Electronics Today

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JANUARY 1988
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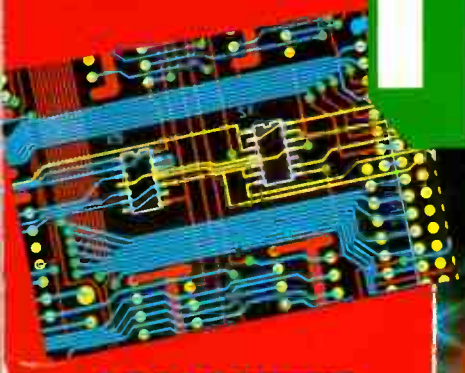

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DATA COMMUNICATIONS

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Cellular Mobile or Two-way Radio Testing... the 2955/57 leaves the others in the dust.

For speed, ease of handling, performance and economy ... nothing on the market comes close. Touch a single key and it instantly sets-up for transmitter, receiver, or duplex testing; repeaters in 10 seconds ... times that leave other test sets in the dust. A unique menu driven, high resolution CRT displays test sequences and results in both text and graphic format. There's even a built-in digital storage scope and 37 user defined non-volatile memories to store your test routines. This AMPS Cellular Radio Test System is a cell site simulator that generates 10kBit AMPS digital overhead message while controlling the RF/AF parameters presented to the radio under test, automatically or manually.

The pace setting 2955/57 comes with these and other "extras" at a sticker price well below competition.

marconi instruments

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For literature or a demo contact:
Marconi Instruments,

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Telephone: (02) 887 6117. Telex: AA26080
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The Japanese made storage a fine art.

Our disk drives continue the tradition.

At Fujitsu the Japanese tradition of attention to fine detail has enabled us to produce disk drives with astounding performance and reliability.

Our disk drives range from 3.5 inch to 10.5 inch. They're fast, they're cost-competitive and enjoy the best MTBF of at least 30,000 hours.

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At Fujitsu, information storage is indeed a fine art.

Phone now for the name and location of your nearest supplier. Fujitsu Australia Limited Sydney (02) 959 6544, Melbourne (03) 529 7633.

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Philips SMDs offer a lot of room for improvement

Philips Surface Mounted Devices give you plenty of room to improve the design, manufacture and performance of your products.

Because they not only take miniaturisation a major step forward, but also make circuit boards less costly and dramatically more reliable.

Smaller boards, closer placement, and because the devices are mounted on, not through the board, the designer can use both sides of the PCB.

Philips SMDs are designed for automation, and Philips is a leader in the specialised automation equipment to accurately site the SMDs. Your products are assembled faster, and more efficiently. And because these components are so highly reliable, the failure rate – during manufacture and in the field – is significantly reduced.

So, before you begin a new design using conventional components, talk to Philips about SMDs.

We can give you exciting information about SMD applications by calling one of our offices below:
Sydney (02) 439 3322 Melbourne (03) 542 3333
Adelaide (08) 243 0155
Perth (09) 277 4199 Brisbane (07) 44 0191
or write to **Philips Electronic Components and Materials**
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Artarmon NSW 2064.

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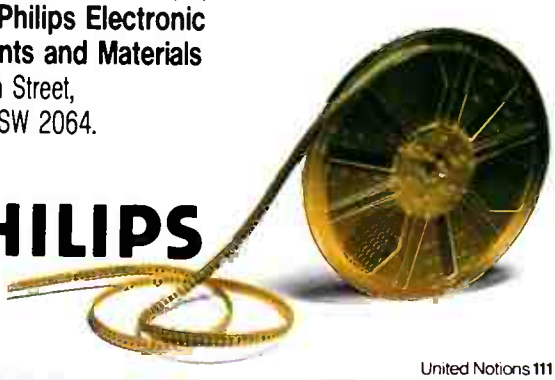
Electronic Components and Materials



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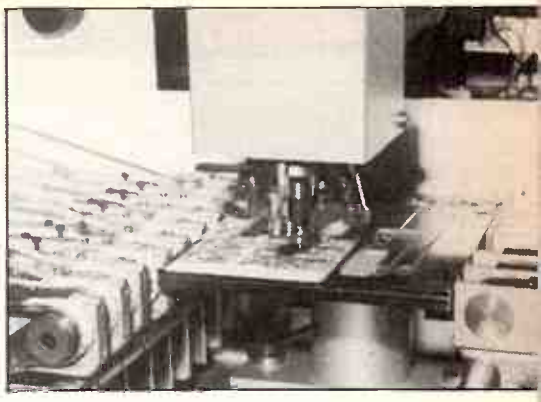
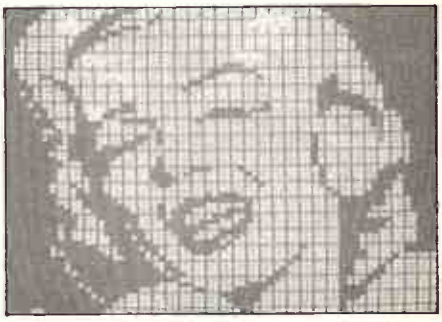
JANUARY, 1988



Page 28

Page 54



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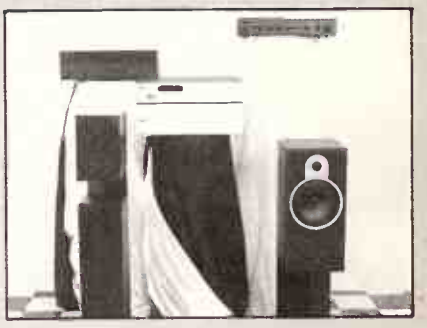

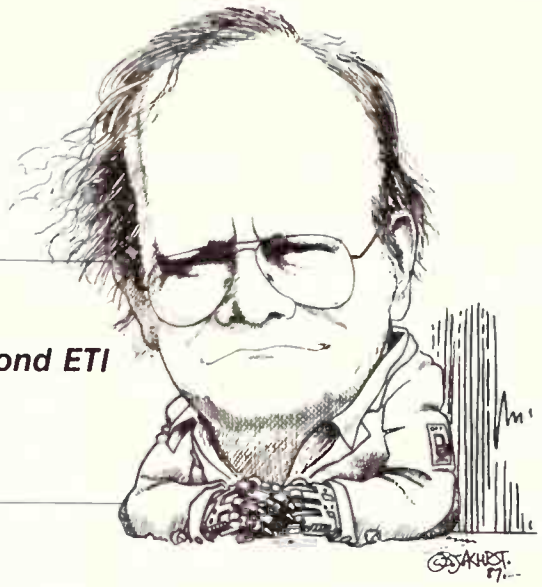

"Welcome to the second ETI Yearbook."

Welcome to our second yearbook. As befits the beginning of a bicentennial year, we've tried to give you a glimpse of where state of the art electronics is heading in Australia today.

For instance, there is a look at plans for the future of digital communications, as well as a few articles on the current state of play in this industry, possibly the most important part of the electronics scene in Australia.

There are a couple of articles on the aerospace industry. With Government funding getting more difficult, this area is in for lean times in the immediate future. Nevertheless it is a fascinating part of electronics and one which, when it really gets going, will have immense ramifications for us all.

Another area that is rapidly assuming prominence is microelectronics, especially with the advent of Application Specific Integrated Circuits, (ASICs). ASICs have the potential to make Australian industry extremely competitive by eliminating labour costs as an advantage for our Asian competitors. The problem with microelectronics in the past has always been the entry price; with the new arrangements in Adelaide that has dropped almost to insignificance.

Computer Aided Design is important in Australia for much the same reasons; it will make our industries more competitive. We have included several articles that cover this important industry, as well as short news items on new products available.

Meanwhile, we haven't forgotten our hobby readers. We have updated the project index from 1987, and this year added a list of erratta. This should be reasonably comprehensive back to 1979, but gets a bit woolly before then. There is also a selection of cunning circuits and practical programmes for your edification and delight.

Finally, best wishes to our readers for 1988 from all the staff at ETI.

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ETI Magazine December 1986

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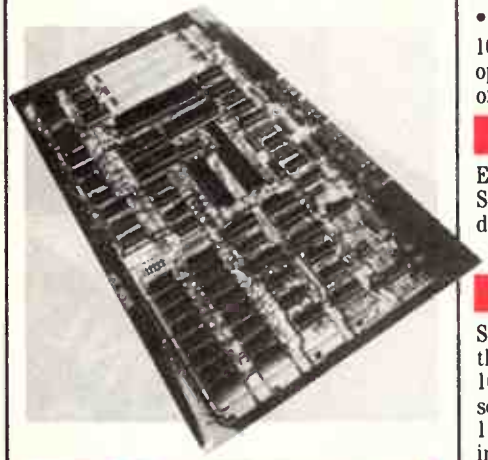
If you take your computing seriously Applix is for you!

The Applix 1616 microcomputer.

The 1616 gives you the power of the Motorola 68000 processor, supported by a hardware design that lends itself to all purposes — industrial control, educational applications or serious programming.

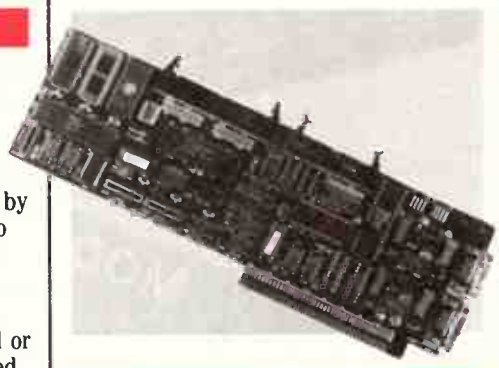
The 1616 is available fully assembled or in "kit" form; the 1616 can be tailored to suit your level of computing needs. Just build up partly for programmable controllers, or all the way for a powerful, flexible personal computer.

After building your system, you have total control using the powerful ROM Resident Operating System, abundant I/O and unlimited expansion capabilities.



POWER AND FUNCTION

- Motorola 68000 (16/32 bit) processor.
- 512K bytes RAM as standard.
- 64K ROM expandable.
- On-board high speed cassette interface.
- Optional disk/co-processor card.
- Four 80 pin expansion slots.
- Dual serial ports.
- Centronics compatible parallel printer port.
- General purpose digital to analogue I/O port.
- Analogue two-button joystick port.
- Graphics: 320H x 200V 16 colours, 640H x 200V any four of 16 colours.
- Standard RGBI interface or composite video.



THE OPERATING SYSTEM

1616/OS offers features such as:

- I/O redirection.
- File management.
- Text editing.
- 68010 support.
- Over 100 documented internal system calls.
- Monitor functions.
- Installable drivers.
- ROM resident.
- Windows and graphics and more . . .

1616/OS is a very powerful and flexible operating system and takes full advantage of the 1616 hardware.

ASSEMBLY LANGUAGE

Each 1616 kit is supplied with a copy of SSASM — a 68000 macro assembler. Full documentation and system macro library supplied.

32 BIT FORTH

SSFORTH is a complete implementation of the FORTH language. SSFORTH runs under 1616/OS, rather than the normal FORTH screen system. It is fast, has full access to 1616/OS (including EDIT) supports 32 bit integers, float and interrupt driven words. Full source code supplied!

BASIC INTERPRETER

SSBASIC features 32 bit integer numbers, floating point, variables, multi-dimensional arrays and character strings. Access to 1616/OS, graphics and assembler from within BASIC.

APPLIX 1616

"C" COMPILER/CROSS COMPILER

All Australian. The Hi-Tech "C" Compiler running under 1616/OS comes with macro assembler, linker and librarian.

A cross-compiler running under MS-DOS and producing code for the 68000 is also available.

DISK CO PROCESSOR CARD

Truly a computer in its own right the 1616 Disk Controller Card adds another dimension to the 1616 system.

Using an 8Mhz Z80H as a co-processor, tasks such as getting data to and from the disk can be off-loaded from the 68000, leaving it to do what it does best!

SSDCC Technical Features:

- On board Z80H CPU (running at 8Mhz).
- 8K to 32K of ROM.
- 8K to 64K of static RAM.
- WD1772 disk controller chip.
- Supports both 3.5" and 5.25" DS 80 track floppy drives.

Options:

- SCSI hard disk interface using the NCR5380.
- Two additional serial ports (under Z80 control) using the Z8530 SCC.
- CP/M support coming!

JOIN THE HUNDREDS OF 1616 USERS

Mini kits start at $239, basic kits from $449, keyboard $139, power supplies from $69, disk controller kit from $249.

If you require further information, pricing and updates, user groups information.

CONTACT APPLIX TODAY

Applix Pty Limited
324 King Georges Road, Beverly Hills
P.O. Box 103, Beverly Hills
N.S.W. 2209, Australia
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Compare the features - look at the value.
(12 month extended warranty on both Megamodems)

All prices include Sales Tax

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Speeds	300 Baud Full Duplex - both models 1200/75 for VIATEL - model 123 1200 Baud Full Duplex - both models
Data Standards	V21, V22 - both models V23 - 123 model only
Command Set	Hayes with extensions
Interface	CCITT V24 (RS232)
Data Format	Asychronous
Power Consumption	<2 watts
Size	27(H) x 120(W) x 157(D)mm
Indicators	8 LEDs
Internal Diagnostic Loop Back	

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MODEL 12 $375
MODEL 123 $449
SAVE UP TO $250 ON OLD PRICE

PC MEGAMODEM

Same features as the Megamodem but plugs into the expansion Bus of your IBM or compatible.
1/2 card will fit any slot as it is the correct height. Make full use of all your expansion slots.
Use Com1 or Com2.
Will run with almost all communication packages.

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MODEL 12 $375
MODEL 123 $449

Multimodem II - Australia's No.1 modem

Australia's top selling modem now offers even more. You get:
Reliability. State of the art digital filters for reliable data transfer, even on noisy lines.
The Expansion Bus. An Avtek exclusive. Developments can be plugged straight in.
Total Flexibility. Both 300/300 and 1200/75 (Viatel) at the flick of a switch.
Autoanswer as standard. A reliable and instant "ring detect" circuit is completely independent of the strength of the ring.

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NOW $299
ONLY
SAVE $50

MINIMODEM II - leader in the value stakes!

Superb performance for those on a limited budget. The Minimodem II offers the same digital filtering and error correction as the Multimodem but at a much lower price. Full 300/300 baud and 1200/75 baud (Viatel standard) are provided at lower cost than some 300 baud only modems - check for value and you'll find Mininmodem wins every time.

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STILL ONLY $199

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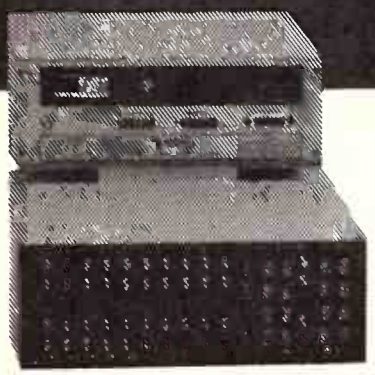

The **7000 MDAS** is capable of making direct measurements of strain, temperature, pressure, voltage, etc, and accommodates virtually any physical parameters, when the appropriate transducer is added to the system - no additional signal conditioning is required.

The equipment can be used in the field and provides analog, digital, frequency I/O, relay and stepper motor controls.

MDAS can be battery powered for remote operation and also has an internal battery back-up system.

Key features include: stand alone operation, high level transfer to any computer's data base.

Considering the cost and performance together, no other product comes close.

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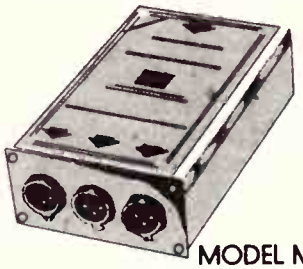
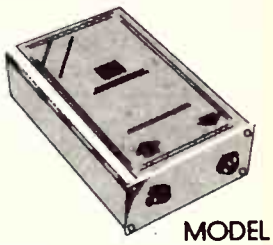
MAKE THE RIGHT CONNECTIONS WITH SESCOM FROM REBEL

MIC-SPLITTERS



MODEL MS14

ACTIVE DIRECT BOXES



MODEL SM2MKIII

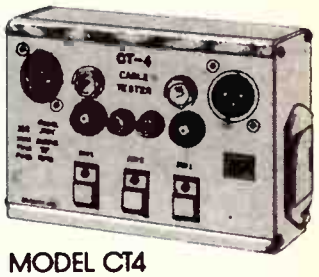
GENERAL PURPOSE AUDIO TRANSFORMERS

IMPEDANCE CHART

MODEL #	PRIMARY IMPEDANCE (ohms)	SECONDARY IMPEDANCE (ohms)	NO OF SECONDARY WINDINGS	REF: 600 ohms POWER LEVEL
MI-75	18·75/75	150/600	1	+18
MI-46	18·75/75	150/600	1	+30
MI-12	150/600	150/600	1	+18
MI-18	150/600	150/600	1	+30
MI-43	150/600	600	2	+18
MI-44	150/600	600	2	+30
MI-8	150/600	600	4	−10
MI-88	150/600	600	1	+4
MI-102	150/600	5K	1	−10
MI-103	150/600	5K	1	+18
MI-104	150/600	5K	1	+30
MI-5	150/600	15K	1	−10
MI-85	150/600	15K	1	+4
MI-9	150/600	15K	1	+18
MI-15	150/600	15K	1	+30
MI-13	3·75K/15K	15K/60K	1	+18
MI-19	3·75K/15K	15K/60K	1	+30
MI-32	15K	15K/60K	1	−10
MI-95	15K	15K/60K	1	+18
MI-98	15K	15K/60K	1	+30

Available in various case styles and magnetic shielding.

CABLE TESTERS



MODEL CT4

MIC-SPLITTING TRANSFORMERS

Available in 2, 3 & 4 split models, these specially designed audio transformers have separate, isolated electro-static shields to prevent common ground loop problems.

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STRONG 15010

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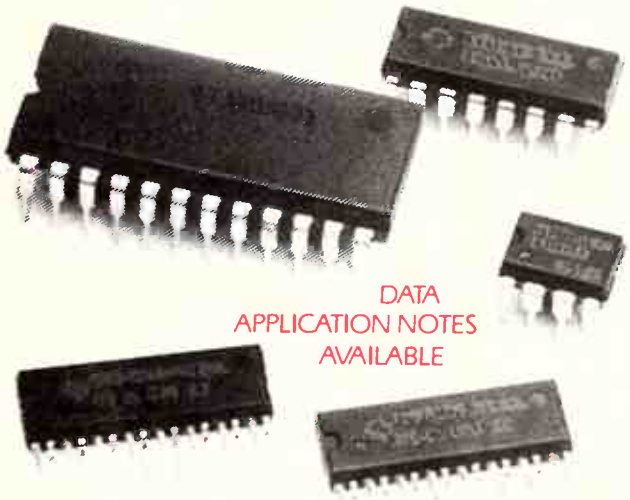
Now you can design your own modems with Sierra!

Sierra have the products to design high technology telecommunications; ACD Itronics has the complete range of quality components for you!

SC11006 240bps analog peripheral.
Compatible with CCITT V22, BIS V22/21, and Bell 212A/103 standards, integrated DTMF/Guard tone generator, call progress monitor, contains an on-chip hybrid. Also analog, digital and remote digital loopback, plus programmable audio outputport, many other features.

SC11008 Stand-alone interface controller.
Complete AT corrand set in firmware for intelligent modems, direct interface to single chip SC1104 x SC1104. Built in uart for RS-232C interface including 38 pin-dip or PLCC package. Compatible with Industry Standard Software, reduces component count and boardspace.



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Serial interface, erasable program memories.
CMOS EE technology in 8 pin packages. 10,000 erase/write cycles and 10 year-data retention. Single 5v supply, very low power dissipation and no external high voltage for programming. Simple microprocessor interface, ask for details.

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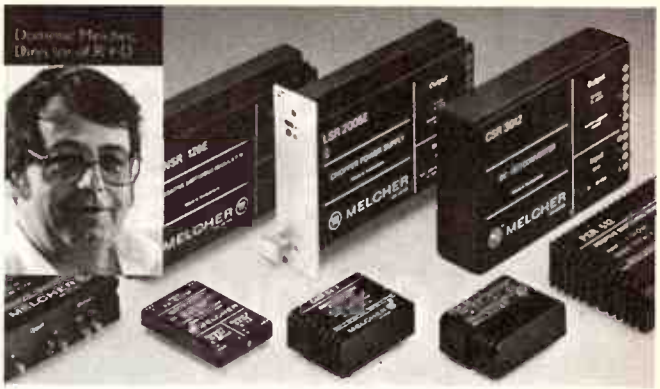

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And this range is steadily growing. Manufacturers and application engineers from industry, transport, communications, defence technology, power utilities, medicine and even entertainment electronics contact us with ever changing requirements. With requests that can only be met by a flexible specialist having inhouse development and manufacture.

However, a great many requirements are already fulfilled with our standard power supply models or with their optional features. With switching regulators up to 300 W, DC/DC converters and chopper supplies up to 50 W; with single and multi-voltage devices, fixed or adjustable; for extreme temperature ranges or quality requirements; with different mounting or connection possibilities etc.

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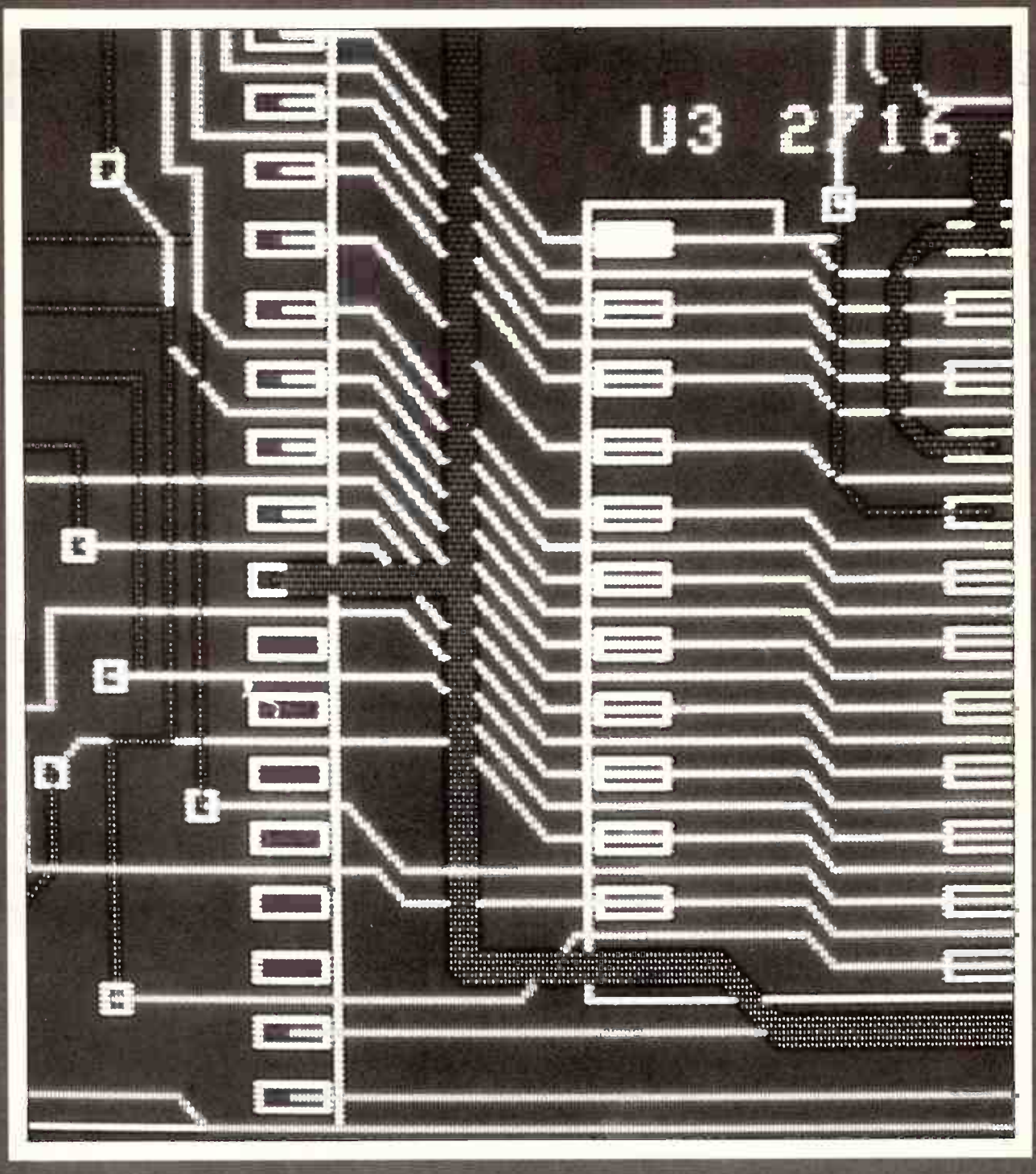


Micro Electronics

AUSTRALIAN SILICON TECHNOLOGY

Australian Silicon Technology is a semi-custom service for industry that is unique in Australia. It utilises software written locally and local facilities to fabricate the integrated circuits. The service allows industry to design their own gate array chips on a personal computer with minimum knowledge of the technology. It is low cost and can accommodate small volumes.

