necessarily being a true monitor speaker gives one of the *most commendable performances from a miniature speaker system that I have yet heard.* More importantly, this is a performance which is belied by the size of the enclosure and the size of the drivers, with a power output and performance which is, to say the least, commendable. ●

AUDIOSOUND MOTET MODEL 8023 LOUDSPEAKER SYSTEM

Dimensions:	*370 mm high, 239 mm wide, 270 mm deep*
Weight:	*7 kg*
Price:	*$329 pair, rrp.*
Manufactured:	*In Australia by Audiosound.*
Distributor:	*Audiosound, 148 Pitt Rd, North Curl Curl NSW. (02)938-2068.*



LOUDSPEAKER DATA SHEET
MEASURED PERFORMANCE OF AUDIOSOUND MOTET 8023
SERIAL NO. 2243

FREQUENCY RESPONSE:		45Hz - 20kHz		
CROSSOVER FREQUENCIES:		3kHz		
SENSITIVITY: (for 90dB average at 2m)		3.7 VRMS = 1.7 Watts (nominal into 8Ω)		
HARMONIC DISTORTION:		100Hz	1kHz	6.3kHz
(for 90dB) at 2m)	2nd	-24.4	-45	-58.4
	3rd	-25.7	-52.3	-60.9
	4th	-	-57.2	-
	5th	-34.5	-62.8	-
	T.H.D.	8.2%	0.63%	0.15%
INPUT IMPEDANCE:	100Hz	25 Ω		
	1kHz	9.6 Ω		
	6.3kHz	10.4Ω		
Minimum at 2.5kHz		8 Ω		

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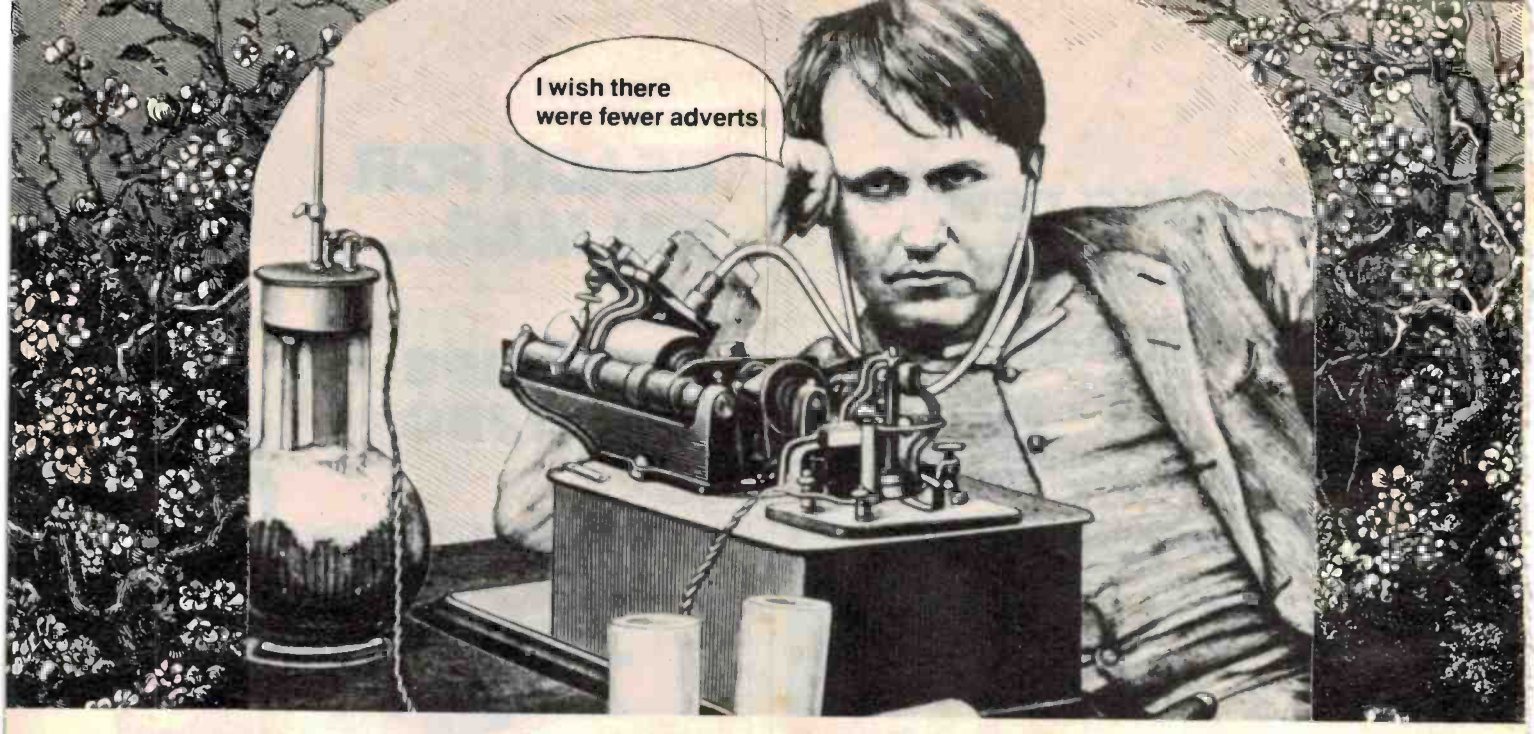
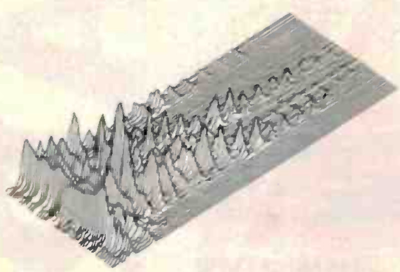