M.R. Haskard,
B. Inwood
M.A. Macdonald,
G. Pouferis

For Australian industry to be competitive, increasing use must be made of modern semiconductor technology. This includes application specific integrated circuits (ASIC) and in particular, semi-custom integrated circuits. The difficulties experienced by many companies are, (1) they have no training or experience with this new technology, (2) the up front costs are normally tens of thousands of dollars, (3) the quantitites of integrated circuits required are by most foundry standards very small and so the foundry operators are not interested and (4) many of the semi-custom facilities available in Australia employ overseas design services. To overcome these problems the Microelectronics Centre at the South Australian Institute of Technology in conjunction with Philips, Hendon, and the Defence Research Centre Salisbury, have established a low cost semi-custom service, which can accommodate very small volumes. It is called Australian Silicon Technology (AST).

Philosophy

The approach employed to minimise costs of the service was by:

1. using gate array technology where there is cost sharing between customers of the silicon processing.. The initial masks and fabrication steps for all designs are identical with only the upper layer characterising the design to a particular customer's requirements;
2. employing a personal computer as a low cost designer's workstation. Monochrome or colour computers of the IBM type or similar may be used.
3. giving customers the option to undertake their own design and testing.

To assist industry to come to grips with this new technology, maximum use has been made of computer-aided design. The software contains all the technology information, so that to design a chip the customer needs only the ability to draw a schematic diagram. The software performs simulation to verify the design and then

Integrated Injection Logic (I^2L)

Since the simultaneous publication in 1972 of papers by H. H. Berger and S. K. Wiedmann from the IBM Laboratories in Germany and C. M. Hart and A. Slob of the Philips laboratories in the Netherlands, we have had available a technique whereby an inverse, upward NPN transistor could be made to operate into loads formed by PNP transistors in a configuration and small size. This new "Merged Transistor Logic" (MTL) or "Integrated Injection Logic" has provided a bipolar digital circuit technique with high packing density, a low power delay product and the ability to operate over a wide range of operating power level.

Being a bipolar circuit approach it is compatible with normal existing analogue and digital IC processes with the exception of gold-doped TTL. An important feature of I^2L is the fact that it is possible to combine on the one chip analogue functions in normal bipolar designs with digital functions in injection logic.

James E. Smith in the introduction to the I.E.E.E. publication Integrated Injection Logic says "In a few exceptional cases I^2L was properly recognised at an early stage as an immediate means of drastically reducing the TTL parts count in high reliability systems where bipolar technology was required, and adding a digital mask programmable gate array. In such applications, I^2L has enjoyed significant (although unpublicised) success which began soon after its introduction."

I^2L processing has been found to be compatible with a standard 12 volt bipolar diffusion process which uses collector wall diffusion. The deep N type collector wall diffusion is normally used to allow a lower resistance contact from the shallow N collector contact on the surface and the buried N layer which runs underneath the normal NPN transistor structure. In Figure 1 the diffusion configuration is shown.

Using seven masks figure 1A shows the injection logic gate structure right provides the current source to the base inputs of the two inversely connected NPN transistors shown. The buried N region below the N-type epitaxial layer combines with the deep N diffusion to enclose the I^2L structure. Figure 1B shows a normal NPN transistor structure using the same diffusion steps. In bipolar design the deep N diffusion is usually only used where there is a need to ensure an adequately low series collector resistance, and in normal bipolar design may not be needed.

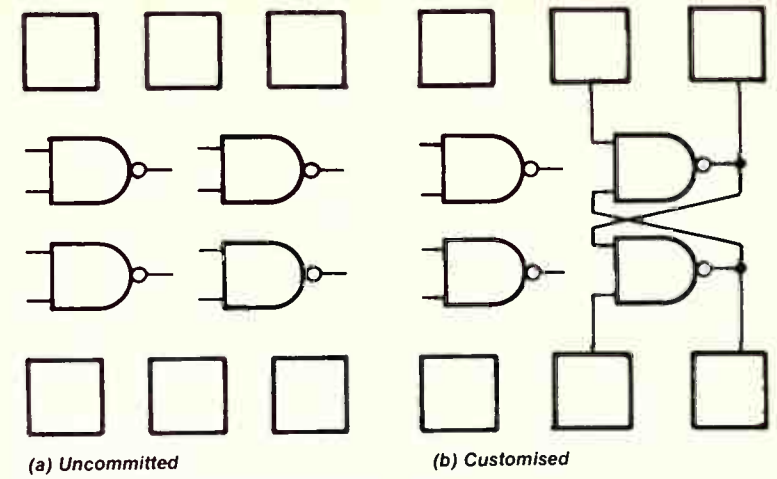
generates test vectors and a net list.

The flow diagram of the service is shown in Figure 1. Using the AST Designer's Kit, customers assemble their system on the computer workstation, verify it and then send off the design to AST. Here, automatic routing lays out the interconnection of the chip, extracts parasitics and then performs a details simulation. After confirmation with the customer that the design still performs correctly, the layout is converted to a format for mask manufacture. Masks are then forwarded to Philips for chip fabrication with packaging carried either at Philips or AST. Five samples are delivered to the customer for testing using the test vectors previously generated. If correct, details for delivery of quantities required are then finalised.

Gate array concepts

A gate array is a chip that contains a prediffused but unconnected matrix of gates or gate elements surrounded by an area reserved for interconnection wiring. This accounts for approximately 90% of the chip's processing. Interconnection of the gates is made by one or more customised masks (usually metal), which uniquely defines the chip's function. This concept is illustrated in Figure 2.

Figure 2 (a) shows an uncustomised gate array as a regular matrix of gats and routing channels surrounded by buffers configurable as either input or output. Figure 2 (b) illustrates a completed gate array customised by a single metal interconnection layer defining its function as a simple latch. In a gate array the percentage of active area is typically 25 per cent, with the remaining silicon allocated to wiring space.



(a) Uncommitted *(b) Customised*

Figure 2. Schematic Representations of a Gate Array.

Since the uniqueness of a gate array's logic function is programmed into the chip during the final stages of the wafer's processing, the uncustomised gate array wafer is common to all customers of the base wafer. hence the volume of uncommitted gate array wafers manufactured will be much larger than in the case of an individual gate array design. This means that the design, development, tooling and learning curve for the uncommitted gate array wafer is shared by many customers, even though each obtains their unique chip or may only be applied to one or two critical transistors.

Probe testing of the diffused silicon slice ensures that only good devices are processed beyond the sawing and breaking stage. From this point there are a variety of different options available. For example, if the pretested circuit is required in chip form, the sawn and broken slice can either be supplied on plastic film or submitted for visual inspection to an agreed standard and the chips placed individually in waffle packs.

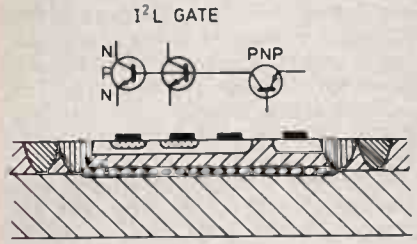
Assembly and testing to provide a finished useable product can continue either in a standard moulded plastic package or in a normal chip carrier. These can be hermetic if desired with nitrogen back filling before sealing. A further possibility which has been found to provide distinct advantages is to assemble the Australian Silicon Technology chip on a hybrid sustrate and in this way integrate the semi-custom gate circuit with other components to gain from both techniques of custom assembly. On a hybrid circuit, built in input and output conditioning can be included with minimum lead lengths, and circuit confidentially can be further protected; where necessary components which operate outside the normal limitations of the semi-custom and I^2L process can be combined to give higher voltage, higher current and other analogue capabilities.

Normal quality control is carried out within the framework defined in AS1822 (Suppliers Quality Systems for Production and Installation). This covers the production process from incoming material control to the definition of the necessary management structures to ensure the independence and authority needed to carry out an effective quality role.

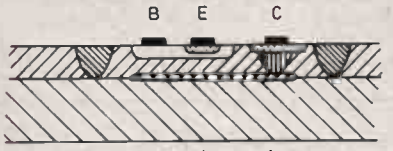
Where needed Military Release procedures are available to Mil. Std. 883C as also are bum-in, life and endurance testing procedures to agreed methods.

Quality Control also requires access to suitable measurement and diagnostic equipment such as a Scanning Electron Microscope, adequate optical microscope and photographic as well as X-ray facilities. This commitment to quality assures the proven maintenance of standards and procedures in offering the diffusion and production service to customers.

John Crawford



Integrated injection logic in seven mask technology. The region enclosed by N^+ regions comprises the injection logic gate structure.



Conventional NPN transistor using seven mask technology.

MASKLIST

–	=	SILICON P-TYPE SUBSTRATE
BN	=	BURIED N DIFFUSION
–	=	N-TYPE EPIT AXIAL LAYER
DP	=	DEEP P DIFFUSION
DN	=	DEEP N DIFFUSION
SP	=	SHALLOW P DIFFUSION
SN	=	SHALLOW N DIFFUSION
CO	=	CONTACT WINDOWS
IN	=	ALUMINIUM INTERCONNECTION

function. Because of this sharing small volume runs are practical.

As the base pattern of transistors/gates is already implemented, the remaining design effort is greatly reduced and simplified to specifying the connectivity of the gates to implement the required function. This ensures rapid design, quick tooling and fast wafer processing, which are traded for optimum transistor design, flexibility and packing density.

The basic advantages of the gate array concept are:

- Minimised chip engineering
- Fast design turn-around
- Fast tooling turn-around
- Fast production turn-around
- Simplified CAD software
- Inexpensive tooling
- Low design risk
- High circuit reliability
- Predictable yields
- Predictable performance
- Design security

AST's Gate Array's

Integrated Injection Logic (IIL), also known as Merged Transistor Logic (MTL), was selected in preference to the other bipolar logic families, (RTL, TTL and ECL), because IIL offers the best compromise between speed of operation, and power dissipation and high packing density.

Input and output buffers placed around the periphery of the gate array have been specially designed to translate the 0 to 0.7V swings of IIL to CMOS and TTL compatible levels.

Prototype chips are usually packaged in 40 pin DIL packages where, as production parts, may be mounted in the package type selected by the customer. The chips may be manufactured to commercial, professional or military standards.

Turnaround time is typically six to eight weeks but is expected to reduce to three weeks once stocks of uncommitted wafers are built up. The cost of the customer used software is $500 and processing prototype quantities is under $6000 for which the customer receives five packaged and five unpackaged die for evaluation. Each wafer is probed to ensure that the process parameters are within specification.

Software

The software programs for AST fall into two categories: the first is that used by the customer on personal computer, and the second set of software is that used by AST itself to process the design and requires a mainframe computer. An IBM personal computer or equivalent is an ideal low-cost workstation; whilst not mandatory, AST do recommend one with enhanced graphics and a hard disk.

The software used by the customer is called the Designer's Kit and consists of several tools. The first is the geometrical

MASKMAKING

The Advanced Engineering Laboratory at Salisbury has capability in maskmaking that pivots around an early model DW MANN photorepeater. This machine is used to produce an array of patterns from a single mask as depicted in Figure 1. The input to the maskmaking system is in the form of magnetic tape containing the geometric data defining each layer of the circuit.

For the AST project, this tape is used to drive the photoplotter to produce original artworks of 50.8X final size. These artworks are reduced by 5.08X to produce the reticles (or intermediate masters) for the photorepeater. Each mask also contains the layer description for process control modules which allow Philips to verify their processing on each wafer. Artwork, reticles and masks are inspected at each state to ensure that dimensions remain within tolerances. Following labelling and final inspection the completed masters are passed to Philips Microelectronics.

To keep development costs low, AEL has been providing Philips with emulsion masters, which are generally not sufficiently robust to withstand the rigours of the production environment. The development circuits have been fabricated in small numbers so this lack of robustness has not been a problem. When production of the Gate Array begins, AEL will supply Philips with chrome on glass masters that are significantly less susceptible to damage. Microengineering Section has the capability to produce antireflective chrome masters and has already done so for use in other projects. The custom masks for defining the metallisation layer on the production Gate Arrays will consist of a single mask which can be delivered within two days of receipt of the magnetic tapes.

As indicated above, maskmaking represents only a minor element of the overall capabilities of the Microengineering Section of AEL. Because the Section is fundamentally an experimental and prototyping facility, it is not subject to the constraints binding other production facilities. The following projects are presented as examples of the unusual nature of some of the Section's work.

The first example is a Surface Acoustic Wave device which is illustrated in Figure 2. The device consisted of input and output transducers separated by 40.04 ± 0.005 mm. The transducers were a mirror image pair and consisted of 14 interdigitated line pairs of 5.5 μm width separated by 5.5μm. Because of the physical limitations of the photoplotter, it was impossible to plot the artwork for this device. However, the pattern was generated by exploiting the capabilities of the DW MANN photorepeater.

A single transducer which was plotted at 100X final size was reduced to 10X final size. A mirror image of this reticle was obtained photographically to produce the reticle for the other transducer. An emulsion master was produced on the photorepeater by firstly exposing the image of one transducer onto a

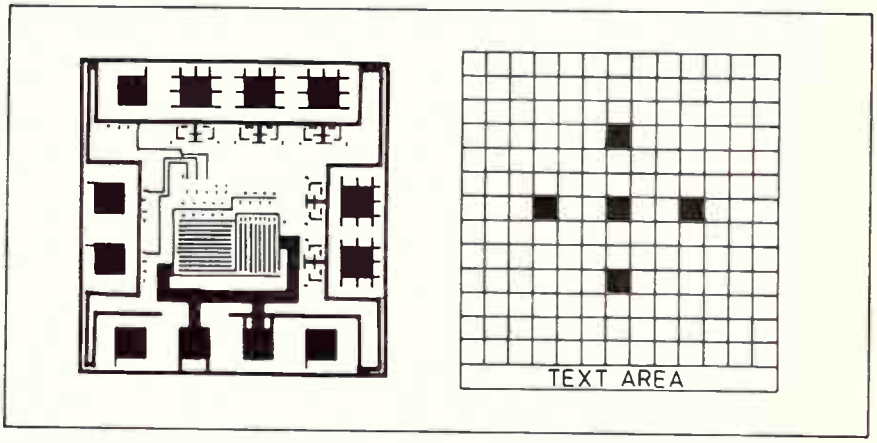


Fig. 1 Producing the mask. Dark chips are Process Control Modules.

editor which uses a Microsoft Mouse or compatible pointing device to make selections from various menus, to place components such as gates, flipflops and pads within the circuit, and to interconnect them with wires. Points in the circuit, or nodes, can be named by the designer for reference later by the simulator programs. Comprehensive help facilities are offered. The circuit schematic can be sent to a printer.

An important objective of the editor program is that it be very simple to use. A circuit can be designed by simply interconnecting the appropriate logic symbols and there is no need to know anything about IIL technology. Further, using the editor is easy in that the rules are, in general, point with the mouse and press the left button to place a component, point and press the right button to remove a component.

The remaining tools in the Designer's Kit are concerned with verifying the function of the circuit. Firstly a validation process is carried out to check the design; for example, that outputs from two or more gates are not connected together (hard-wired OR logic is not allowed), and that the customer is warned if an input to a gate is not connected. Errors and warnings are reported with co-ordinates which pinpoint the location of the problem in the schematic layout so that it may be readily found. If there are no serious errors an expansion process then expands flipflops and other marcocells into their IIL gate implementation, and actually configures the circuit in terms of IIL gates. This expansion process is the only component of the Designer's Kit that knows about the fabrication technology. AST also has a TTL and will have ECL and CMOS versions of the expansion program in the near future which will allow alternative technologies to be used.

From the expanded circuit description, a simulation program is used to predict the behaviour of the original circuit; points, or nodes in the circuit can be observed and can be driven with predefined values. The validation, expansion and simulation programs are packaged in a convenient way so that they may be invoked one after another by typing only one command. Subsequent simulation runs can be executed immediately since there is no need to validate and expand the circuit again unless changes have been made to it.

The simulator in the Designer's Kit sees devices simply as switches with three possible values: high, low and unknown. Since the actual wiring paths of the gate array structure are still unknown, this simulator uses gate propagation delays as its time step. This is adequate to detect the majority of timing problems in a circuit.

Nodes in the circuit are referred to by the names given when designing the circuit with the editor. Nodes can be driven with test vectors which can be captured together with the circuit response, for use later in the more detailed simulation, and for testing prototype chips.

Once a design has been completed the information is transferred to AST via floppy disk or dialup facilities at the South Australian Institute of Technology for subsequent processing. First an automatic routing program places the gates and macrocells onto the gate array structure and wires them appropriately. Standard cells have also been catered for. Since the circuit path lengths are now known, a more detailed simulation of the circuit is then undertaken by AST and the results of this simulation are reported to the designer for confirmation that the circuit performs according to specification. Finally, the data geometrically describing the layout is converted in a CIF-to-Gerber program to that required to drive the photoplotter to generate the masks for chip fabrication.

All of the programs described have been developd by AST specifically for this semi-custom service. AST also has other software programs available which may be more suitable for different custom and semi-custom requirements.

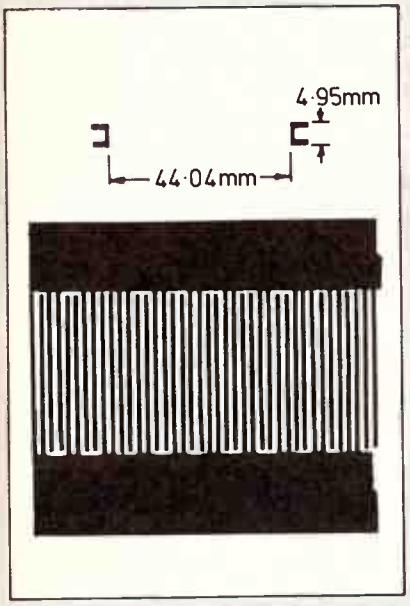


Fig 2. Surface Acoustic Wave Device showing transducer detail.

photographic plate, replacing the reticle with its accurately registered mirror image, stepping the photorepeater across by the appropriate distance and then exposing the image of the other transducer. The resulting master was used to successfully fabricate the SAW.

Following the successful fabrication of thin film thermocouples on neoprene rubber which recorded temperature transients of 1000°C in a few milliseconds, the section was asked to fabricate thin film thermocouples of extremely low thermal mass. They were fabricated by evaporating the thermocouples materials through metal stencil onto a tensioned 2 micrometre Mylar film. Although the minimum detailed size of 0.1 mm (see Figure 3) is large by microelectronic standards, this project presented some novel challenges.

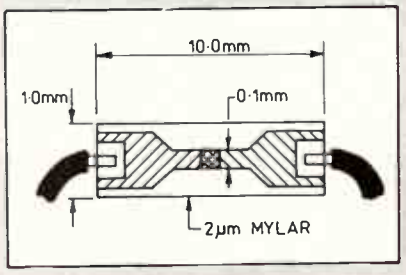


Fig 3. Thin Film Thermocouple for Propellant Studies.

A final example is a thick film hybrid EPROM module. It has a storage capacity of 512 kbits and has a footprint of 50 x 25 mm.

The circuit employs multilayer technology and contains five conductor layers. The unusual aspect of the example if that suitable unpackaged EPROM dies could not be obtained, even though the device was available in packaged form. A number of packages were purchased and "reverse engineered" to remove the ICs from the packages.

Henry Kutek

A case study

The circuit under consideration is best described as a state variable control system. The controller monitors the input states and switches selected outputs on for a preprogrammed amount of time depending on the value of the inputs.

An expected production requirement of 2500 units per year means that implementation of this circuit on a gate array would be the most cost effective approach.

The existing design employs the follow-

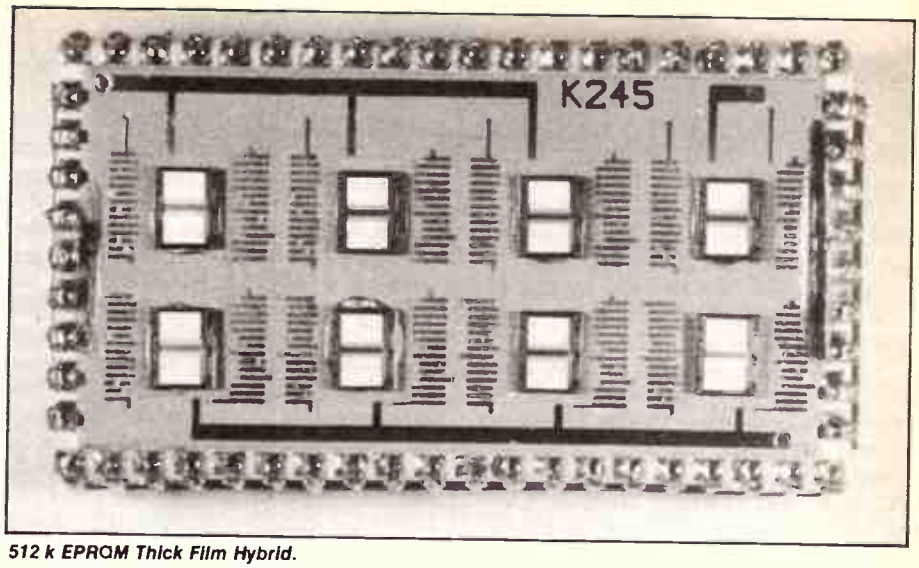
ing MSI chips: 4077, 4043, 4081, and 4520 which are surface mounted on a hybrid. In this case the whole circuit may be incorporated on a single gate array. However, for larger designs where more than one ASIC is required the circuit must be partitioned in a way that minimises the ASIC count. Factors to be considered are:

- the number of pins required for both signals and poewr must be able to be incorporated by the ASIC selected;
- critical timing paths should, as far as possible, be placed on chip; and
- the I/O requirements of the ASIC used must be compatible with the external circuitry.

Once the system has been defined and a block diagram drawn, AST will provide a detailed quotation on prototyping and production costs for the ASIC's. This allows the customer to evaluate the best approach of implementing their design. ●

AST Designer's Kit:	
Schematic entry	**Customer**
Simulation	**or AST**
Test Vectors	
Not List	
↓	
Automatic Gate Array Layout	**AST**
↓	
Detailed Simulation	**AST**
Confirmation by Customer	
Design Correct	**Customer**
↓	
Generation Mask Tape	**AST**
Mask Manufacture	**DRCS**
↓	
Chip Manufacture	**Philips**
Packaging	**Philips or AST**
↓	
Testing Chips	**Customer Philips or AST**

Figure 1. Steps in the production of an AST gate array.



512 k EPROM Thick Film Hybrid.

M. R. Haskard, B. Inwood, M.A. Macdonald and G. Pouferis work at the Microelectronics centre, SAIT, Adelaide. Henry Kutek is at the Advanced Engineering Laboratory, Salisbury, SA. John Crawford is with Philips Microelectronics, Hendon, SA.

WHO'S WHO IN SEMI CONDUCTORS

This list covers all the main players in the field of semi conductors in Australia. While we have tried to be reasonably comprehensive, note that omission from our list merely implies our data base was incomplete at the time of going to press.

AACI
18 Cleeland Road,
Oakleigh South 3167
(03) 543 3444

ACD ITRONICS
106 Belmore Road,
Riverwood 2210
(02) 534 6200

ACE ELECTRONICS
14 Primrose Avenue,
Rosebery 2018
(02) 693 0382

ADILAM ELECTRONICS
Suite 7, 145 Parker Street,
Templestowe 3105
(03) 846 2511

AIR & NOISE ENGINEERING (VIC)
34 Clarice Road,
Box Hill South 3128
(03) 890 0316

AJ DISTRIBUTORS
44 Prospect Road,
Prospect 5082
(08) 269 1244

ALL — SYSTEMS ELECTRONICS
16 Hope Street,
Seven Hills 2147
(02) 624 4644

ALL ELECTRONIC COMPONENTS
118-122 Londsdale Street,
Melbourne 3000
(03) 662 3506

ALLIED CAPACITORS
6/25 Chard Road,
Brookvale 2100
(02) 938 2041

ALTRONIC DISTRIBUTORS
174 Roe Street,
Perth 6000
(09) 328 2199

AMPEC ELECTRONICS
Unit 8, 142 James Ruse Drive,
Rosehill 2142
(02) 689 3522

AMTEX ELECTRONICS
36 Lisbon Street,
Fairfield 2165
(02) 728 2121

AP IMPORTS
41 Box Road,
Crossroads 2170
(02) 600 9722

APPLIED COMMUNICATIONS
389 St Georges Road,
North Fitzroy 3068
(03) 486 2299

APPLIED MEASUREMENT
27 Dalgetty Street,
Oakleigh 3166
(03) 568 0588

AVISUN
PO Box 1340,
Crows Nest 2065
(02) 438 3900

AWA MICRO ELECTRONICS
422 Lane Cove Road,
North Ryde 2113
(02) 887 7355

BALTEC SYSTEMS
26 Mayneview Street,
Milton 4064
(07) 369 5900

BJE ENTERPRISES
35 West Parade,
Eastwood 2122
(02) 858 5611

BRYAN CATT INDUSTRIES
10/59 Gymea Bay Road,
Gymea 2227
(02) 526 2222

CENTRE FOR INDUSTRIAL MICROELECTRONICS
3rd Floor,
449 Swanston Street, 3000
(03) 660 5111

COLTRONICS
6 Stanley Street,
Silverwater 2141
(02) 647 1566

DELSOUND
1 Wickham Street,
Brisbane 4000
(07) 839 6155

DICK SMITH ELECTRONICS
Cnr Lane Cove & Waterloo Roads,
North Ryde 2113
(02) 888-3200

DYNAMIC COMPONENT SALES
PO Box 476,
Ringwood 3134
(03) 873 4755

ELECTRONIC DEVELOPMENT SALES
92 Chandos Street,
St. Leonards 2065
(02) 438 2500

ELECTRONIC DISCOUNTERS
305 Morphett Street,
Adelaide 5000
(08) 212 1799

ELECTRONIC WORLD
30 Lacey Street,
Croydon 3136
(03) 723 3860

ELECRONICS & SEMICONDUCTOR
Unit 4, Cnr. Barrie Road — Adina Court, Tullamarine 3043
(03) 370 5522

ENERGY CONTROL INTERNATIONAL
26 Boron Street,
Sumner 4074
(07) 376 2955

FAIRMONT MARKETING
Suite 3, 208 Whitehorse Road,
Blackburn 3130
(03) 877 5444

FASTRON PTY LTD
11 Kembla Street,
Cheltenham 3192
(03) 584 8988

FERRANTI COMPUTER SYSTEMS
2A Mavis Street,
Revesby 2212
(02) 708 6655

FORCE ELECTRONICS
203 Wright Street,
Adelaide 8000
(08) 212 5400

FUJITSU AUST P/L
41 McLaren Street,
North Sydney 2060
(02) 959 6555

GEOFF WOOD ELECTRONICS
229 Burns Bay Road,
Lane Cove West 2066
(02) 427 1676

GEORGE BROWN ELECTRONICS GROUP
174 Parramatta Road,
Camperdown 2050
(02) 519 5855

HI-COM UNITRONICS
7 President Lane
Caringbah 2229
(02) 524 7878

HITACHI AUSTRALIA
18th floor, 111 Pacific Highway,
Nth Sydney 2060
(02) 929 8799

INTEL
Level 6, 200 Pacific Highway,
Crows Nest NSW 2065
(02) 957 2744

IRH COMPONENTS
92 Parramatta Road,
Lidcombe 2141
(02) 648 5455

JAYCAR ELECTRONICS
115-117 Parramatta Road,
Concord 2137
(02) 747 2022

JED Microprocessors
7/5-7 Chandler Road,
Boronia 3155
(03) 762 3588

MACRO DYNAMICS
80 Lewis Road,
Wantirna South 3153
(03) 220 7260

MAGRATHS
202 Bell Street,
Preston 3072
(03) 487 3335

MIMAKA
57 Tyron Road,
Lindfield 2070
(02) 467 2629

MOTOROLA SEMICONDUCTOR
250 Pacific Highway,
Crows Nest 2065
(02) 438 1955

NSD AUSTRALIA
205 Middleborough Road,
Box Hill 3128
(03) 899 0819

NATIONAL SEMICONDUCTOR
11 Khartoum Road,
North Ryde 2113
(02) 887 4455

NEXUS ELECTRONICS
Unit 8, James Ruse Drive,
Rosehill 2142
(02) 891 1444

NOVOCASTRIAN ELECTRONIC SUPPLIES
24 Broadmeadow Road,
Broadmeadow 2292
(049) 62 1358

PARAMETERS
25-27 Paul Street North,
North Ryde 2113
(02) 888 8777

PHILIPS
11 Waltham Street,
Artarmon 2064
(02) 439-3322

PLESSEY COMPONENTS
Christina Road,
Villawood 2163
(02) 72 0133

PRESTON ELECTRONIC COMPONENTS
217 High Street,
Preston
(03) 484 0191

PROMARK ELECTRONICS
6 Clarke Street,
Crows Nest 2065
(02) 439 6477

R & D ELECTRONICS
4 Florence Street,
Burwood 3125
(03) 288 8911

RADIOSPARES COMPONENTS
28-30 Northwood Street,
West Leederville 6007
(09) 381 4799

RAE INDUSTRIAL ELECTRONICS
178 Pacific Highway,
St Leonards 2065
(02) 439 7599

RESERVE ELECTRONICS
24 Brisbane Street,
East Perth 6014
(09) 328 9755

RIFA
202 Bell Street,
Preston 3072
(03) 480 1211

ROD IRVING ELECTRONICS
48 A'Beckett Street,
Melbourne 3000
(03) 663 6151

RVB PRODUCTS
242 Huntingdale Road,
Huntingdale.
(03) 568 3588

SGS THOMSON MICROELECTRONICS
Suite 211, Edgecliff Centre,
203-233 New South Head Road,
Edgecliff 2027
(02) 327 3922

SIEMENS INDUSTRIES
544 Church Street,
Richmond 3161
(03) 420 7111

SINGAPORE TRADE DEVELOPMENT BOARD
1 Alfred Street,
Sydney 2000
(02) 233-7015

SKANDIA ELECTRONICS
183 Burwood Road,
Hawthorn 3122
(03) 819 2466

SOANAR
30-32 Lexton Road,
Box Hill 3128
(03) 895-0222

ST LUCIA ELECTRONICS
24 Campbell Street,
Bowen Hills 4006
(07) 527 4666

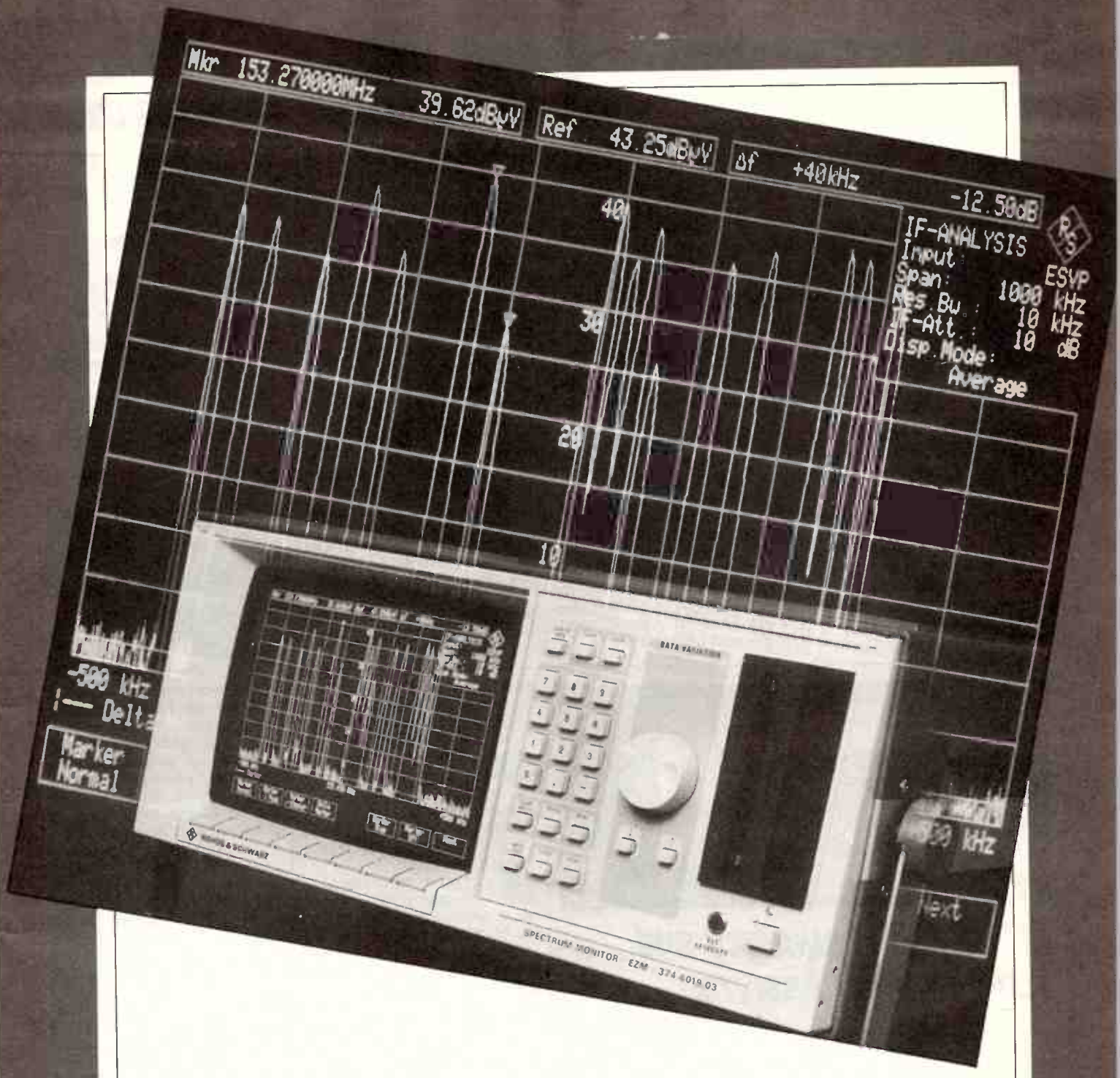
TEXAS INSTRUMENTS
6-10 Talavera Road,
North Ryde 2113
(02) 887-1122

THE COMPONENT SPECIALISTS
11 Manston Street,
Elizabeth South 5112
(08) 252-2292

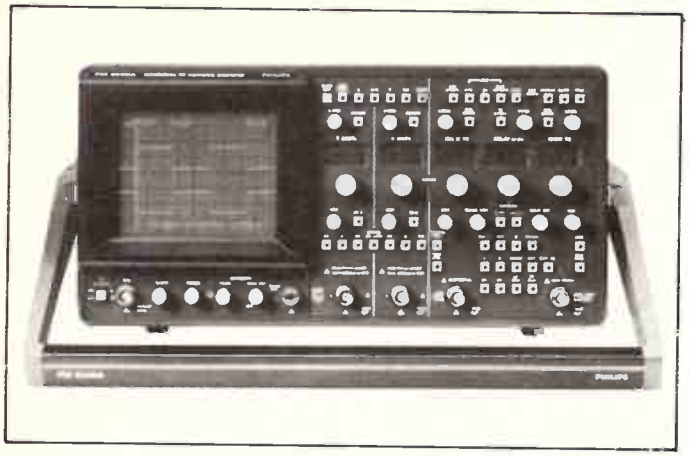
TOTAL ELECTRONICS
9 Harker Street,
Burwood 3125
(03) 288 4044

VSI ELECTRONICS
16 Dickson Avenue,
Artarmon 2064
(02) 439 4655

WESTINGHOUSE BRAKE & SIGNAL CO.
80 Douglas Parade,
Williamstown 3016
(03) 397 1033



Test & Measurement



Philips Oscilloscopes

The new Philips PM 3296A and PM 3286A VHF oscillosopes feature a memory for 75 complete front-panel settings. These settings are stored in non-volatile memory, and can be recalled instantly whenever required using a unique infra-red remote control unit.

As well as economy in production environments, where it can eliminate the need for an external computer, this remote-control facility is also valuable for operation in hazardous environments or inaccessible locations, where normal manual control would be impossible.

READER INFO No. 175

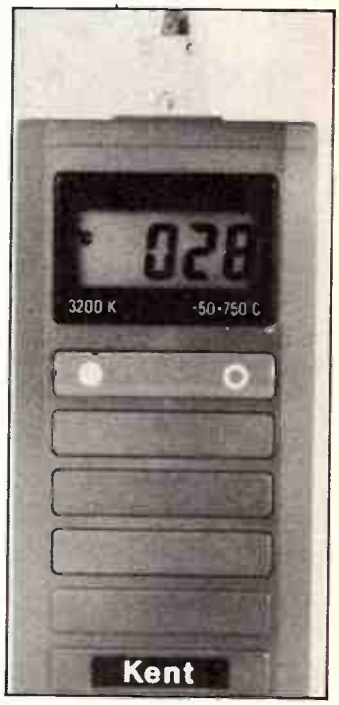
Digital Temperature Indicator

Kent Instruments have released a new pocket-sized digital temperature indicator for temperature measurement in the range −50 to 750°C.

Designated the Kent Model 3200K Hand-Held Digital Temperature Indicator, it utilises a blend of proven circuitry and the latest high performance, low power technology. The instrument is suitable for use with all Type K thermo-couple probes, connection being by means of a miniature thermocouple plug.

The Kent Model 3200K is packaged in an extremely robust, waterproof, moulded case which is ergonomically designed to allow for single-handed operation. A large 3½ digit display provides a clear indication of temperature even under the poorest ambient lighting conditions.

READER INFO No. 176



HP 5371A Frequency and Time-interval Analyzer

Hewlett-Packard's new frequency and time-interval analyzer provides statistical analysis and time-profiling of such parameters as frequency, phase, time-interval and jitter on dynamic conditions on the HP 5371A is made possible by new continuous-measurement technology, which makes measurements at rates up to 10 x 106 results/second.

The HP 5371A's measurement rate makes possible analysis as a function of time. This is sometimes referred to as time-sampling. Just as a voltage digitizer adds the time dimension to voltmeter measurements, the HP 5371A displays frequency or time-interval variation with time, just as a conventional sampling oscilloscope displays voltage variation with time.

The HP 5371A offers a wide selection of basic measurements, resulting in increased flexibility for the analysis of complex signals. This versatile analyzer can measure, store, analyze and display blocks of up to 1000 single-result or 500 dual-result measurements for the following types and ranges:

- Frequency from 0.125 Hz to 500 MHz;
- Phase;
- Period from 2 ns to 8 seconds;
- Time interval;
- Pulse rise and fall times from 1 ns to 100 microsecond transitions;

To achieve this performance, HP uses a new instrument architecture. Signals to be analyzed are connected to a proprietary two-channel, counter-like measurement unit with wide bandwidth input, triggering circuitry, and continuous-counting registers. A high-speed, 1000-measurement memory samples and stores input-signal timing information contained in the continuous-counting registers. Signal-processing firmware then reduces the stored data based on the measurment type selected.

An external triggering and arming input combined with multilevel triggering criteria allows the user to choose conditions that start the measurement block as well as define the conditions to trigger the individual measurements in the block.

For example, the start of a measurement block can be set up to occur at an arming edge or after a specified number of events or time. Then the individual measurements in the block can be set to occur on edges, at time intervals or on cycles of the input signal. In addition, automatic and default modes are provided to aid in initial setup.

HP has a special design that permits count totals to be sampled at rates to 10 MHz for input signals to 500 MHz, without interrupting the counting process. In continuous mode, the HP 5371A's count registers are never reset from one measurement to the next. Three, 32-bit-count chains operate simultaneously for arming or measurements.

In addition to sampling data at high speed, the HP 5371A custom IC interpolates time for each measurement to a 200ps least-significant digit, sends the results to memory, and rearms for the next measurement in less than 100 ns.

For more information contact H-P on (03) 895 2895.

READER INFO No. 177

Marconi Sweep Generator

Marconi Instruments has released the new 6311 Programmable Sweep Generator. With applications in scalar network analysis, active device measurements and ATE testing, the 6311 now covers 0.01 to 20 GHz in a single sweep. This extended range means the instrument now covers IF, HF, VHF and UHF frequencies under 1 GHz as well as military and civilian satellite links.

READER INFO No. 178

Model 37

The FLUKE model 37 has just been released through a new distribution company, Obiat. It features full annunciation of function and range. It is also claimed to have high accuracy and excellent resolution from the 3200 count combined analogue/digital display. The unit is equipped with full shielding against electromagnetic interference and electrical overload. It has minimum, maximum, relative reading and touch hold modes, and a diode test and continuity beeper function.

For further details on the 37 contact OBIAT on (02) 698-4776.

READER INFO No. 179

YOKOGAWA 3655E and 3656 WAVEFORM ANALYZING RECORDERS

Recently released from Parameters Pty Ltd is the Yokogawa 3655E/3656 Analyzing Recorder Range. The instruments provide simultaneous measurement, computation, display and plotting on two input channels. A choice of 8K or 32K words/channel is available. Ranges include (± 60 mV to 60 ± V) AC and DC volts and five types of cold junction compensated thermocouple inputs. Larger voltages and currents can also be accommodated. The Yokogawa 3656 may be used as a digital data logger, continuous pen recorder, transient recorder, temperature recorder, FFT analyzer, oscilloscope and oscillograph recorder. The 3655E/3656 consolidates all of these features into a simple all-in-one instrument which provides convenient measurement and quick accurate analysis.

Both instruments have 32K words/channel and the 3656 can digitise signals at a rate of up to 5MHz with 10 bit resolution. The Yokogawa 3655E and 3656 utilize simple menu programming with soft key control, have a 7" CRT waveform display in addition to zooming and scroll features which provide increased waveform detail. Furthermore, the instrument comes with a built-in high speed 4 colour digital plotter. A flexible plotting mode allows information to be plotted in real time and money.

In memory mode both instruments provide numerous display formats. On the 3656 input signals are sampled at a rate of up to 0.20μS/word and the waveform is displayed on the CRT screen. Once the waveform has been varified the operator can plot the displayed signals out. Waveform ranging from DC to fast changing signals can then be accurately analyzed.

In the basic two channel format these instruments cost around $10,000.00. Additionally a data memory module, GPIB or RS-232C interface and an FFT module may all be optionally fitted. The 3655 and 3656 instruments will also trigger off an external event capturing a single shot transient in a similar fashion to a UV recorder. This feature coupled with the unit's frequency analysis capability (FFT) will also allow the instrument to measure, analyze, compute and plot for example, on-line load regulation characteristics, 50Hz harmonics fluctuations or bearing vibration.

READER INFO No. 171

Highest Resolution

Image Analysising Services (IAS) has installed CADAM software sourced from the Lockheed company in the US. The company claims this gives it the highest resolution of any CAD bureau in the country, with 1024 x 1024 pixels.

CADAM (Computer Augmented Design and Manufacture) was produced by CADAM Inc, a subsidiary of Lockheed in 1985. The product runs on an IBM 4361 M5 mainframe, and customers can either make use of this system at the IAS premises, or alternatively, use a remote control terminal in their own office.

To maximise the value of the system, IAS run an extensive variety of training courses to familiarize draughtsmen and engineers with the facilities available on the equipment. Alternatively, they can provide a complete service themselves.

CADAM was designed to a requirement from Lockheed for extensive CAD facilities. It is composed of number of modules centres on a CADAM interactive base. These include an I/O module for numerical control, 3D modelling, printed circuit board design, a design/build/manage module and so on.

The interactive solids modeler, for instance, comes with an extensive set of geometric primitives, from which comprehensive 3D models can be built up. There is a choice of how the model is displayed. It can be a wireframe, have hidden lines removed, or have different colour specified for different bits. Finally, almost photographic quality images can be displayed on the screen, with realistic shading and definable light sources. More importantly, fourteen mass properties can be specified for each solid, and then it can be assigned a part in a large shape. When dealing with a number of solids on the screen, it can look for interference between the two solids, or tell the operator the smallest distance between them.

For more information, contact IAS on (03) 584-8088.

READER INFO No. 172

UPA Driver Software

The UPA audio analyser from Rohde and Schwarz is an extremely powerful and versatile instrument capable of operating in three modes:

- Manual
- Manual plus talk only, ie, direct transfer of measured values by IEEE-488 bus to printer without the need of a controller.
- Automatic, controlled by a computer with IEEE-488 interface.

For normal applications an IBM Compatible XT-PC is suitable if fitted with a GPIB interface card. For test item control it is usually desirable to also include an interface card with TTL or relay contacts for test item control.

Comprehensive UPA software for the PC is theoretically possible for general purpose testing. However, since the introduction of the UPA to the Australian market the only apparent common feature in client test requirments is that they are all different. Therefore any software would need to be extremely lengthy, with very extended dialogue facilities to allow selection of the required tests. This would make it both tedious to use and complex to modify to individual requirements.

Instead Rhode & Schwarz are offering a driver software package which will allow them to:

- operate the UPA automatically
- readily extend the programme from the building blocks provided, to suit their requirements.

The driver software, in dialogue form, allows the user to select some, any or all of the following:

- frequency response
- level compression
- distortion
- signal to noise ratio
- Sinad
- wow and flutter

and for stereo systems:

- cross talk
- phase angle

In each case the user can nominate the required frequency and measurement range plus instrument settings, eg, which filters are to be used, RMS or quasi peak detetection, etc. Measured results are displayed in tabular form on the VDU and can be printed out as hard copy. The software is supplied on 5 ¼" floppy disk with operating instructions. The language is GW-BASIC.