THE MARCH OF MUSICAL TIME...1877: Thomas Edison invents the first phonograph.

DREGS

NOW THAT the festive season is over and you're all recovering your wits, we thought we'd bounce back with another Dregs competition — hereinafter to be known as the 'Dregs Post Festive Season Competition'. The story goes like this:

Teledyne Acoustic Research of the US has developed a 'voice print computer' system that will analyse your speech and provide a printout, like that shown here.



Everybody's voice has a unique 'signature', just like your fingerprints. The voice print chart here is that of Teledyne's boss, Bob Berkovitz. We'll send a free copy of Circuits 3/Top Projects Vol. 5/ Simple Projects Vol. 2/Test Gear Vol. 1 (pick one) to every entrant who can tell us what Bob Berkovitz said. (Clue: it's only one word and all the letters are contained in this clue).

Write your entry on the back of a sealed envelope and include your name and address below it. Send it to Dregs Post Festive Season Competition, ETI Magazine, 15 Boundary St, Rushcutters Bay NSW 2011. Entries must be postmarked no later than 31 January.

Double vision?

If you're surprised at the number of people these days who walk about with headphones on, listening to their Sony Walkman (or similar), you ain't seen nothing yet! The Dregs R & D laboratory is currently working on an invention that will make 'stereo to go' look like old-fashioned steam radio. Our lightweight VideoSpex will fit comfortably over your eyes and replace boring everyday scenery with your favourite TV programmes (or soft porn movies if you must). Signals are provided by a miniature receiver/recorder that clips on your belt or fits in your handbag, and displayed on a flat LCD matrix screen. So far, so simple. The real problem is with the optics, because human eyes can't focus closer than about 250 mm. A special lens system had to be developed which makes the screen appear to be a few metres away, while at the same time filling the whole field of view. Reckless volunteers who have tried out the system say the effect is fantastic, better than wide-screen movies, especially as the focal length adjustment has been developed into a proper zoom facility. The zoom, together with a system for laterally displacing the image, lets you enlarge particularly interesting sections of the picture for closer scrutiny. Soft porn addicts find this feature very gratifying.

Dregs' scientists are sometimes as hidebound and unimaginative as anybody. They originally planned to have a single screen with sets of prisms that directed the image simultaneously into both eyes, but they eventually realised what an opportunity they were missing and are now frantically working to perfect a stereoscopic system. Results from crude prototypes with separate cassettes for each channel are astounding. Hitherto impossible visual effects can now be produced — objects rushing through the centre of your head and so forth. So next time you see someone opposite you on the train, wearing funny-looking dark glasses and ducking and twitching all the time, take a closer look. He may not be a mental defective and deserving of your sympathy; he may be a member of Dregs's evaluation team trying out a horror movie on the VideoSpex. Then again, maybe all of Dregs's staff are mental defectives deserving of your sympathy.