READER INFO No. 173

Mass storage For LeCroy

Two new packages for LeCroy's 9400 digital storage oscilloscope are you available through ETP Oxford. They allow full, partial or segmented waveforms to be stored and retrieved. Partial waveform storage allows the user to record only that section of the waveform that is of interest, ensuring efficient storage and allowing storage of hundreds of waveforms on a floppy disc. Front-panel setups can also be stored so that the conditions under which waveforms were recorded are always known, so exactly the same measurement can be repeated in the future. Date and time stamps complete the waveform documentation.

For further information contact ETP Oxford (02) 858-5122

READER INFO No. 174

The 6060B From Elmeasco

Elmeasco have released the 6060B from Fluke. This high quality general purpose signal generator can handle a wide range of assignments in the 10 kHz to 1 GHz range, testing a variety of RF instruments and components. Whether your application is land mobile, tactical communication, rf components, or pagers, the 6060B delivers the performance of much more expensive generators.

The 6060B is programmable from −147 dBm to above +13 dBm with 0.1 dB resolution, for sensitivity and dynamic range testing. It offers extensive modulation versatility; for example, simultaneous combinations of internal and external AM and FM. And accuracy is ±1.0 dB from an amplitude range from −127 to +13 dBm (0.1μV to 1V).

A number of amplitude features, including Relative Amplitude, RF On/Off, and Fixed Range add operating convenience and save testing time. The Fixed Range mode, used for squelch testing in radios, inhibits the switching of the attenuator sections, forcing the 6060B to use its electronic amplitude control for monotonic amplitude control.

Laser Loss Set

Scientific Devices are distributing a paired optical power meter and stable laser source in a single unit. Its called the Intelco 160A. The paired transmitter and receiver enable highly accurate readings of losses in a fibre or optical component.

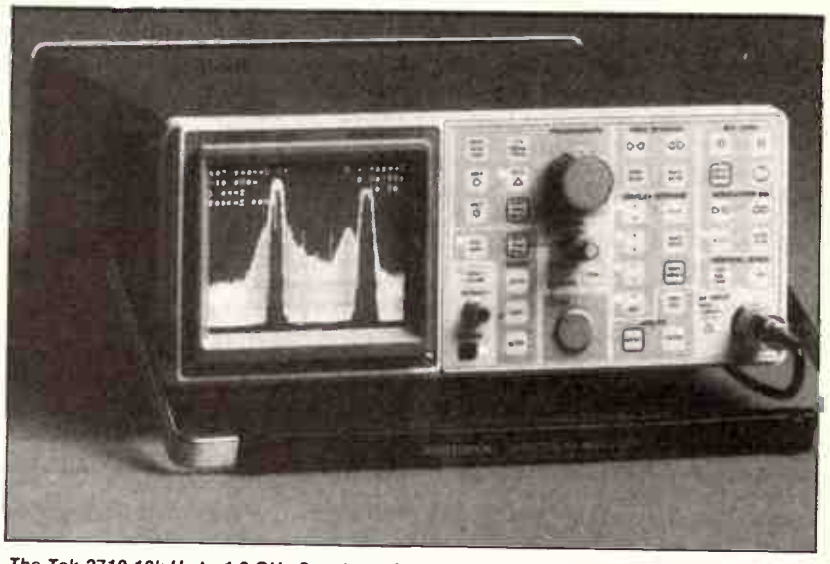
The unit is available at 1300/1500, 1300 or 1500 nm output. The 1300/1500 mode is multiplexed together. There are two separate laser source to provide the different outputs and they can be electronically switched. It has a LCD display on the front panel that shows lass, power and wavelength. The unit is advertised as accurate to within 0.5 dB with a 0.001 dB resolution. Dynamic range is from +0.5 to −70 dBm.

For more information contact Scientific Devices on (03) 579-3622.

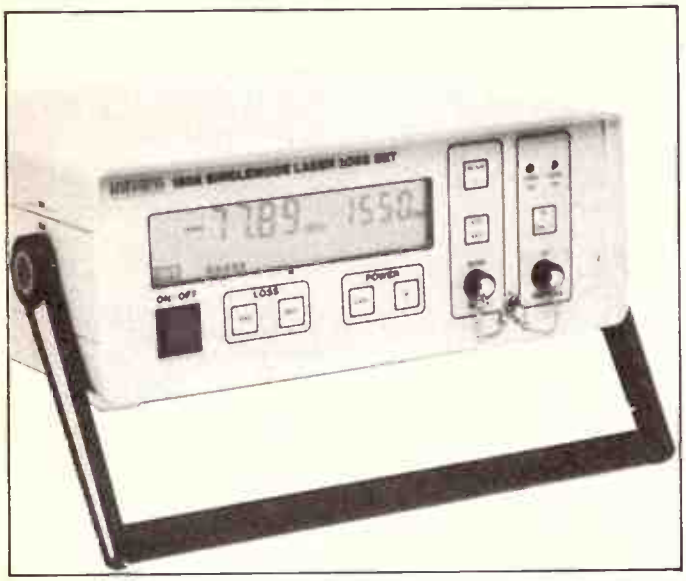
READER INFO No. 183

Brüel & Kjær printer

The instrument company B & K has just released a hard copy generator that can plug into its instruments. The graphic documentation printer type 2318 is a small, lightweight, battery-operated printer for graphic and alphanumeric printouts from instruments with a serial interface. When it is used with Brüel & Kjær's Modular Precision Sound Level Meter Type 2231, all information necessary for an accurate analysis of the measurement data (e.g. bandwidth, range, weighting factor, and mod-



The Tek 2710 10k Hz to 1.8 GHz Spectrum Analyzer from Tektron. READER INFO No. 180



The Intelco 160A single mode Laser Loss Set.

ule in use) is recorded on the printout. A space is left for the operator to record any extra information. The presentation of data from the Type 2231 can be in the form of fully annotated graphs, tables or multi-component bar charts, a brand new feature.

Many different characters are available. Apart from the ISO 7-bit character set — equivalent to US ASCII — the characters from Japanese (Kana), as well as most European languages including Greek and Russian are available. There are two special character sets: a user-definable character-set in which you can make use of a 7x7 matrix to define all the 96 characters to suit your own needs; and a graphic set known as Picture Description Instruction which is used for the production of histograms, graphs, and lines.

When connected to B & K sound level meters, the printer ensures that printing noise does not affect the validity of measurements. While the data is being printed out it temporarily prevents measurement from taking place. Hold-ups are generally prevented by the unusually large character buffer capacity which can contain approximately 500 lines of text.

For more information contact B & K on (03) 370-7666.

READER INFO No. 181

New Swedish Measurement Probe

A new high performance measurement probe intended for surface mounted semiconductor components has been launched by AMCO of Sweden.

Designated the SMOCC (Signal Measurement On Chip Carrier) it works by the use of vacuum and individual resilient pins, one for each pad connected to the carrier.

The SMOCC does not need any manual power after it is placed on the component. This makes hands free measurement possible of all signals coming into and out from the carrier at the same time.

Used with a digital analyzer, the SMOCC makes it easy to make signal groups that suit the different signal functions on the carrier. A typical example is that addresses into a RAM may have their own group as well as data WE and CS signals.

For further information contact Mr Ron Parker at Fairmont Marketing, Suite 3, 208 Whitehorse Road, Blackburn, Vic. Telephone (03) 877 5444.

READER INFO No. 182

WHO'S WHO IN TEST AND MEASURING INSTRUMENTS

This list covers all the main players in the field of manufacturing or distributing test and measuring instruments in Australia. While we have tried to be reasonably comprehensive, note that omission from our list merely implies our data base was incomplete at the time of going to press.

A & I ELECTRONICS
640 Warrandyte Road,
North Ringwood 3134
(03) 876 1159

ACET
PO Box 67,
Mt Hawthorn 6016
(09) 446 9090

ACME ELECTRONICS
205 Middlesborough Road,
Box Hill 3128
(03) 890 0900

AEGIS
141 Christmas Street,
Fairfield 3078
(03) 481 1422

AJ DISTRIBUTORS
44 Prospect Road,
Prospect 5082
(08) 269 1244

ALFATRON
1761 Ferntree Gully Road,
Ferntree Gully 3156
(03) 758 9000

ALL ELECTRONIC COMPONENTS
118-122 Londsdale Street,
Melbourne 3000
(03) 662 3506

ALTEST ELECTRONICS
37 Benwerrin Drive,
Burwood East 3151
(03) 233 5744

ALTRONIC DISTRIBUTORS
174 Roe Street,
Perth 6000
(09) 328 2199

AMALGAMATED INSTRUMENT
7/12 Tepko Road,
Terrey Hills 2084
(02) 450 2661

AMPEC ELECTRONICS
Unit 8, 142 James Ruse Drive,
Rosehill 2142
(02) 689 3522

AMS TECHNICAL SERVICES
PO Box 87
Camberwell Vic 3124
(03) 25 4515

AMTEX ELECTRONICS
36 Lisbon Street,
Fairfield 2165
(02) 728 2121

ANITECH INSTRUMENTS DIVISION
1 Carter Street,
Liccombe NSW 2141
(02) 648 4088

ANSETT TECHNOLOGIES
Parer Road,
Airport West 3042
(03) 668 1122

AP IMPORTS
41 Box Road,
Crossroads 2170
(02) 600 9722

APPLIED MEASUREMENT
27 Dalgetty Street,
Oakleigh 3166
(03) 568 0588

ARLEC
30-32 & 42-46 Lexton Road,
Box Hill 3128
(03) 895 0222

ARLIN ELECTRONICS
85 Chadstone Road,
Chadstone 3148
(03) 569 6984

ASSOCIATED CALIBRATION LABORATORIES
27 Rosella Street,
Doncaster East 3109
(03) 842 8822

ASSOCIATED CONTROLS
342 Kent Street,
Sydney 2000
(02) 29 6731

AUSTRALIA MEASUREMENT & CONTROL
222 Bay Street,
Port Melbourne 3207
(03) 646 5255

AWA INSTRUMENTATION
Cnr Talavera & Lane Cove Roads,
Macquarie Park North Ryde 2113
(02) 887 7111

BALTEC SYSTEMS
26 Mayneview Street,
Milton Qld 4064
(07) 369 5900

BASSTECH
Unit 3, 12 Gordon Street,
Bairnsdale 3875
(051) 52 5500

BELL INSTRUMENTS
74 Raglan Street,
Preston 3072
(03) 44 5021

BELLCO CONTROLS
15 Hume Street,
Huntingdale 3166
(03) 874 2677

BENELEC
581 Gardeners Road,
Mascot 2020
(02) 693 5111

BRANDNER AUST
20 Shasta Avenue,
Brighton 3186
592 4298

BRIAN GRIFFIN
8 Hargrave Street,
East Sydney 2010
(02) 357 4978

BRUEL & KJAER
24 Tepko Road,
Terrey Hills 2084
(02) 450 2066

CLIFF ELECTRONICS
PO Box 732,
Fortitude Valley Qld 4006
(07) 341-4655

COLTRONICS
6 Stanley Street,
Silverwater 2141
(02) 647 1566

COMBUSTION ENGINEERING AUSTRALIA
275 Middleborough Road,
Box Hill 3128
(03) 890 0201

Who's Who

CROMPTON INSTRUMENTS
Unit 19, 380 392 Airds Road,
Minto 2566
(02) 603 2066
CRUSADER ELECTRONICS
81 Princes Highway,
St Peters NSW 2044
(02) 519 5030
DATA ELECTRONICS
46 Wadhurst Drive,
Knoxfield 3180
(03) 221 1277
DATAMATIC
9 Byfield Street,
North Ryde NSW 2113
(02) 888 1788
DGE SYSTEMS
103 Broadmeadow Road,
Broadmeadow NSW 2292
(049) 69 1625
DOBBIE INSTRUMENTS
18-20 George Street,
Sandringham 3191
(03) 598 8244
EAGLE ELECTRONICS
24 Unley Road,
Unley 5061
(08) 271 2885
ECOTECH
Factory 6, 22 Bridge Street,
Eltham 3095
(03) 439 5639
ECQ ELECTRONICS
16 Staple Street,
Jindalee 4074
(07) 376 5677
EDL AUSTRALIA
223B East Boundary Road,
East Bentleigh 3165
(03) 579 2722
ELECTRICAL EQUIPMENT
Unit C, 8 Lyon Park Road,
North Ryde, 2113
(02) 888 9000
ELECTRONIC COMPONENTS AND EQUIPMENT
64 Stuart Street,
Adelaide 5000
(08) 232 0001
ELECTRONIC DEVELOPMENT SALES
92 Chandos Street,
St Leonards 2065
(02) 438 2500
ELECTRONIC DEVELOPMENT AND SERVICES
27 Buckley Street,
Marrickville 2204
519 7007
ELECTRONIC DISCOUNTERS
305 Morphett Street,
Adelaide 5000
(08) 212 1799
ELECTRONIC SERVICE COMPANY
1/25 Garema Circuit,
Kingsgrove 2208
(02) 759 9055
ELLISTRONICS
289 La Trobe Street,
Melbourne 3000
(03) 602 3499
ELMEASCO INSTRUMENTS
12 Maroondah Highway,
Ringwood 3134
(03) 879 2266
ELMEASCO INSTRUMENTS
15 McDonald Street,
Mortlake NSW 2137
(02) 736 2888
EMAIL
15-17 Hume Street,
Huntingdale 3166
(03) 544 8244
EMONA INSTRUMENTS
86 Parramatta Road,
Camperdown NSW 2050
(02) 519 3933
ESTEC ELECTRONICS
1 Brewer Street,
East Perth
(09) 227 9455
ETP OXFORD
31 Hope Street,
Ermington NSW 2115
(02) 858 5122
EVERETT INTERNATIONAL
17 North Wood Street,
Leederville WA 6007
(09) 381 5500
FAIRMONT MARKETING
Suite 3, 208 Whitehorse Road,
Blackburn 3130
(03) 877 5444
FIBERNET
1/54 Malvern Street,
Bayswater 3153
(03) 729 7000
FISHER, K. D. & CO
14 Benjamin Street,
St Marys 5042
(08) 277 3288
FORCE ELECTRONICS
203 Wright Street,
Adelaide 5000
(08) 212 5505
GALAXY ELECTRONICS
777 Punchbowl Road,
Punchbowl 2196
(02) 708 5888
GEORGE BROWN ELECTRONICS GROUP
174 Parramatta Road,
Camperdown 2050
(02) 519 5855
HASLER PACIFIC
2 Patya Close,
Epping 2121
(02) 868 1131
HEWLETT PACKARD
31 Joseph Street,
Blackburn 3130
(03) 895 2895
HEYDEN-SPIKE
Unit 1, 91-93 Old Pittwater Road,
Brookvale NSW 2100
(02) 938 1566
KENELEC
38 Henderson Road,
Clayton 3168
(03) 560 1011
KENT INSTRUMENTS
70-78 Box Road,
Carringbah 2229
(02) 525 2811
KINGFISHER INTERNATIONAL
14 Excalibur Avenue,
Glen Waverley 3150
(03) 233 5998
LABTAM INTERNATIONAL
43 Malcolm Road,
Braeside 3195
(03) 587 14444
LAWRENCE & HANSEN
142 Dorcas Street,
South Melbourne 3205
(03) 697 1685
LEATHAM ELECTRONICS
8 Brodie Street,
Rydalmere 2116
(02) 684 2477
LINBROOK INTERNATIONAL
96 Reserve Road,
Artarmon 2064
(02) 438 4322
MACEYS ELECTRICAL
Suite 8, 9 Foamerest Avenue,
Newport 2106
(02) 997 8544
MARCONI INSTRUMENTS
2 Giffnock Avenue,
North Ryde NSW 2113
(02) 887 6222
MASTATEK
12/18 Leighton Place,
Hornsby 2077
477 6120
MASTER INSTRUMENTS
Corner Sloane & Saywell Streets,
Marrickville 2204
519 1200
MEASUREMENT CONTROL EQUIPMENT
16 Bridge Street,
Rydalmere 2116
(02 638 5166
MULTICORP
69 Boronia Street,
Redfern 2016,
(02) 698 5238
NATIONAL PANASONIC INDUSTRIAL PRODUCTS
95 Epping Road,
North Ryde 2113
(02) 886 0200
NEI PAKLOG
112 Christine Road,
Villawood 2163
(02) 727 0055
NILSEN INSTRUMENTS
200 Berkley Street,
Carlton 3053
347 9166
NOVATECH CONTROLS
429 Graham Street,
Port Melbourne Vic 3207
(03) 645 2377
NOVOCASTRIAN ELECTRONIC SUPPLIES
24 Broadmeadow Road,
Broadmeadow 2292
(049) 62 1358
OBIAT
129 Queen Road,
Beaconsfield 2015
(02) 698 4776
O'DONNELL GRIFFIN
37 Hargreaves Street,
Belmont 6104
(09) 277 1922
PACIFIC ELECTRONICS
54 Dow Street,
South Melbourne 3205
(03) 696 2522
PARAMETERS
25-27 Paul Street North,
North Ryde 2113
(02) 8888 777
PHILIPS SCIENTIFIC & INDUSTRIAL
25-27 Paul Street North,
North Ryde NSW 2113
(02) 888 8222, (008) 22 6661
PRE-PAK ELECTRONICS
1A West Street,
Lewisham 2049
(02) 569 9797
PRECISION INSTRUMENTS
5-6 Dunlop Road,
Mulgrave 3170
(02) 561 2888
PRESTON ELECTRONIC COMPONENTS
217 High Street,
Preston
(03) 484 0191
RACAL ELECTRONICS
47 Talavera Road,
North Ryde 2113
888 6444
RADIOSPARES COMPONENTS
28-30 Northwood Street,
West Leaderville 6007
(09) 381 4799
RF DEVICES
Suite 2, P' ck A,
9 Lyn Parade Lurnea 2170
(02) 267 2622
ROHDE & SCHWARZ
13-15 Wentworth Avenue,
Darlinghurst 2010
(02) 671 5588
SAM TECHNOLOGY
36 Binney Street,
Marayong 2148
(02) 671 5588
SCHLUMBERGER TEST SYSTEMS
382 Wellington Road,
Mulgrave 3170
(03) 560 1166
SCIENCE & COMPUTING APPLICATIONS
1st Floor, 117-119 Anzac Parade,
Kensington 2033
(02) 662 4255
SCIENTIFIC ATLANTA
Unit 2, 2 Aquatic Drive,
Frenchs Forest 2086
(02) 452 3388
SCIENTIFIC DEVICES
2 Jacks Road,
South Oakleigh Vic 3167
(03) 579-3622
SCIENTIFIC INSTRUMENT & OPTICAL SALES
70 Kelvin Grove Road,
Normanby 4059
(07) 831 7672
SIEMENS INDUSTRIES
544 Church Street,
Richmond 3161
(03) 420 7111
ECONOMIC ELECTRONICS
24 Campbell Street,
Bowen Hills 4006
(07) 527 4666
STANDARD COMMUNICATIONS
6 Frank Street,
Gladesville 2111
816 4755
STC MEASURING INSTRUMENTS
58 Queensbridge Street,
South Melbourne 3205
(03) 615 6677
TECH-RENTALS
18 Hilly Street,
Mortlake 2137
(02) 736 2066
TECH-SALES
12 Maroondah Highway,
Ringwood Vic 3134
(03) 879 2266
TECNICO ELECTRONICS
11 Waltham Street,
Artarmon 2064
439 2200
TEKTRONIX
80 Waterloo Road,
North Ryde NSW 2113
(02) 888-7066
TESTRONIC
3 Montana Street,
North Rocks 2151
(02) 630 7528
THE COMPONENT SPECIALISTS
11 Manston Street,
Elizabeth South SA 5112
(08) 252-2292
THE DINDIMA GROUP
PO Box 106
Vermont 3133
(03) 873 4455
TPS PTY LTD
4 Jackeroo Street,
Springwood 4127
(07) 208 8447
UNIDATA AUST
3 Whyalla Street,
Willeton 6102
(09) 457 1499
UNIVERSITY PATON INSTRUMENTS
106 Belmore Road North,
Riverwood NSW 2210
(02) 53 0644
VDO INSTRUMENTS
115 Northern Road,
Heidelberg West 3081
(03) 450 3209
WANDEL & GOLTERMANN
Suite 13, 20 Commercial Road,
Melbourne 3004
(03) 267 8699
WARSASH
PO Box 217
Double Bay 2028
(02) 30 6815

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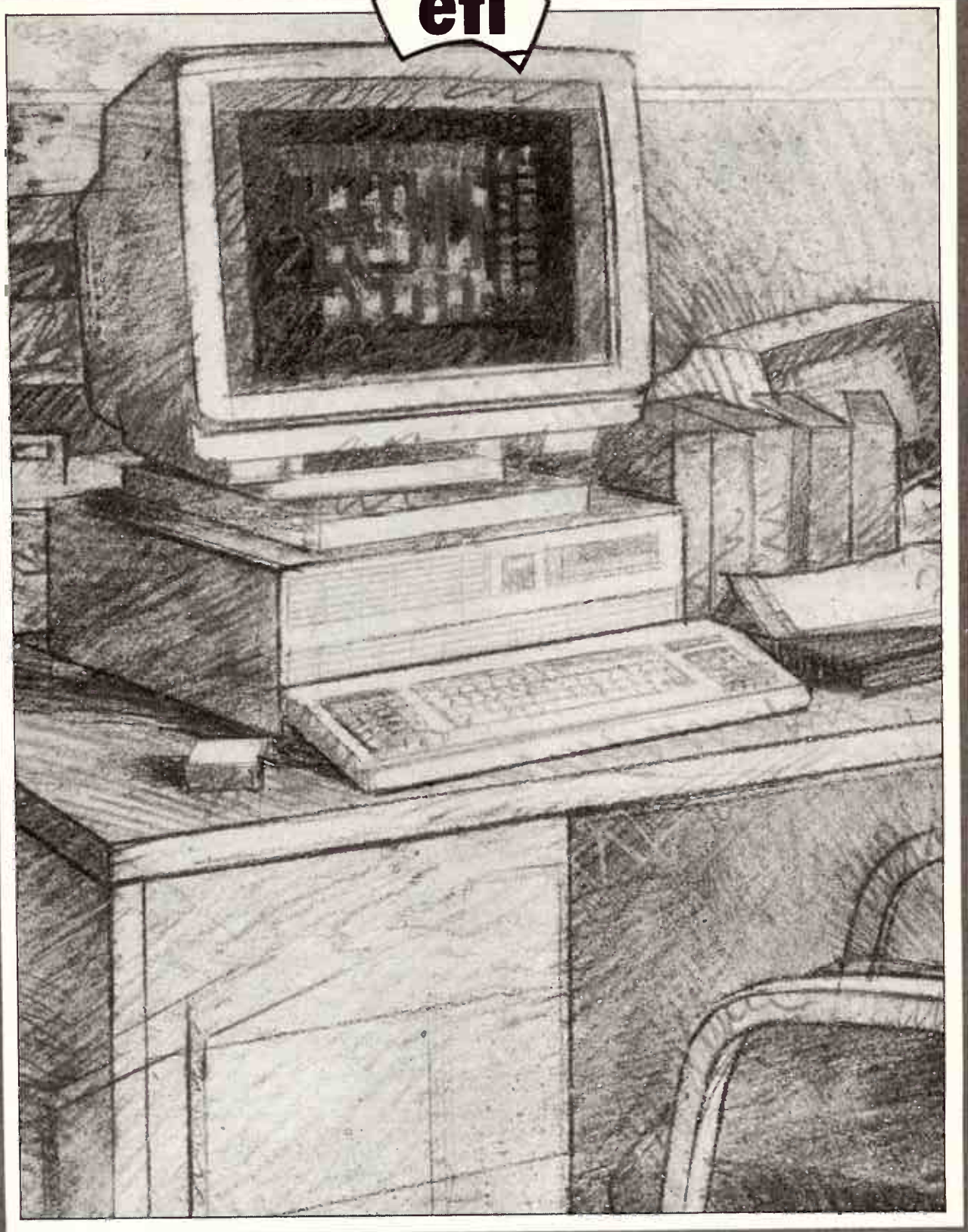


CAD/CAM

CAE IN AUSTRALIA

Computer Assisted Engineering is becoming a valuable tool in Australian Manufacturing

Glen Jones

There are many changes currently taking place in the electronics industry that are stimulating CAE purchasing. One of the most significant of these changes is the increasing complexity of design.

The trend towards more complex designs is seen not only at the system and board levels, but also in application specific integrated circuits (ASICs) like: gate arrays, standard cells, and full custom ICs. This complexity is shown most dramatically by examining the number of gates per IC, which is growing by a factor of around 250 every decade; from approximately 250 gates per IC in 1970 to 64 thousand in 1980, to an estimated 16 million in 1990. This increase in chip density directly translates into an increase in board density and thus overall design complexity.

Design complexity is not only due to an increase in chip complexity, but is also due to the transition from board-level designs to ASIC designs. ASICs allow engineers to design in a more proprietary manner. The primary reason for this is to increase profit margin by using custom, as opposed to off-the-shelf parts. A secondary reason is to avoid industry piracy and reverse engineering. It is harder to reverse engineer an ASIC than a board.

From an estimated $0.5 billion in 1982, the ASIC market is expected to grow to over $7 billion by 1991. In order to utilize the attributes of ASICs, designers are required to use capabilities that can only be found in CAE tools.

The increase in design complexity, particularly in the area of ASICs, is resulting in a significant increase in time-to-market. The number of man-months for development of an IC has gone from an average of 50 in 1970, to 200 in 1980, and to an expected 400 in 1990. This increase is not surprising given the significantly larger increase in the number of gates per IC.

Compounding the problem of a longer design cycle is a shorter product life cycle. This decrease in the product life cycle is due primarily to technological obsolescence. Some good examples of these changes are the power of a three-year-old mini computer that is available as a micro today, the change from Schottky to ECL to CMOS and now to gallium arsenide, and the change in IC fabrication from VLSI to VHSIC and waferscale. Should these shorter product life cycles continue to accelerate without decreasing the time-to-market, an electronics manufacturer could be in a fairly dangerous situation. A new set of engineering tools is required.

The tools that the engineer uses must integrate the entire design process: from concept through design capture, simulation, fault grading, place and route, mask generation and board design, to IC and board test. These tools require that each phase of the process is well integrated with previous and following phases. In fact, it is desirable to use the output from one phase directly as the input to the next phase.

In a growing number of cases, the role of the engineer involved in the design phase is changing. Engineers are being forced to cross traditional boundaries. The most prevalent of these changes is the design engineer's involvement with test engineering. As designs become more complex, testability is becoming more of a consideration. To ensure that the design is testable without having to run numerous, time consuming fault simulations, the test engineer and design engineer must work very closely. In many cases, the same simulation vectors used by the design engineer for logic simulation should be used by the test engineer to perform fault simulation. This can be accomplished by coupling a logic simulator with a fault simulator in a common CAE system.

The need to integrate the engineer's tools goes beyond the engineering and test departments. In addition to testability, manufacturability is becoming a major consideration in the design process. Engineers must be able to determine if their design can, in fact, be built. i.e: will the board require too many layers or will the gate array be routable. A tightly integrated set of tools will minimize "round-trip" time. i.e: the time it takes to enter a design, simulate it, create and grade test vectors, and then route a gate array or board. By minimizing this round-trip time, the design team can optimize the design for manufacturability as well as testability.

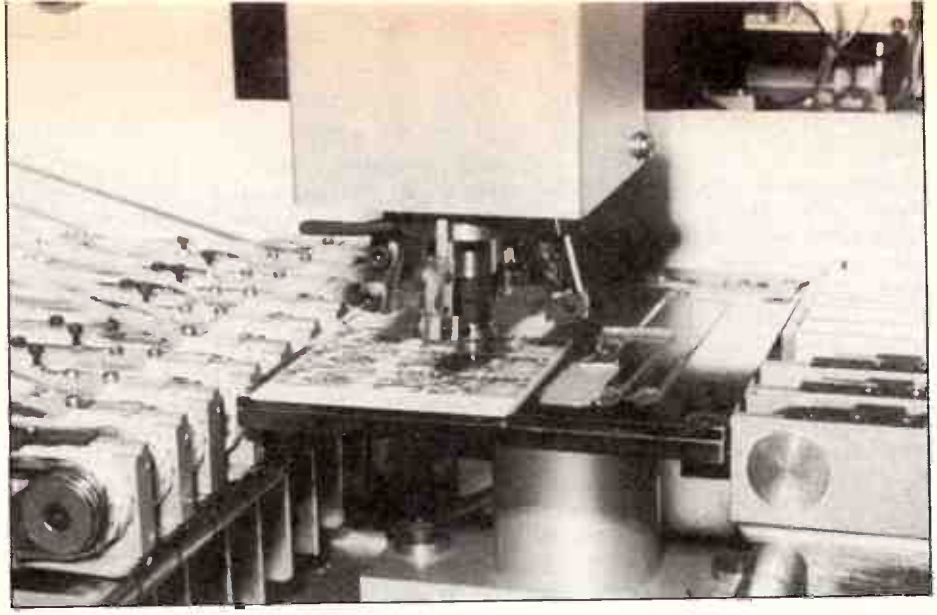
CAE also has implications beyond the design process. A typical engineer spends 35 percent of time actually designing and testing. The remainder of this time is spent planning, gathering information, and documenting results. By using computers to integrate these functions, an engineer can realize a dramatic increase in productivity and, since there is an ever increasing shortage of electrical engineers, an increase in productivity will be the only means of maintaining a sufficient engineering work force.

As computers become more prevalent in all departments of the company, there exists a need to ensure that engineering ties into the other areas. For example, the bill of materials generated by a CAE or CAD system can easily be used for inventory control and accounting purposes.

The factors given above are just some of the changes that are taking place in the eletronics industry that are forcing engineering departments to change the methods with which they design. The key to implementing new methods is the use of CAE equipment.

Purchasing

The primary reason a company purchases CAE equipment is to reduce the total cost



of getting a product to market. The costs associated with product life cycle include designing, manufacturing, testing, marketing, and then redesigning the product to extend it's life.

Prior to the advent of CAE, engineers created schematics using paper and pencil. The design was then given to a draftsman to create production schematics. The schematics were then used to input a netlist by hand for use by a wire-wrap machine. The wire-wrap machine would create a prototype, which would be tested to find bugs. Once this phase was completed, changes would be made in the original schematics, and the process would start again. This would involve multiple iterations.

CAE has changed that entire process. Now engineers can create a fully documented schematic while they design by taking advantage of an advanced graphics editor. This process results in designs that can be created faster with less errors and with higher quality documentation.

Once the schematics are created, the engineer avoids the prototype phase by using the schematic as a virtual breadboard and a logic simulator as a virtual logic analyizer. When an error is found, the engineer goes back into the graphics editor, makes a change, and then resimulates the circuit (all in a matter of minutes as opposed to days). Once the design is verified, the engineer can automatically create a netlist that can be accepted by a layout system or by a gate array vendor.

During a product's life, changes must be made due to either a new innovation in the market place (e.g. a faster IC) or a new feature that a customer might want. When a change is required, the original drawing can be modified, the design quickly verified, and an updated netlist generated. This revision process can be completed in a matter of days as opposed to weeks using the old method.

CAE allows the engineer to design using a hierarchical approach. Hierarchical methodology allows complex systems to be developed much more easily. During the conceptual phase of a top-down design strategy, behavioural modelling supports quick creation of alternative architectures. Once the high level architecture is optimized, each sub-section of the design is simulated at the gate level based on the function specifications developed in the behavourial models.

As each building block checks out against its function specification, it can be integrated with the overall behavioural models developed in the conceptual phase. This ensures that the specifications were correctly written. A by-product of this approach is that the database used for one design can be reused in another design. This is another example of the reduction in redundant work that can be realized using CAE equipment. A common database is also a means of maintaining design consistency, good communications, and better management through better team communications.

By using CAE equipment, users can also take advantage of ASIC devices. ASICs offer lower costs, better reliability, added functions, better performance and more compact designs. These characteristics are not only of importance to designers, but are also desired by the customers who buy the end products.

Impacts

The largest impact of CAE equipment is on engineering productivity. This increase in engineering productivity can best be measured by looking at each phase of the design process. A study by Drexal, Burnham, Lambert has shown a productivity improvements of 140 percent when CAE is used for all phases of the design cycle.

By increasing productivity, the product can also get to market quicker. Based on a 140 percent increase in productivity, a product that took 55 weeks to get to layout will take only 23 weeks using CAE equipment. And given a $4,000,000 first year revenue at 55 percent gross margin, profit can be increased $1,354,000: (32/52 X $4,000,000 X 0.55).

CAE allows engineers to design in a more proprietary manner, which increases the market worth of the product. CAE also enables engineers to use ASICs, which lowers the overall cost of goods sold. In either case, gross margin can be increased two percent to seven percent. Assuming a five percent increase in gross margin, profits can be increased by $200,000 : 0.05 X $4,000,000.

The resulting increase in first years profits alone is phenomenal:

Increase in engineers productivity: $390,000
Quicker realization of profit: $1,354,000
Increase due to proprietary added: $200,000
Total: $1,944,000

TABLE 1
PRODUCTIVITY IMPROVEMENTS

TASK	Percent of Development Cycle	Productivity Improvements
Schematic Entry	20%	75%
Schematic Editing and Revisions	22%	300%
Timing Verification	18%	200%
Simulation	17%	50%
Test Development	15%	50%
Documentation	8%	75%
	100%	

Productivity Increase = $\frac{\text{Time Required Without CAE}}{\text{Time Required With CAE}} - 1$

i.e., 100% productivity increase cuts time in half

Other Issues

A financial justification is not the end of the story, however.

After a financial justification, engineer-

ing management might want to have some benchmarks performed. Since benchmarks are very manpower intensive, they should only be requested after the list of potential systems is narrowed down to two or three.

The benchmark should include total turnaround time. Turnaround time includes schematic capture, compilation, simulation, and post-processing. Due to the complexity of systems that perform these tasks, evaluators should be aware of some potential pitfallls of the benchmark.

Schematic capture is a crucial area since designers spend a great deal of time in the schematic capture process. In addition to speed, ease of use should also be considered. An experienced applications engineer can demonstrate the speed with which an experienced user can enter a schematic, but this is not always a good indication that the system is easy to use. The evaluator should always try to enter a simple schematic personally.

After capturing the schematic, the design must be compiled. Compilation can be a time consuming bottleneck. It is particularly time consuming for systems that require the total design to be recompiled when ever a change is made in the circuit topology. Incremental compilation requires that only the section of the design that was modified be recompiled.

When evaluating simulators, benchmarking two circuits is best. The small circuit can be used for testing the interactive capabilities for controlling the simulation. To test the sped of the simulator, a large circuit of about 50,000 gates should be used.

Other issues worth considering are:

- Substantiation of the vendor's service and support capabilities. Not only should the equipment be reliable, but when it does need repair, the customer requires a fast response from the vendor's field service. Strong applications supports is also mandatory to ensure that the customer can make best use of the system. And to educate the user, the vendor should be able to supply clear and concise documentation, as well as a full array of training classes.
- Management will also want to evaluate the vendor's long-term product development plans. A system that increases productivity this year may be the bottleneck in the design process a few years in the future.
- Obsolescence is also a key factor. The hardware platforms that provide an adequate cost/performance ratio change rapidly, and there is an ever increasing demand by engineering management for standard platforms. Contingent on having the ability to port to these new platforms is portable software. Only software that is written in standard languages and for standard operating systems can be considered portable.
- Libraries can be the weakest link in the CAE system. Evaluators should look at all aspects of the vendor's library support tools. Does the vendor offer libraries from most of the major technologies (LSTTL, ECL, FAST, CMOS, etc), for most of the major gate arrays and standard cell foundries, and physical models for VLSI devices. Since many users might want to create their own libraries, library development tools should also be considered.
- Finally, the system must be easy to use. Engineers cannot spend months learning new procedures to take advantage of the systems capabilities. For instance, software packages with icons, menus, user prompts, and "help" screens can greatly assist getting an engineer up the learning curve. ●

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SCHEMATIC CAPTURE UNDER REVIEW

OrCAD, Protel and HiWIRE are three new CAD packages for creating circuit schematics.

Tony Pugatchew

Electronic engineers have at their disposal very powerful software tools that simplify the drawing of schematic diagrams and the design of printed circuit boards. These packages range from very simple computer assisted drafting programmes that simply substitute the computer for pen and ink, all the way thorough to packages that assist in every aspect of the design and drafting environment. They provide a plethora of extra utilities that perform tasks such as extraction of bills of materials, conversion of formats to permit the use of other systems and production of hardcopy on a variety of devices.

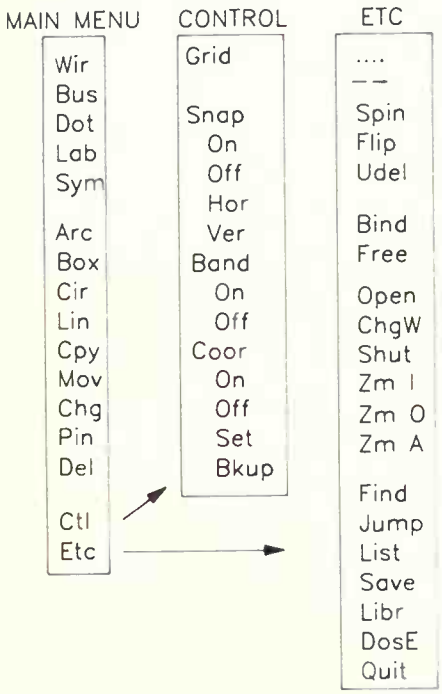

Figure 1: HiWIRE menu options.

ETI has reviewed several low cost pc board design packages such as smART-WORK and Protel-PCB. We also looked at AutoCAD with the specific aim in mind of performing the entry of schematic diagrams. It was concluded that specific electronic functions are best handled by tools that are designed for these tasks. Accordingly, in this review we look at a trio of products that do just that: Protel-schematic, HiWIRES and OrCAD/SDT. These were chosen because the first two are companion systems to Protel-PCB and smARTWORK. OrCAD/SDT is a very popular and innovative system with a completely different mode of operation.

As before, these systems are used with IBM PC machines or clones.

CAD Tasks

The main task of the schematic capture package is to assist the user in the rapid and accurate entry of electronic components and their subsequent interlinking with wires. Group of wires such as address, data and control lines are joined into a *bus* and each bus member and wire is usually given a netname.

Most packages contain a library where components are available. It is often possible to modify the library to permit the design of new components in either a graphic or textual mode.

Many complex circuits run the risk of being entirely incomprehensible if drawn on one sheet because too much detail is squashed together. One strategy to solve this problem is to break the circuit down with a tree-structure. The fundamental functions of the circuit are initially drawn as a set of labelled boxes. The new lower level of this hierarchy expands this further into another set of boxes and so on until we reach the basic circuit level. For example, a modern microprocessor schematic can be broken into CPU, memory and input-output. Thus, the whole schematic can be dissected into small manageable chunks. This strategy is called heirarchial structure.

Another approach is based on the use of multiple sheets. This is called a flat file and is a traditional technique where single sheets connect each other through named module ports that share common names.

Several other important tasks may be required when the schematic is finished. A *netlist extraction* will produce a file that contains all the connections between the components. Usually, the connection will be given a netname such as ADDRESS to make it easy to check the location of the wire. This file will be the entry to the pc board design phase. The system may produce a *wirelist* where each section describes the netname and it subsequent connection. A *netcheck* utility may detail circuit errors such as joined output pins, multiple labels on nets or unconnected line segments.

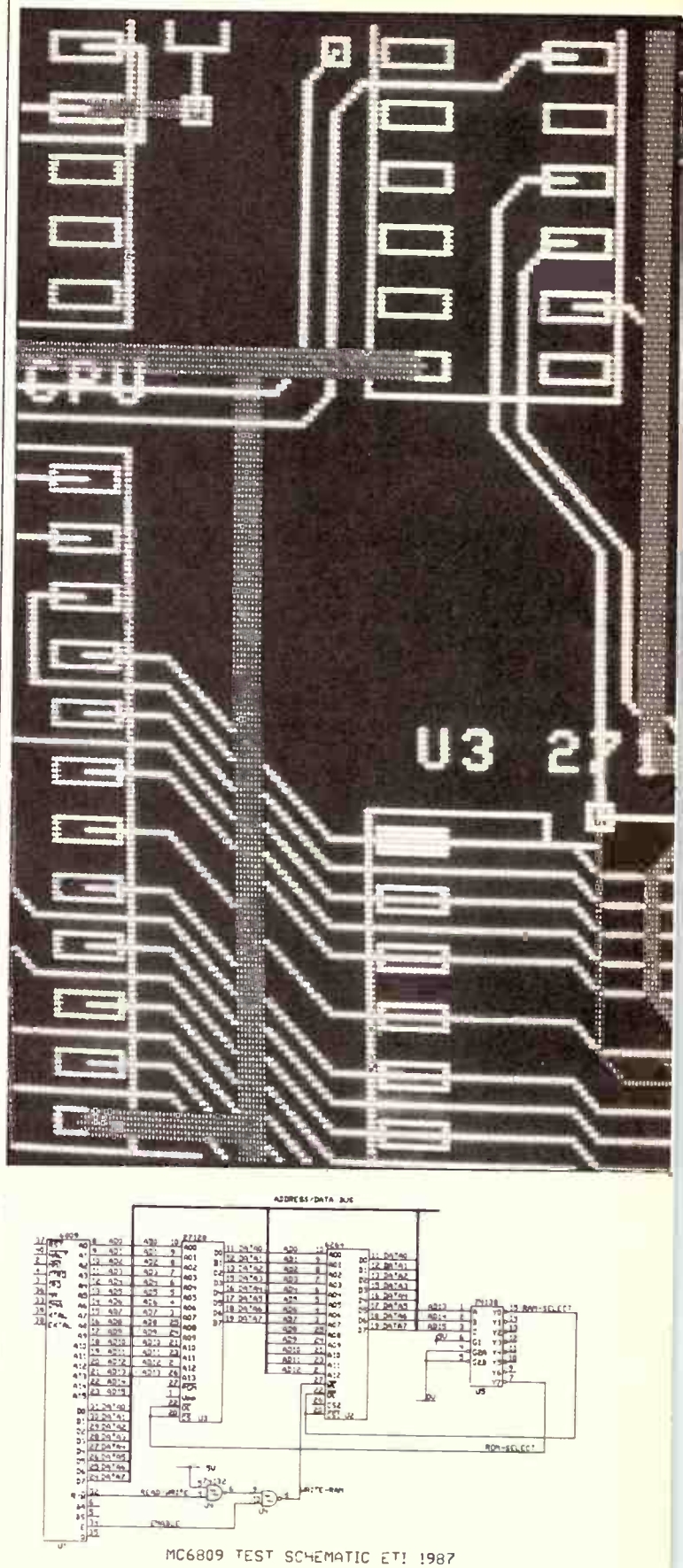

Figure 2: A small schematic drawn on Hi-WIRE showing labelling functions.

Several other utilities may be provided to plot and print on a dot-matrix printer, or for format conversion of the netlist to other commercial systems. A bill of materials is very useful.

Of these, the most useful package is the conversion utility. It may happen that the schematic package is not tied to any particular PCB package. The use of comprehensive conversion options means that the netlist can be imported into other systems that have been designed by companies with more experience in these areas.

HiWIRE Version 1.1

HiWIRE is a schematic package designed by the American company Wintek, who may be familiar as the designers of the layout system called smARTWORK. Its relatively easy to get started since the command choice is from a set of nested Menus. Continuous panning across the screen means that components and their interconnections can be placed quickly and with minimum fuss. Netlist extraction can be performed and the net can be imported into smARTWORK or other packages which can now auto-route the board (Version 1.3 revision 4). Netlist and checking against smARTWORK layouts can be accomplished.

HiWIRE uses a set of menus that perform all the required operations. The cursor, which is moved by the mouse or with the direction keys, assumes various formats to indicate the status of specific functions. For example, the idle cursor is a tick, the drawing cursor is a cross, the arc cursor is an X and the select cursor is an arrow. The system requires no keyboard input apart from text entry for net names, bus names or free text on the schematic for documentation purposes.

An interesting feature is the use of user selected windows where several different views may be stored. It is very easy to jump from one view to another where, for example, one window may be an overall picture of the schematic and the other window may be successive zoomed up selections.

A diagram can only be started after a library is specified. A set of libraries can be typed in provided these are separated with a semi-colon. Symbols or components are placed with the SYM command and the typing the name of the component. The library contents can be seen by going to the STATUS option in the secondary menu. After the component is selected an outline is shown on the screen which can be moved around with the mouse. The final placement is determined by pressing the mouse key. The dashed representation is then filled in with the final symbol which includes text such as the reference designator and pin number and names.

In order to change this two options are available. The symbol can be made FREE which means that any of the information can be modified. This mode is indicated by changing the colour of the symbol from the green bound state to the red unbound state. There is no way to change these colours or to manipulate the screen background and foreground colours. If you suffer from red-green colour blindness . . . too bad!

A label within a symbol can be changed with the Pin command. This is useful for changing component values, pinouts and site or component names.

Wires are used to connect the pins of the placed components. Buses are used to group wires and dots or junctions are used to connect wires and buses together. The placement of these links can only can be performed in a horizontal or vertical fashion. It is not possible to perform 45 degree connection of wires to buses which is a standard aesthetic technique. It is important to make the distinction between wires and lines. A line is a graphical entry but a wire is in fact a physical connection between two component pins. There is no visual distinction made in HiWIRES. As before, the wires, bus and dot options are selected from the primary menu. Other objects such as borders, arcs and circles can be drawn and these play an important role in symbol creation.

Labels are very important because subsequent steps such as netlist extraction produce intelligent output if signals and buses are named. The label function is selected with the Lab command from the primary menu which is easy but the size is selected in a roundabout fashion by typing in some directives for size, width, height and rotation. Inverted labels are created by preceding the label with the ! letter. When naming nets it is important to be aware of the labels "hot-spot" in the lower left corner which must be placed over the desired wire to nominate it as the named net.