What is your turntable's "warp factor"?

You may not realize it but every record has some degree of warp. And no matter how slight, it can give your turntable fits.

Warp, along with off-centring, were the reasons why Sony invented Biotracer.

The continuously correcting action of the electronic Biotracer tonearm perfectly suspends the stylus in the record grooves with no tension resulting from the forces of gravity or lateral pressure.

Biotracer is featured on Sony's PS-X600 and X500 with the advantages of stifling low frequency resonance, expanding dynamic range and maximizing performance from any cartridge you use. Biotracer also suppresses peak tonearm resonance electronically within a range of 3dB.

The sole object of its design was to neutralize the effects of record warp and off-centring through microcomputer precision. Which Sony does with aplomb.

PS-X600

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THE ONE AND ONLY

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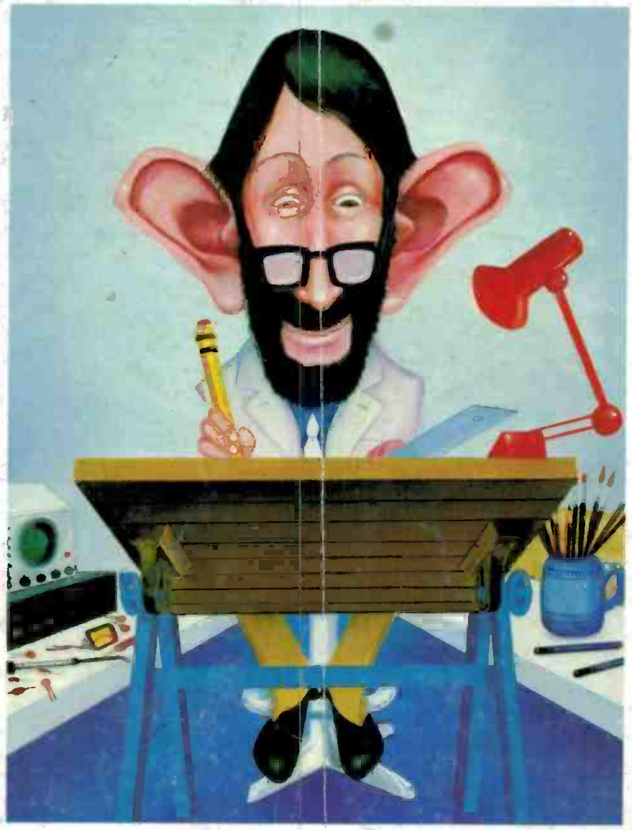
The average hi-fi designer versus the human ear.

The human ear forms part of a sound receiving system that outperforms the best audio equipment known to science.

Capable of interpreting a dynamic range of 120db or 10 octaves, it has double the capability of any man made electronic equipment.

The ear can discern direction, coloration and musical within a complex detail rendition of a 50 piece orchestra in a manner no electronic equipment is able to do.

It is, in short, a sophisticated piece of equipment that should represent the most stimulating challenge to any designer of audio equipment.



Unfortunately it's a challenge that's largely ignored. Which is why in most stereo

systems handling power and volume are substituted for subtlety and frequency response. Vector Research however is one of the few exceptions. Developed by a team of highly experienced audio engineers who were tired of compromise, Vector Research represents a new standard in high fidelity excellence.

Discussing the Vector VRX 9000, *Stereo Review* states "The receiver surpassed virtually every one of its performance specifications . . . it sounds as good as it looks, which is saying a lot . . ."

High Fidelity states "a receiver with such sophisticated performance and functions demands attention."

Popular Electronics on the Vector VCX 600 cassette deck, "Lower Flutter readings than those of the VCX 600 are hard to find . . . while not cheap, it affords excellent value." *Hi-Fi Buyer's Review* sums up.

"Vector Research is a newcomer to the audio scene, but if the VCX 600 is any guide, this company should be very successful."

If then you are an audiophile whose interest goes beyond famous names and shiny knobs then you owe it to yourself to learn more about Vector Research.

Dear V.R., In my book, beauty is in the ear of the beholder. Send me the test reports and the name of my nearest stockist.

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