Symbol Creation

It is worth discussing symbol creation in a special section since this function will make or break the schematic package. HiWIRE provides a set of nearly 700 components and uses a graphical method to enter a symbol. A box is drawn and wires, pin functions and pin number are added according to the designers preference. This symbol is then *bound* into a symbol file. Symbol creation is therefore similar to a miniature schematic diagram. The BIND command groups existing symbols into a new set. This function is

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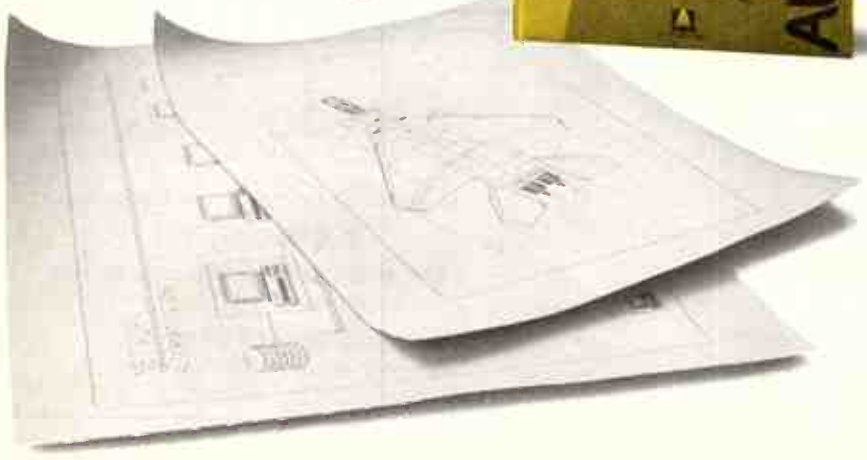

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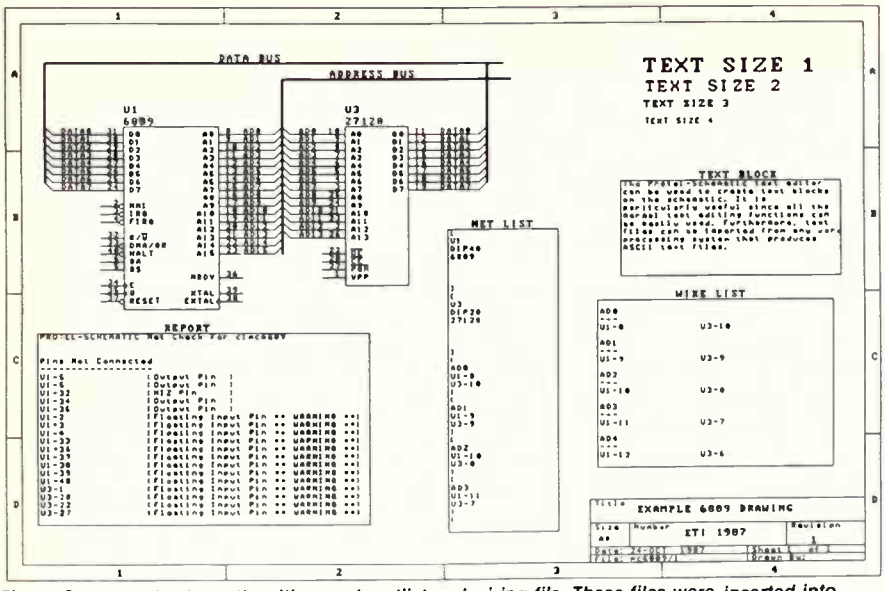

Figure 3: A Protel schematic with report, netlist and wiring file. These files were inserted into predetermined text.

very useful since many existing symbols can be easily changed into the desired format.

Editing

Selection and modification are part and parcel of editing steps. Without these CAD would be no better than an unaided draftsperson. HiWIRE provides the usual operations. An object can be deleted with the Del function and replaced and restored if bungled with the UDel command. (Why aren't these paired commands on the same menu?) Objects can be moved, copied, rotated or mirrored. These latter two steps produce problems since the system does not take account of the text that that is associated with the symbol. For example, a rotated microprocessor would have the label reversed.

When a symbol is moved, HiWIRES will attempt to maintain connections with "rubberbands". The rubber-band is not displayed as the component is moved but is drawn when the final placement is decided. The wires, which are often at strange angles, are easily cleaned up with the MOV command.

Windows

Although HiWIRES quickly pan across the screen the use of a window to display a certain area while we work on another section is very useful. Several viewpoints can be opened and both the size and position of the windows can be chosen. Each window is independent of others and may be scrolled or panned. It is only possible to manipulate objects in the active window. This working section is chosen from the *ChgW* or change window command.

Expansion

The *NETCVT* or net convert utility supplied in the smARTWORK PCB package permits OrCAD and Tango (Protel-schematic) schematics to be converted into a HiWIRE format. The system can auto-route a schematic from this stage. A reverse type of operation permits a smARTWORK board to be checked against the HiWIRE drawing. This is not very efficient since several utilities have to be used. A grid file is produced with smARTWORK GRID.EXE which is a HiWIRE drawing file containing many one-pixel wires each corresponding to a pad on the circuit board. Furthermore, we have to create a pictorial file showing the component overlay and a netlist. The HiWIRE program CHECK.EVE will compare the connections in the layout with those specified in the schematic . . .

Summary

HiWIRE is very quick and easy to get started in the production of high quality schematics. The menus provided all the commands and the rapid panning and window support mean that large complex diagrams can be easily maintained. The hierarchical design is covered in 3 pages in the manual under the heading of Netlist extraction. A simple example is presented but should be expanded into a large section. The only netlist format is EDIF and no information is provided on the format (Please write to the EDIF users group!). The creation of new library components is very easy due to the facilities of changing existing schematics.

Protel-schematic version 1.0

HST of Hobart, Tasmania has enjoyed considerable success with the Protel-PCB package I reviewed previously (ETI September, 1986). I have made sure that the version number of their latest schematic package is clearly displayed since some of the shortcomings that I presented in my earlier review had been rectified in the new release. (*MORAL — these reviews have a three-month time lag so please check with the supplier for new features.*)

Protel-PCB and Protel-Schematic has been released in USA as Tango, together with an auto router. This review will concentrate on the schematic entry — Protel-schematic.

The manual is very comprehensive and follows a well tried formula of using some tutorial chapters to give some practice. The commands follow the Protel-PCB format so most experienced users will have no trouble in getting good results immediately. Commands are selected with combinations of function, CTRL, and ALT keys. The diagram size (up to A size) is selected with CTRL S and the colours of various drawing features such as wires, buses may be selected. Protel-Schematic supports the flat-sheet organisation by appending up the file name a number to show that the sheets are part of one large diagram. For example, DRAW/ and DRAW/2 will produce files called DRAW.SO1 and DRAW.SO2. All nets on these drawings must have the same name.

Component libraries are selected by existing from the schematic and changing the library from the main menu. Components are selected from a comprehensive set: Zilog, Western digital, Voltage Regulators, Synertek,TTL, CMOS, NEC, Operational Amplifiers, Memory, Motorola, Intel, Linear and Discrete. Nearly 3000 components are supplied in what must be the most comprehensive library ever.

A drawing can only be begun once the starting conditions are initilised. The library is specified from the starting directory and once the main blank sheet is presented entry of parts is specified with the the ALT-F1 combination. The component type, component name and comments are required. Multiple gates on chips such as inverters and gates are specified by giving a label as U4/4 or U4:4. The appropriate pins of the fourth gate in the chip will be shown. The component is not placed in final position until the RETURN key is pressed.

Once the components are placed on the sheet the wires and buses can be easily placed. The tedious entry of repetive wires and net names is removed with the REPEAT key. The repeat step in the x and y direction is specified in the OPTIONS menu. CTRL R key will repeat the previous drawing function at this spacing. If a net name has been entered as say A0, on this wire then the next wire will automatically be designated A1. A wise time saver.

A bus is drawn by changing the wires to BUS with the CTRL-L command but the interconnection of specific wires must take place by allocating corresponding netnames on entry and exist from this bus. Forty-five degree connection of wires to buses is sup-

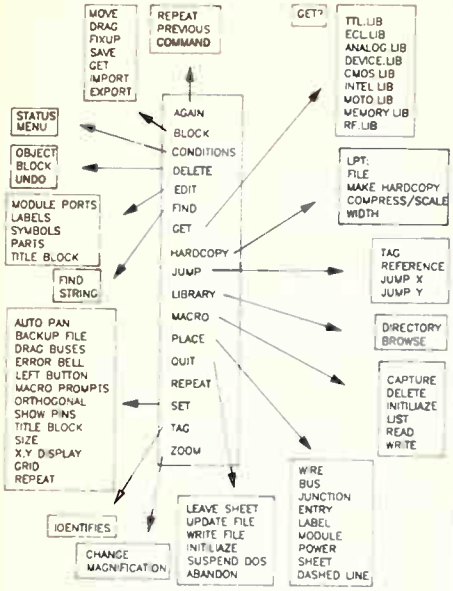

Figure 4: OrCAD's primary menu and the next level down.

ported.

The system does not support panning so the user must move the cursor towards the region of interest and then do a display recentre.

A further automatic feature is seen in the allocation of component labels. The user need only enter the beginning of the label such as U followed by a question mark. The system will replace the ? with the lowest number and extension which it can find. Multi-gate packages will be shown in U4:4, U4:B, etc.

Components can be deleted and moved, rotated or mirror imaged. In this case the component labels are not messed up but are neatly presented. When these operations are performed the option of dragging wires or buses is presented. If the user desires connectivity to be preserved the wires will cross and the track editing functions will clean up the mess. Fortunately, the move-wholeline function (ALT-F7) is quick to use in conjunction with the break command (F7).

Symbol creation

Although the library is exceptionally comprehensive there will be a continuing need to create specific symbols such as new connectors, interface chips, etc. Protel uses a text based system to create symbols. I was a little unsure of the effectiveness as compared with HiWIREs but the system offers considerable advantages. Protel has two types of component elements called *Blocks* and *Bitmaps*. These can be used together or alone. The block mode is used for symbols such as IC's with straight elements and the bitmap is used for curved sections as is seen in gates, etc.

The format of the component description is as follows: Device name; Package type; X axis width; Y axis width; number of devices; pin location, pin number; pin name and pin function. Nine pin functions can be specified — clock, inversion symbol, input and output, high impedance, and open collector. Power and ground are also indicated but are not displayed if the word *hidden* is used. The great advantage of this scheme is that an existing component specification can be easily copied with a word processor and subsequently modified. The *decompile* utility will produce an ASCII text file which can be expanded and modified. The resultant file then must be compiled with the compile utility to produce a library file.

Editing Functions

Components and tracks can easily be moved with the edit defined keys. The components can also be renamed and renumbered if necessary. Advanced editing features permit some special functions to be performed rapidly.

Block commands

Protel-schematic shares with its PC layout relation comprehensive block definition and block move operators. A well supported use of these features is the saving and reuse of common repetitive blocks such as memory arrays.

A novel feature of Protel-schematic is the use of free-text blocks on the schematic. These text blocks can indicate certain points to the reader. Normal text editing functions such as moving text, marking, deleting and inserting blocks of text are performed with relative ease. The commands are based on the Wordstar format which is useful. Furthermore, text files can be imported into the schematic.

Netlist extraction

Protel-schematic processes schematic files to produce four output files: a netlist, a wirelist, a net check report and a bill of materials. One utility program called *post* generates these files. The netlist is in standard *Protel-PBC* format which does not comply with EDIF standards.

The *netcheck* utility compares schematics with the Protel-PCB net file name. The two systems work well together. The netlist is imported into Protel-PCB as a rats nest connection on the solder layer. That is, the tracks are joined from destination to source pins. It is difficult to lay the tracks in this configuration. It would be an improvement if the rats nest was on a virtual layer. Hence, if a pin was designated as the start then the destination should be indicated and as the connection is made on the appropriate real layers the number of rats-nest connections is reduced. Perhaps this will be a feature in future releases.

If you are a consistent user of Protel-PCB then this schematic system is very easy to use. The provision of help keys is welcomed. Ease of component creation and the provision of a huge number of components in the library are also excellent features.

I feel that some rationalisation should be performed on the way various functions are grouped. For example, the zoom in and out are located on keys F5 and F6 while the Redraw and recentre are on F9 and F10. It would be useful to have variable zooms since at one zoom level the text is too small and at the next level too big. Extra recentring is required.

OrCAD/SDT

OrCAD schematic design tools (SDT) from OrCAD systems is the final system to be reviewed. The designers have incorporated some very novel and useful ideas into this system. Extensive part libraries and utility programmes to generate bill of materials, netlistings and design checking show a great deal of awareness of engineers' requirements. The system is completely menu driven and supports the widest selection of screen, printer and plotter options of the reviewed systems.

OrCAD/SDT system supports colour and monochrome graphics, sheet sizes from "A" to "E", unlimited levels of hierarchy, design of keyboard macros, part rotation and mirroring, and automatic panning which can be disabled. A novel feature is the definition of certain TAGGED regions which can be referred to quickly, and the most comprehensive netlist interchange options in the review.

Getting started

The documentation is divided into chapters that present all the important commands. The learning period is very short. On first use the hardware configuration and required files are set up and the user is presented with an empty worksheet. The primary or root menu, on the left side of the screen, is shown by pressing a mouse key figure 5. The primary menu is displayed after pressing the appropriate mouse key or the keyboard ENTER key. The first step is to select the *set* option in order to specify the size of drawing sheet, etc. Components are placed by selecting *get*. The user is shown a small window with the name of the pre-loaded library files. The component name can be entered from the keyboard by selecting the appropriate family. Now, all the library components are shown in a small scrolled window and the user can move to the required part. If the user wishes to see the library component then the *library* option will present a directory of the chosen library or the user can scroll forwards or backwards through the library. In this case the component is shown fully on the screen. The *place* command will place the selected component at the cursor position. An op-

tion is presented in order to select the appropriate. An option is presented in order to select the appropriate orientation, etc. Wires, buses, labels and entry to junctions (45 degree lines are drawn) are all invoked with the place command. A further option is to present certain parts with their DeMorgan equivalents.

Block commands are straightforward. The user is prompted for the lower and upper points of the block and then the command is performed. The *conditions* menu displays free RAM and other important system facts.

Repetitive tasks such a creating memory arrays, connecting wires to bus entry lines or labelling items on the worksheet are made less tedious with the *Macro* command. OrCAD/SDT can record over 100 macros which can be assigned to function keys, CONTROL, SHIFT or ALT keys or the middle of the mouse keys. For example suppose the user wishes to work entirely in the TTL library since the circuit is full of "glue chips". The function key F1 can be assigned to display the TTL parts directory by typing MACRO, CAPTURE subcommand, F1 at the CAPTURE MACRO? prompt and then performing the steps that would get one into the TTL library. (ie, GET — GEt? — TTL. LIB). The ENTER key is pressed twice followed by M to leave the macro capture mode.

This feature means that all the function keys can be assigned to the selected libraries and a small cardboard overlay can remind the user which key is required. The macros can be displayed, saved to disk or read from the disc. The macro format is in a simple ASCII format which can be edited and enhanced outside the OrCAD environment. MACROS can also be nested.

Utilities

Six utilities assist the designer in maintaining these schematics. For example, The *treelist* utility would produce a text file that would show the Root file and the subsequent different level schematics.

Annotate automatically updates all reference designators that are placed on the sheet. *Cleanup* removes duplicate or overlapping wires, buses and junctions. *Ercheck* performs a basic electrical rules check. *Netlist* is self-explantory but has options to produce formats for nearly 18 subsequent PCB packages.

OrCAD supports an extensive family of components: TTL, CMOS, ECL, Analog, Intel, Motorola, Ladder, Spice, Pspice, Synertek and discrete and electromechanical parts. The creation of new libraries or addition of components to existing libraries is done with a text based system similar to PROTEL. The *composer* utility takes a library source file and produces an ASCII library file. Decomp performs the opposite function. Pins can be numbered and the functions defined from a comprehensive list such as inputs, outputs, tristate, etc. The format of these component definitions are similar to that of PROTEL but the order of the functions and pin labels is reversed.

Conclusion

All the packages produce good schematics. Once particular quirks are resolved it is easy to extract the most benefit from each. The easiest package to use in terms of the screen functions, documentation and provision of nearly every possible option in the utilities area was definitely OrCAD/SDT. Future packages that perform system simulation and PCB layout make this a very powerful combination. However, many improvements are on the way for both PROTEL and HiWIRE so the best method of making a choice is to obtain a demonstration diskette from your local supplier. Talk to other users and get a feel for other designers opinions. Above all, remember that this review was completed in mid-November so some systems may undergo changes. ●

Since the copy for this article was received we have been advised that new versions of Protel will be available shortly with a number of important additions. We hope to have a review within the next few months — Ed.

The author is at the South Australian Institute of Technology (08) 236-2211.

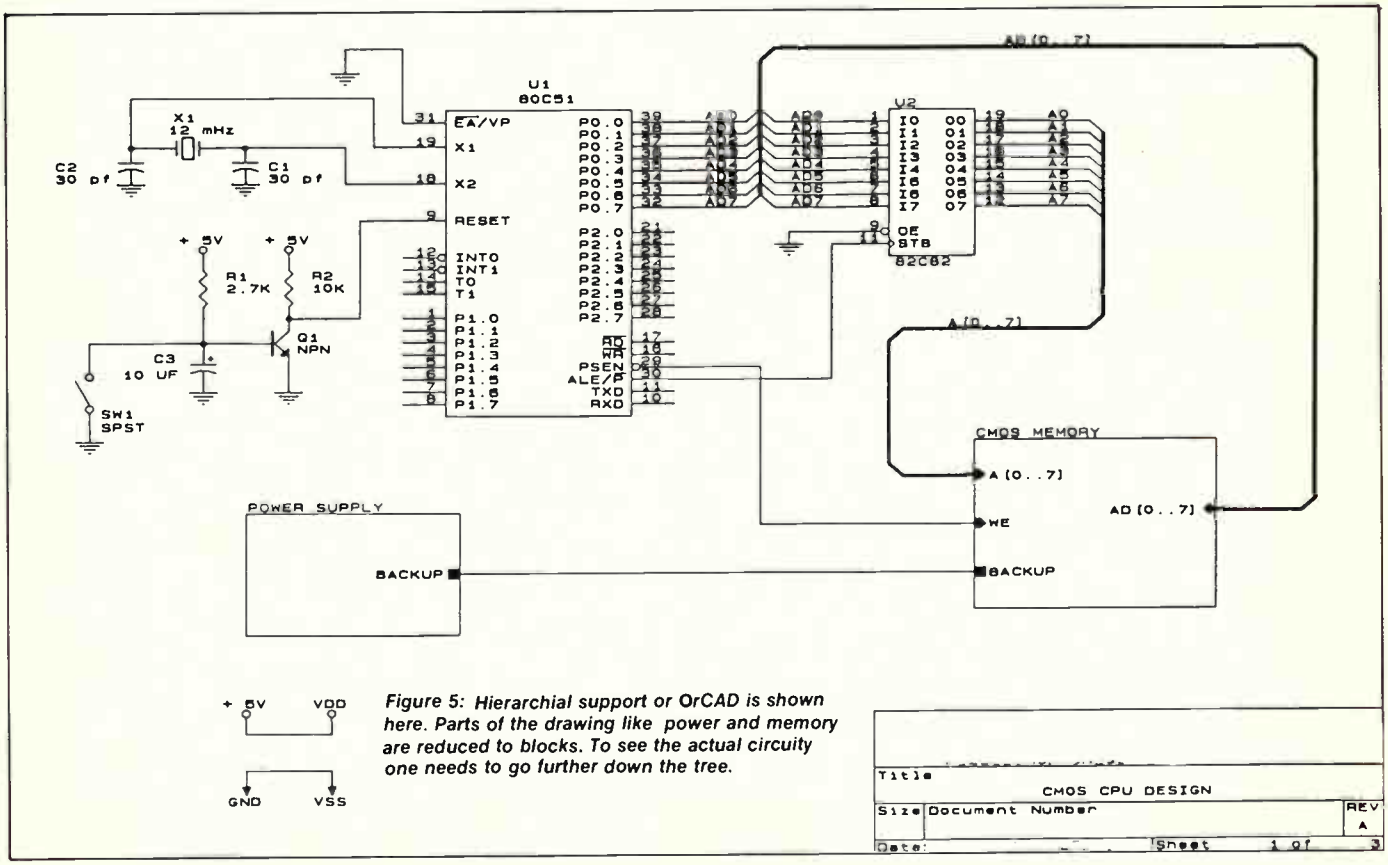

Figure 5: Hierarchial support or OrCAD is shown here. Parts of the drawing like power and memory are reduced to blocks. To see the actual circuity one needs to go further down the tree.

Autodesk to sell No. 9 . . .

Autodesk Australia have announced the pending release of an AutoCAD upgrade. To be called AutoCAD 9 (this is the ninth major enhancement of AutoCAD), the new product features an advanced user interface with pull-down menus, icon menus, and dialogue boxes that supplements the keyboard, screen menu, and digitiser template as a means of entering commands. The pull-down and icon menus programmable , so that designers and drafters can customise their working environment.

The major new feature is file portability. It now doesn't matter under which of the AutoCAD-supported operating systems — PC-DOS/MS-DOS, Apollo's AEGIS, Digital Equipment's VMS, Sun Microsystems; UNIX — drawings are created. Any computer running AutoCAD will recognise those drawings. There will no longer be a need to convert them first to an immediate format like DXF or IGES.

Other new features include improved curve generation using B-splines; 20 new text fonts; several enhancements to AutoLISP, the high-level programming language embedded in AutoCAD; support for a faster Autodesk Device Interface (ADI) driver for displays; and a drawing slide utility program that arranges AutoCAD drawing slides in libraries as an aid in creating icon menus.

Autodesk has in the past used an intemal product version numbering system with the last current product being labelled AutoCAD version 2.6. However, Autodesk will now switch their product version numbering system to reflect major releases so that customers can easily identify current product and can keep abreast of Autodesk's continued efforts to enhance the program.

AutoCAD Release 9 will be distributed only thorugh authorised AutoCAD dealers and has a suggested retail price of $4,800 excluding sales tax.

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. . . and handout a freebee

Autodesk Australia will award in excess of $1 million worth of CAD software products during 1987-88 as part of their Autodesk grant programme.

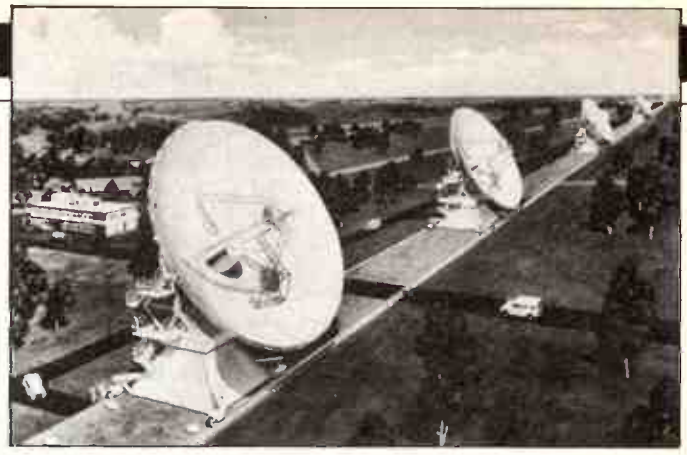
Autodesk products that will be included in a grant program are AutoCAD, the most widely used PC-based computer aided design package; AutoShade, a rendering package which provides 3D graphic visualisation of wirefram models; and AutoSketch, a low-cost drawing package.

The GRANTS will not be limited to govemment funded groups. Private individuals, students, teachers, institutions, research and development groups, libraries, technology awareness groups etc, will be eligible for participation in the program.

In order to be considered for a grant, registration of interest (in writing) must first be lodged with Autodesk Australia. Autodesk will then forward an application form and conditions of the program. Applicants will be asked to provide an outline of their current and projected CAD needs and skills, and a brief summary of how and when they would put the software to use.

Autodesk Australia, the fifth international subsidiary of Autodesk, Inc. (USA), was formed in June 1987 to meet the growing needs of the Australian AutoCAD community, now numbering more than 2600. (AutoCAD was previously distributed by Entercom Computer Company, the staff and assets of whcih now make up Autodesk Australia).

For further information please contact: Julie Volpe, Autodesk Australia, PO Box 458, Richmond, Vic 3121.



CAD at the AT

Both CSIRO and consulting engineering firm, Macdonald Wagner, used Intergraph computer aided design systems on the Australia Telescope (AT), currently being built at Culgoora, NSW.

The AT consists of seven fully steerable parabolic antennas each with a diameter of 22 metres together with the well known 64-metre Parkes Radiotelescope. Six of the antennas — the "compact array" — will be at Culgoora. Five will be movable along a three-kilometre rail track with the sixth one another three kilometres away. The seventh antenna will be near Coonabarrabran, a further 100 kilometres away. The eighth antenna, at Parkes, is 320 km to the south.

This spacing of the antennas gives the AT the capability of very high resolution. Because a range of solutions is possible, it could be said the telescope has a zoom ratio of 10,000 to 1.

Because the accuracy of the dish surface must be better than one tenth of the wave length of the received radio signals, deflection and sagging in the structures had to kept within an absolute range of a few millimetres. More important, the relative deflection had to be within a few tenths of a millimetre of a best-fit paraboloid.

The design has tumed out to be so successful, a modified form has been used for OTC's new satellite antennas. At the recent Engineering Awards, the Institution of Engineers, Australia gave the design its "Highly Commended" award.

Macdonald Wagner uses an Intergraph 751, two Intergraph InterAct workstations and four LSI workstations on the design.

The firm bought its equipment in 1982 — being one of the first Intergraph customers in Australia.

Once the structural analysis of the design was carried out, the data was transferred to the Intergraph system. The system generated various views of the structure to find the one most useful for all the final drawings. "We had to have a powerful CAD system to carry out the specialised number crunching in this kind of manipulation," said David Ireland, Macdonald Wagner's national CAD manager.

The Division of Radiophysics also uses an Intergraph 751 and has Intergraph's InterAct and InterPro workstations. The Division used its CAD system to design the four layer circuit boards for the digital correlator — the "brains of the AT.

Data from the telescopes come into the correlator at the rate of 2 gigabits per second from each of the six antennas in the compact array. Twelve gigabits per second is well into the "supercomputer" range and the design of the correlator was a major project in itself.

It is the most powerful processing system of its kind designed and built entirely in Australia. CSIRO's Intergraph system was used for almost a year to design the correlator circuit boards. More than 3000 Australian-made CSIRO-/Austek chips were used on the boards with each chip containing the equivalent of 46,000 transistors.

Graphtime 2.7

A new version of Graphtime-II (2.7) has been released with major new features and enhancements.

First released in 1985, Graphtime-II has enjoyed considerable success both in Australia and overseas. The demonstration version of the package was the first piece of Australian software to be included in the US PC-SIG library (which is now available on CD-ROM).

The main new features are full support for EGA/CGA or Hercules graphics modes and drivers for all HPGL graph plotters. Fourteen graph types can be generated and enchanced with the built-in graphics screen editor.

Ease-of-use has been enhanced with menu selection by command letter, mouse pointer or arrow keys. Data points per graph now extend to 730 with unlimited points per screen. Each screen can have mulitiple windows. Any mathematical or trionometrical function can now be displayed or plotted. Printout to standard dot-matrix printers now available in two resolutions. Data can be entered from Loftus, dBASE II and III, Multiplan or any ASCII file.

The recommended retail price is only $147. It's available from Technical Imports Australia on (02) 922 6833.

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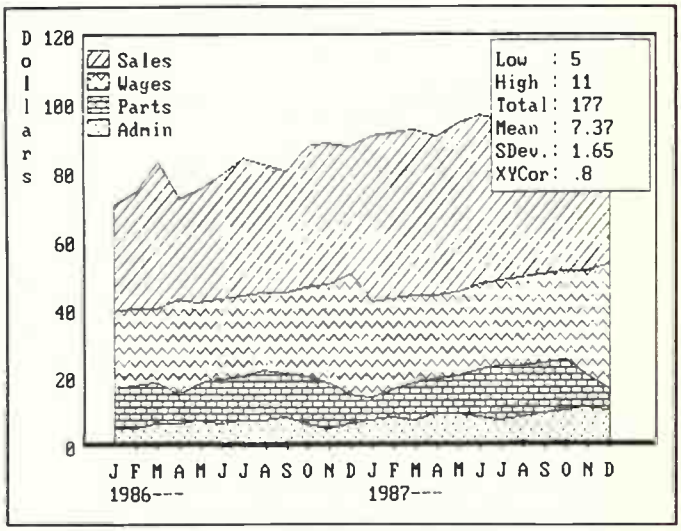

CAD APPLICATIONS

Ray Smith

Having just seen the end of the 1987 World Drivers Championship run in Adelaide, one ponders the level and pace of technological development. The formula one racing car is not (and has not been for some time) merely a mechanical masterpiece, but an electronic one as well. With on board computers controlling and monitoring just about every critical function, sophisticated radio communication and telemetry back to the pits, the typical modern racing car is a work of technological art.

All these developments and those in the material sciences have been made possible by the development of micro computers in general and computer aided design and documentation in particular.

Utilizing the power of the current generation of CAD systems, thousands of man hours have been knocked off the typical research and development cycle of a new product, whether it be a racing car, a road or a building. In most cases whole systems can be designed and dynamically simulated before a single turn of a lathe or a yard of concrete is poured. Loads and stress can be calculated and tested, circuits simulated, timing diagrams printed, heat dissapation demonstrated and so on.

What is even more exciting is that all of this is not restricted to the multi million dollar operations of a formula one race team or aerospace development lab.

Within reasonable limits these systems for design, simulation and documentation are available to the masses. In fact, it is now possible to purchase a basic drafting software package for less than $200. I am not suggesting for a minute that it will contain all the features described above but it will certainly contain some of them. In any event, it is a big step from what was available only a few short years ago.

The really significant thing about all this is that Australian business has ready access to the technology. In fact some of the best low to medium cost CAD software is written in Australia and exported to all corners of the globe. Nevertheless, the manufacturing sector has been relatively slow to take up the use of CAD, and when they have it has been without sufficient thought being given to the specific requirements of the environment.

So how should one buy a CAD system? A thorough examination of the requirements for CAD, and a comparison with what is available in the market, will usually result in a short list of two or three systems. To evaluate effectively beyond this point the only conclusive method is to sit down with the system and be trained on it.

In this way a potential purchaser (who should also be the user) soon comes to grips with the good and bad points of a system. One of the most important aspects is the user friendliness of the software, and this will be reflected in the time it takes to become proficient. Another important aspect is how "complete" the software is. By this I mean that the user should be able to do most, if not all, of a design on the system without having to customise it, or write additional programs and interfaces.

Finally the CAD system should be purchased from a vendor that can support it locally, knows the product and his business.

Implementing CAD in the manufacturing environment is essential if Australian industry is to compete in the global arena. It is important that it be implemented properly, that an appropriate company infrastructure be set up to take full advantage of the benefits and that initially, your expectations are not too high. Be advised by your vendor and don't be afraid to ask difficult questions.

Extensive use can be made of CAD techniques and it will result in higher quality documentation, less errors, less rework, improved turnaround and of course, improved profitability. It is important to realize that CAD doesn't always result in improved productivity. Productivity gains vary with the type of application and the number of standard components used in your engineering discipline. An experienced vendor will be the best guide.

Ray Smith is managing director of RCS Design, a CAD bureau in Melbourne. They are distributors for a number of CAD packages including Qikdraw, Protel and Racal's Cadstar and Redcad. Phone (03) 49 6404.

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WHO'S WHO IN COMPUTER AIDED DESIGN

This list covers all the main players in the construction of computer aided design systems in Australia. While we have tried to be reasonably comprehensive, note that omission from our list merely implies our data base was incomplete at the time of going to press.

ADVANCE PERIPHERALS
38 Burraga Avenue,
Terrey Hills 2084
(02) 450 2177

ALL ELECTRONIC COMPONENTS
118-122 Londsdale Street,
Melbourne 3000
(03) 662 3506

ANITECH INSTRUMENTS DIVISION
1 Carter Street,
Lidcombe 2141
(02) 648 4088

AP IMPORTS
41 Box Road,
Crossroads 2170
(02) 600 9722

APPLE COMPUTERS
37 Waterloo Road,
North Ryde 2113
(02) 888 5888

ASSCO
17 Heatherdale Road,
Ringwood 3134
(03) 873 2266

ASSOCIATION FOR COMPUTER AIDED DESIGN
576 St Kilda Road,
Melbourne 3004
(03) 51 9153 telex 37174

AUTODESK AUSTRALIA
132 Bridge Road,
Richmond 3121
(03) 429 9888

AWA M & C DIVISION
Unit C, 8 Lyon Park Road,
North Ryde, 2113
(02) 888 9000

BALTEC SYSTEMS
26 Mayneview Street,
Milton Qld 4064
(07) 369 5900

BAYSIDE COMPUTER SYSTEMS
Cnr Sky Road & Fanell Street,
Frankston 3199
(03) 785 2922

BELL ELECTRONIC INDUSTRIES
157 Abernethy Road,
Belmont WA 6104
(09) 277-2111

CAD SYSTEMS AUSTRALIA
17 Hayling Street,
Salisbury Qld 4107
(07) 277 0011

CADCOM
Suite 10, Greenwich Square,
130-134 Pacific Highway,
Greenwich 2065
(02) 438 4788

CEANET
4th Floor, 56 Berry Street,
North Sydney 2060
(02) 922 6311

CENTRE INDUSTRIES
187 Allambie Road,
Allambie Heights
(02) 451 5555

CIRCUIT COMPONENTS
383 Forest Road,
Bexley 2207
59 6550

COMPAK COMPUTER CENTRE
156 Martin Street,
Gardenvale 3185
(03) 596 7222

COMPLETE TECHNOLOGY
170A Riley Street,
Darlinghurst 2010
(02) 331 7474

COMPRADOR BUSINESS SYSTEMS
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Smithfield 2164
681 4000

COMPUMOD
10th Floor, 20 Martin Place,
Sydney 2000
(02) 27 7405

COMPUTER & ELECTRONIC SERVICES
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Wheelers Hill 3150
(03) 561 8947

COMPUTER & PERIPHERAL SALES
2-18 Salisbury Road,
Asquith 2078
(02) 476 6400

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55 Waymouth Street, Adelaide 5000
(08) 212 7577

COMPUTERVISION
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Crows Nest 2065
(02) 922 2644

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9 Byfield Street,
North Ryde 2113
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Cottlesbridge 3099
(03) 714 8269

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North Sydney 2060
(02) 929 5855

DISCWARE
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Broadway 2007
(02) 212 6933

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North Sydney 2060
(02) 957 3382

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Glebe 2037
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Gordon 2072
(02) 498 2144

ELECTRI BOARD DESIGNS
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EMONA INSTRUMENTS
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Kent Town 0567
(08) 363 0454

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Blackburn 3130
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Mentone 3194
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Frenchs Forest 2086
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Archerfield 4108
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West Ryde 2114
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Welshpool 6106
(09) 350 5555

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Clayton 3168
(03) 560 1011

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Ryde 2112
(02) 807 4822

MAGNA TECHTRONICS
7 George Place,
Artarmon 2064
(02) 427 0666

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North Ryde 2113
(02) 887 6222

MENTOR GRAPHICS
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North Sydney 2060
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Blackburn Vic 3130
(03) 894 1500

MINICOMP
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North Sydney 2060

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Belconnen ACT 2616
(062) 64 4764

PANTEK AUSTRALIA
757 Riversdale Road,
Camberwell 3124

PRECISION GRAPHICS
Unit 15, 31 Waterloo Road,
North Ryde 2113
(02) 887 2648

PRINTRONICS
33 College Street,
Gladesville NSW 2111
(02) 816 5066

PROMETHEUS SOFTWARE DEVELOPMENTS
Suite 3, 191 Riversdale Road,
Hawthorn 3192
(03) 819 6088

QPSX COMMUNICATIONS
10 Stirling Highway,
Nedlands 6009
(09) 389 1666

QUEST INTERNATIONAL COMPUTERS
1 Hamilton Place,
Mt Waverley 3149
(03) 277 7444

RACAL ELECTRONICS
47 Talavera Road,
North Ryde 2113
(02) 888 6444

RANK XEROX
970 Pacific Highway,
Pymble 2073
(02) 449 0499

RCS DESIGN
728 Heidelberg Road,
Alphington Vic 3078
(03) 49 6404

RHIL ENGINEERING
Unit 6, 516 Sydney Road,
Seaforth 2092
(02) 949 3688

ROBOCOM AUSTRALASIA
693 Whitehorse Road,
Balwyn 3127
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ROBS COMPUTER CENTRE
295 Thomas Street,
Dandenong 3175
(03) 791 2900

ROLAND CORP (AUST)
50 Garden Street,
South Yarra Vic 3141
(03) 241 1254

SCHLUMBERGER SYSTEMS
382 Wellington Road
Mulgrave 3170
(03) 560 1166

SOFTWARE CORPORATION OF AUSTRALIA
138 Buckhurst Street,
South Melbourne 3205
(03) 699 7255

SOFTWARE SUPPLIERS
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North Ryde 2113
(02) 888 1955

SYMBIOTIC COMPUTER SYSTEMS
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Camberwell 3124
(03) 882 2248

TECH-RENTALS
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Ringwood 3134
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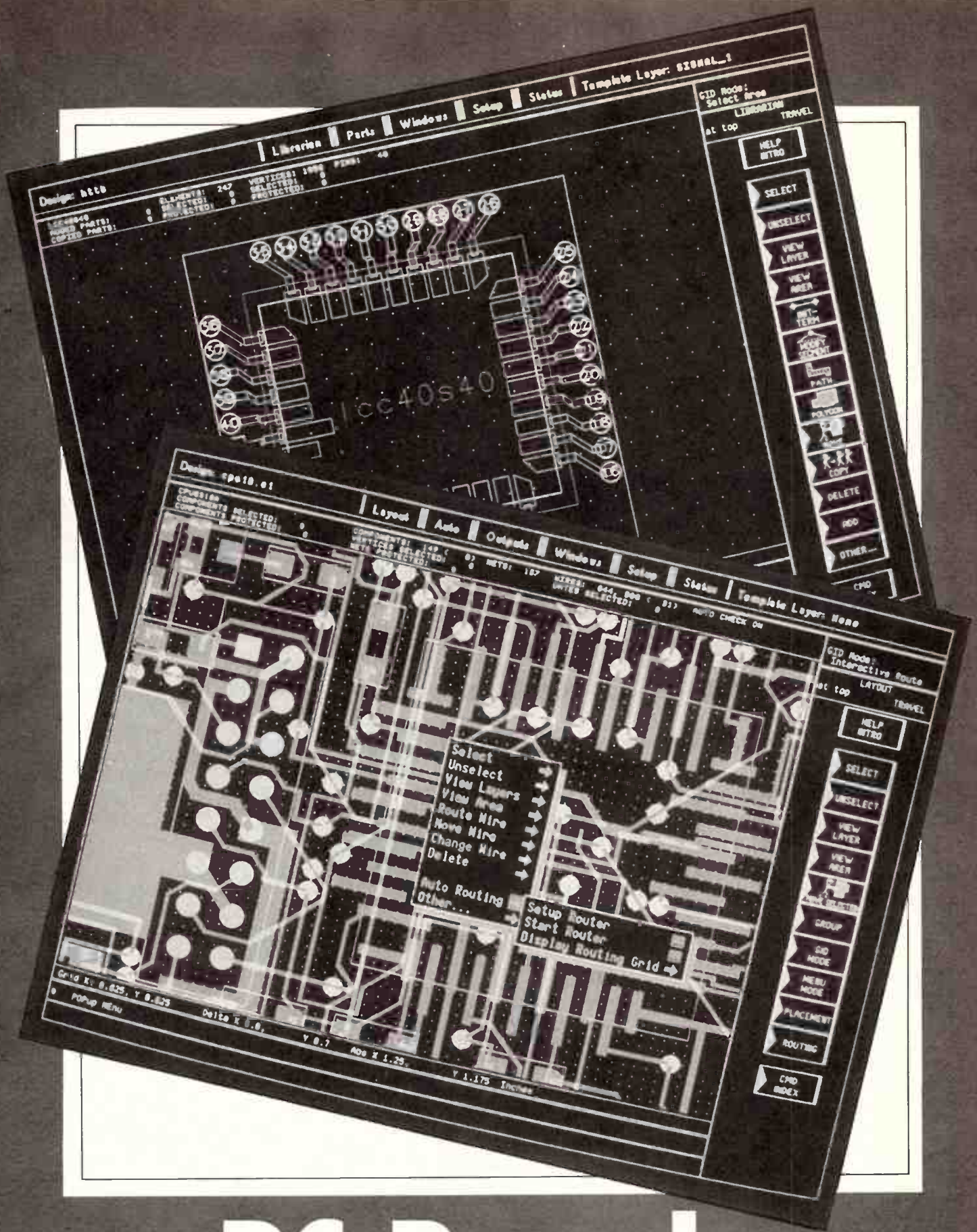
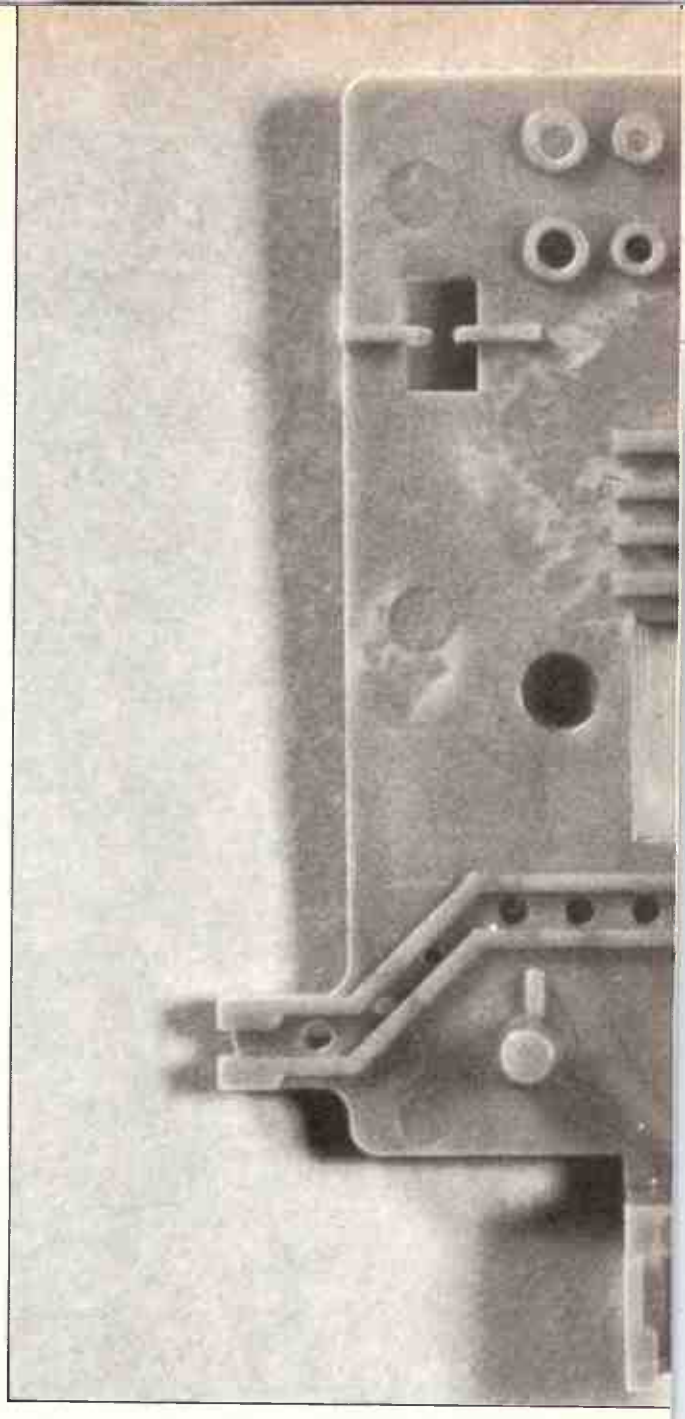


PC Boards

INJECTION MOULDED PC BOARDS



Enormous changes to the humble pc board will take place over the next few years. One of these will be the advent of plastics to replace the glass epoxy substrate in use at present.

Ian Johnston

Printed circuit boards are the basic building blocks of the electronics industry. Almost without exception, the electronic products we take for granted these days have one or more circuits housed on a flat printed circuit board. Over the past 20 years the electronic components have undergone a myriad of changes, to the point that it is difficult to keep up with the daily announcements of miniaturisation and new developments.

But for all the changes that have occurred in electronic components, there has been very little in the way of major changes to the printed circuit board substrate itself. The epoxy/fibreglass laminate has remained unchanged over recent years.

History

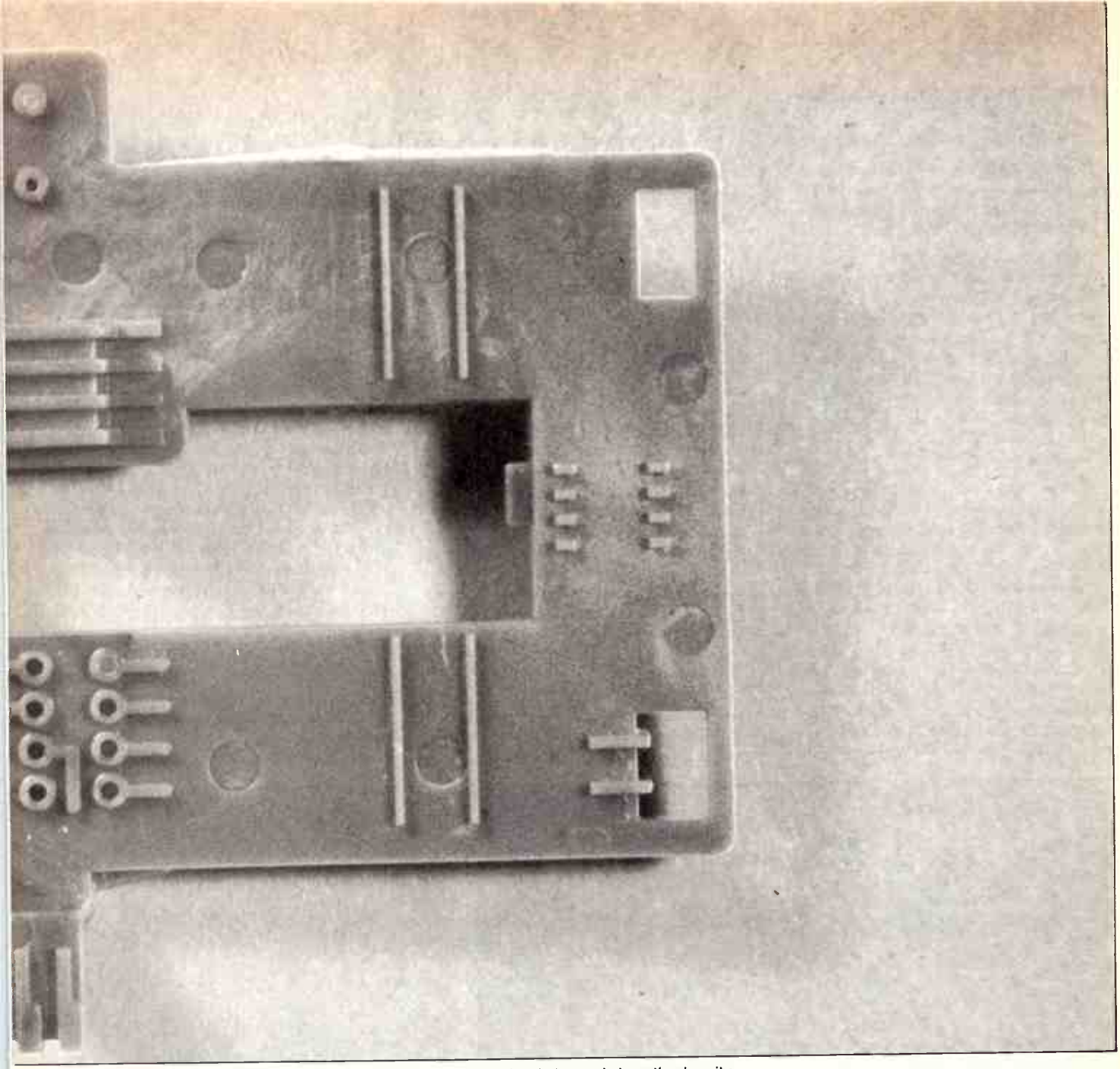
In the late sixties, researchers at A.T. & T's Bell Laboratories, began experimenting with injection moulded printed circuit board substrates as a means of producing low-cost, high volume, high quality parts requiring limited finishing steps. The efforts of Bell Laboratory's researchers were stymied by the lack of suitable high temperature thermoplastics and the lack of a suitable plating process to satisfactorily plate the copper tracks.

The temperatures reached in the soldering stage meant that the parts either warped badly or degraded to a point where they were useless. The chemicals used in the plating process were far too aggressive for the candidate materials available at that time.

In the late 70's and, ever more so in the 80's, there have been sufficient developments in high temperature and chemical resistant grades of thermoplastics to make injection moulded printed circuit board substrates a reality.

Problems

At present, printed circuit board substrates are composites of glass cloth, glass fibres, or cellulose paper fabric bonded with a thermoset resin system under heat and pressure to form a two dimensional board. These boards are produced in sheets and are then guillotined into the desired flat configuration. The most commonly used material is an epoxy-glass combination usually referred to as FR-4



Moulded board substrate showing detailed standups, tracks of insulation and strengthening ribs.

by the electronics industry.

If we examine the existing FR-4 substrates we find several shortcomings which, over the years, have been adapted to and accepted. One of these is the phenomena of conductive anodic filament (CAF) growth. This is an electrochemical migration characteristic of a conductive copper compound along the interface of the resin and glass filaments in a reinforced laminate. This is quite common in FR-4 laminates exposed to humid conditions and leads to corrosion, short circuits and subsequent reduction in service life of the board.

If conventional FR-4 board is required to be 'flame retardant' it is often achieved using halogenated additives. These additives commonly give off corrosive by-products which can damage other components on the board.

The electrical properties of FR-4 boards are not as good as the industry would like in a lot of applications. Many of the new materials used in moulded circuit boards have much lower dielectric constants and up to 10 times lower dissipation factors than standard FR-4.

Being a laminated material the FR-4 boards have a much higher thermal expansion coefficient in the Z direction than they do in the X or Y direction. The glass reinforcement usually controls the expansion in the X and Y direction but the base resin (usually epoxy) controls the expansion in the thickness or Z direction. This can lead to warping during soldering.

In an industry constantly trying to reduce the size and weight of various components, the substrate material used for a standard FR-4 board is some 23 per cent heavier than materials recommended for moulded printed circuit boards.

One additional factor which has caused concern to designers of traditional FR-4 based circuit boards is that the FR-4 material is supplied in flat two dimensional blanks. These blanks must then be guillotined into the desired shape. This step can, and almost always does, lead to scrap product which is not re-usable. FR-4 blanks are not manufactured locally in Australia and must be imported from overseas.

Solutions

As mentioned earlier, injection moulded printed circuit boards offer a solution to many of the problems associated with standard FR-4 substrates.

The most important of these is the design freedom to go three dimensional with printed circuit boards and do away with many of the traditional "add-on" bits. Connector bodies and mounting bosses, can be moulded onto the board. Standups can support elevated LEDs or locate batteries or large capacitors. Really, the freedom of design if offers printed circuit board users is limited only to their own imagination limits.

Many skeptics of moulded printed circuit boards quite rightly point out that injection moulders seldom have an understanding of the requirements of the electronics industry, and that electronics designers seldom have any 'feel' for the process of injection moulding. Indeed, there is a great deal of education to be done in both camps, but the overriding factor is that there are real savings to be made by the manufacturers of printed circuit boards and, in no way are they to be made at the expense of product quality. In fact many of the properties of moulded circuit boards are superior to those of conventional FR-4 boards.

Materials

The necessary properties for a printed circuit board substrate are as follows:

a) Flatness
b) Close dimensional tolerances
c) Heat stability at wave soldering temperatures
d) Plateability with copper tracks
e) Low dielectric constant
f) Low dissipation factor
g) Absolutely reproducible
h) Cost effectiveness

To achieve all of the above properties in one material has, up until recently been very difficult. The materials developed for use as moulded printed circuit board substrates are:

- Glass and/or glass mineral reinforced polyether sulphone.
- Glass reinforced polyetherimide.
- Glass reinforced polyetheretherketone.

These materials range in price from $20/kilogram to over $100/kilogram so they are certainly not in the commodity classification of plastics.

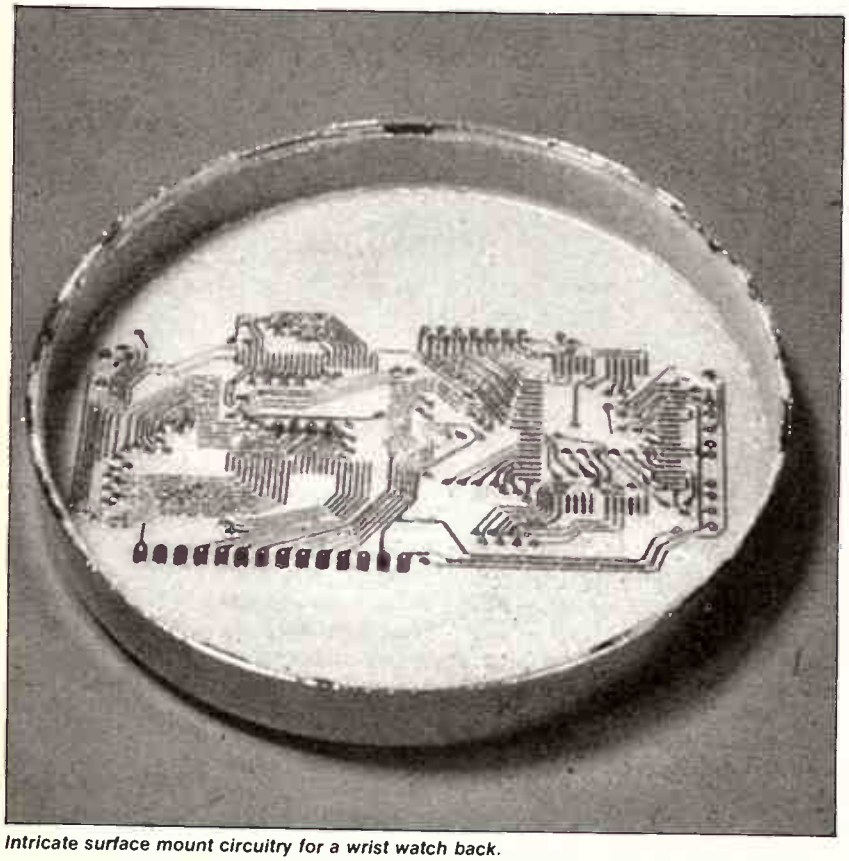
It can be seen that the FR-4 material is excellent in mechanical properties when compared to its rivals but these properties are over and above those required for a printed circuit board. In the electrical and thermal properties, the thermoplastic moulding materials excel over the FR-4 material.

The specifications for printed circuit board substrates are, for the most part written around epoxy/glass boards and, as such the mechanical properties are higher on the specifications than those achieveable from the thermoplastics. The properties of the thermoplastics are certainly adequate for the circuit board application.

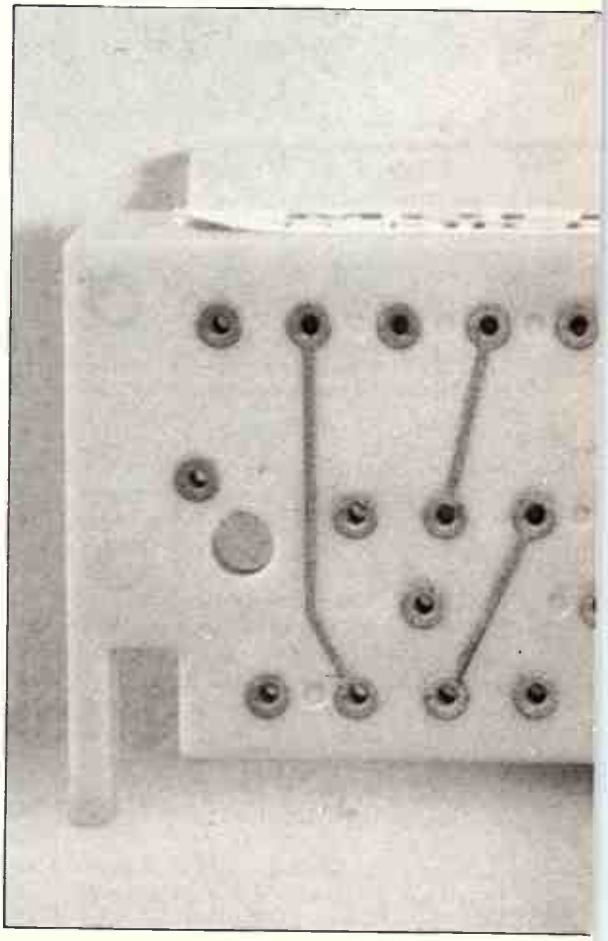
Performance in this area is primarily defined by Tg (glass transition temperature). This translates to the board's dimensional stability during processing and end-use. Thermal stability at elevated temperatures is one of the major advantages of materials such as polyethersulphone, polyetherimide and polyetheretherketone. Epoxy's TG is typically 100°C whilst those of the above thermoplastics is around 200°C. This adds up to less warpage during wave soldering processes.

Plating

There remains the question of how to deposit a printed circuit accurately on the surface of an injection moulded board and ensure that it stays there. Traditional addi-



Intricate surface mount circuitry for a wrist watch back.



Right angle moulding of a double sided board for a simple switching device.

tive plating methods used for FR-4 boards can be used for thermoplastic moulded boards provided they are flat 2-D configurations. The injection moulding materials are all able to give the required 8 to 10 lbs/inch adhesion requirements for conventional boards.

Obviously the main attraction of injection moulding circuit boards is to make them 3-dimensional and this also means plating three dimensional shapes. Resistless imaging or photoselective plating does not use the standard 'resist' layer common to normal additive plating to prevent conductor deposits forming where they are not needed. This system uses a special compound sensitive to ultraviolet light to create the pattern for circuit printing. The properties of the compound are such that copper is deposited (in a plating bath) only on those areas that have been exposed to ultra-violet light. The correct exposure is ensured through the use of a photomask or photo-tool which fits over the plastic blank to cover those areas where a conductive surface is not required.

The dip plating process is a much easier one than electroplating because there is no requirement for electrical continuity of the plated surface, while the copper is built up to even thickness wherever it is deposited. Plating is also highly efficient, in that the treated blanks can be tightly packed (up to 2 square feet of surface per gallon of copper bearing solution).

The rapidly growing importance of this process has also encouraged the development of plating baths with much higher rates of deposition and excellent metallic structure within the copper. Just as important, circuits laid down on these thermoplastic surfaces in this way should achieve good peel strength. As a further advantage, independant areas of platings can be plated at the same time as the circuits themselves are plated, to act as selective screens against electromagnetic interference — yet another type of component which the plain board designers have to install and locate in some other less convenient manner.

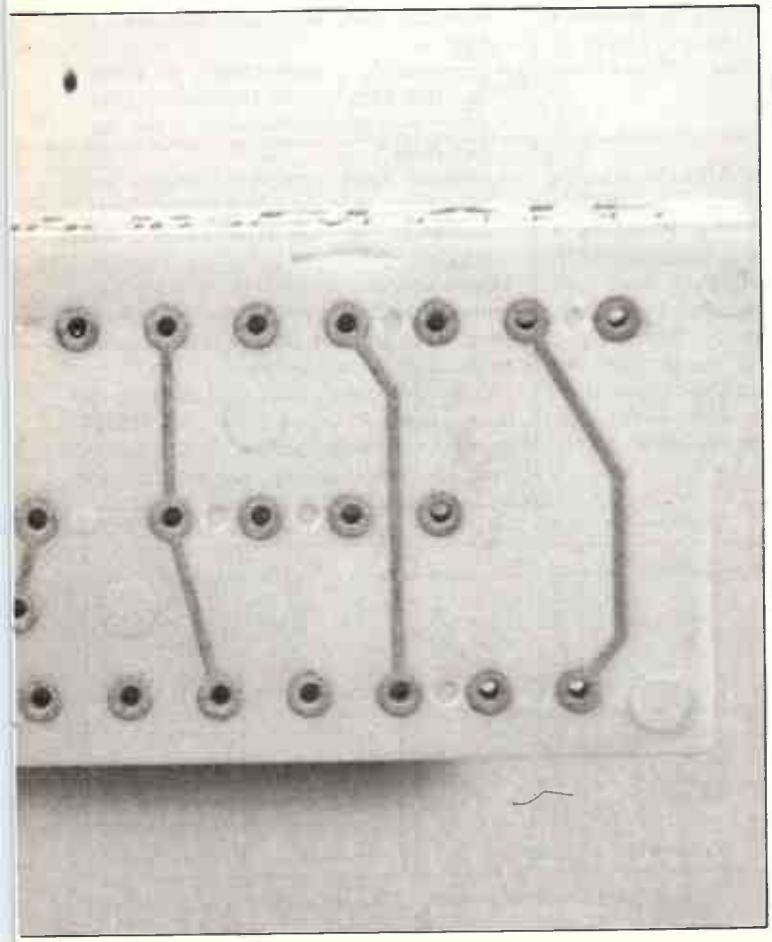
Summary

Development of this technology has shown that there are a few rules to which designers of moulded circuit boards must conform. Copper circuits, like stress itself, abhor sharp edges and corners, so the designer must allow for modest radii. Good injection moulding practice sets limits to such things as rib thickness and boss dimensions, but these are hardly likely to worry a designer whose previous preoccupation was how to add such features separately to something absolutely flat. The designer is more likely to speculate on the may possibilities previously considered impossible in 2-D circuitry.

Economically, the picture depends on the intended production volume. Anyone talking in tens of thousands of boards will probably find that a moulded board will be some 30% cheaper than an equivalent stock of bare, drilled and/or routed up-rinted laminated boards. You would never consider tooling up for 10 boards.

The ultimate future of moulded circuit boards will depend upon the electronics industry but it is not difficult to conceive that all aspects of the industry could be touched by this new trend. ●

Ian D. Johnston is the Account Manager, Plastics Group, ICI Australia Operations, Parramatta NSW.



SURFACE MOUNT RESISTORS

Developing components for surface mount applications is driving technology to the limits. High standards are required in a package as small as possible.

H. Flunkert and H. Horstmann

Even in modern high density circuits, there is a continuing need for discrete resistors. In an age of silicon integration, there are still many functions that require extremely high accuracy, better than can be secured within an integrated circuit. Some of these applications include precise amplification in circuits based on op-amps, precision digital to analogue converters, shunt applications, RC filters and impedance matching.

In the last ten years this increased requirement for accuracy has led to a change from carbon-film to metal-film construction because the temperature coefficient can be made very low in the latter type. This leads to better long term stability and smaller tolerances.

However, at almost the same time, the move from conventional pc board type wired device technology to surface mounting on ceramic substrates has led to a requirement for extremely small resistors with the same characteristics. Historically, the first answer to this problem was the chip resistor. This is a rectangular block in which the resist is laid down using thick film technology.

This satisfied a number of requirements but a thick film solution is by no means perfect. The temperature coefficient can be as high as 200 parts per million for every degree. Tolerance is normally 5 per cent, and can be taken up to 1 per cent, but this drives the price up, considerably. Its pulse loading is poor, its current noise higher than normal and its long term stability is questionable.

Comparison

If this introduction is correct, then resistors suitable for surface mounting are necessary with metal film type characteristics. The answer is the Metal ELectrode Face bonding (MELF) type. Essentially, this is just a metal film resistor without leads. Instead, caps are fitted to the resistor body for direct soldering to the substrate.

Table 1 shows a direct comparison of rectangular chip to cylindrical MELF type resistors. This data has been selected from manufacturers handbooks, and demonstrates the superiority of the metal film type even in this small format. For a comparison, it is helpful to look at the damage threshold for single pulse loading when an SMD resistor is loaded step by step with pulses of increasing energy. Figure 1 shows the results of four different constructions.

Construction

A cross section of a MELF-resistor is shown in Figure 2.

A cylindrical carrier 1 is filmed by a sputtering process with a metal alloy (2), mounted with nickel finished steel caps (3). The metal-film is spiralled by a YAG-laser to the final value (5). Between the caps an isolation finish (6) protects the film against humidity and aggressive environments. Finally the outside of the caps are finished for an incontastable solder process (4).

The requirements of substrates for thin film resistors may be summarized as follows:

- good electrical insulation properties,
- low and consistent surface roughness characteristics;
- high thermal conductivity for power dissipation, especially for pulse load requirements;
- chemically and physically compatible with resistor films, so that a strong bond between thin film and substrate is formed;
- reproducible in manufacture to ensure that thin films are not affected by differences in substrate composition and surface finish;
- minimal alkali impurities (sodium and potassium) to prevent migration effects, important for long term stability and reliability.

High alumina ceramics with alumina contents in the range 80-99.7 per cent have been found to meet most of these requirements for thin film resistors.

Some properties, such as dielectric constant, thermal conductivity and tensile strength vary with alumina content. However, the variables listed are not the only

Style	Rectangular (3,2 x 1,6 x 0,7)		Cylindrical (3,4 x 1,4 ⌀)	
film type	thick	thin	carbon	metal
resistance range	1R ÷ 10M	100R ÷ 100K	10R ÷ 10M	0,22R ÷ 10M
tolerance %	10; 5; 2; (1)	1; .5; .25; .1	10; 5; 2; 1	5 ÷ 0.1
temp. coefficient	±200; ±100	50; 25; 15; (5)	-200 ÷ -1000	50; 25; 15
rated dissipation	0.25 W	0.05 W	0.25 W	0.25 W
current noise	1 ÷ > 10 µV/V	< 1 µV/V	1 ÷ > 10 µV/V	0.05 ÷ 2 µV/V
drift (10.000 h)	≤ 1.5%	n.d.	≤ 3%	≤ 0.5%
pulse load rating	inferior	dubios	good	good*
HF-operation	excellent	different	useful	useful**
robustn. of termin.	useful	irritable	good	excellent
rap. change of temp.	≤ 1.5%	n.d.	≤ 1%	≤ 0.25%
res. to solder. heat	≤ 1%	n.d.	≤ 1%	≤ 0.25%
solderability	different	irritable	different	excellent
price situation	favourable	expensive	moderate	favourable

*dependent from ceramic carrier **excellent for special finish

Table 1

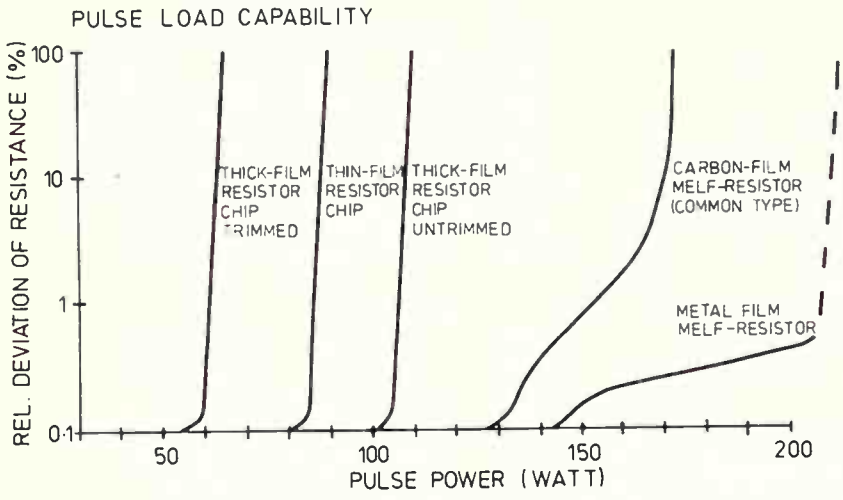


Figure 1: Deviation of resistance from nominal as a function of pulse power.

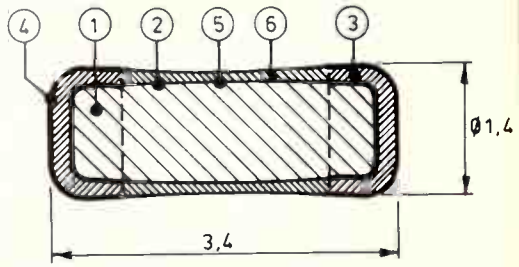


Figure 2: The parts of a MELF resistor: 1. Ceramic body 2. Metal film 3. Metal caps 4. Solder finish 5. Helixing 6. Isolation finish

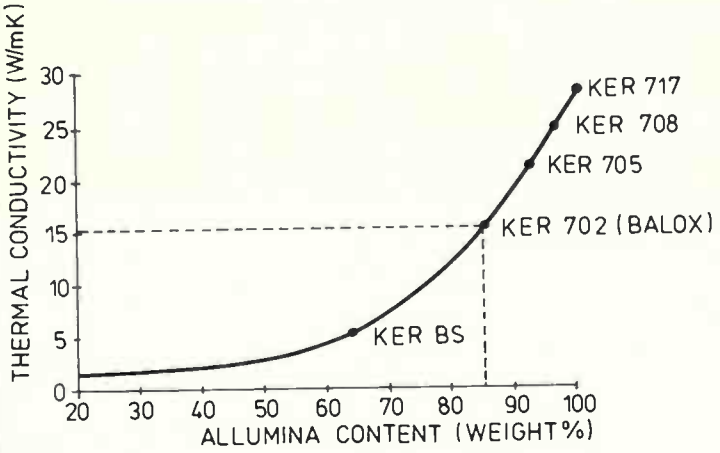


Figure 3. Thermal conductivity versus Alumina content.

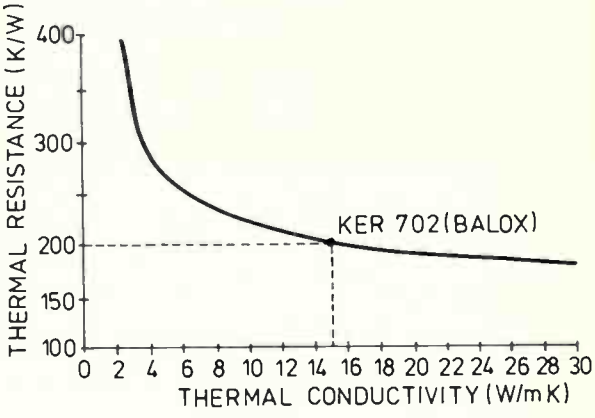


Figure 4. Thermal resistance versus Thermal conductivity.

important ones. The density, average grain size and type of minority phase present are also important. Figure 3 shows the thermal conductivity versus the alumina content.

The bulk of thin film requirements can be satisfied by debased alumina bodies containing 80-90 per cent alumina. Figure 4 shows the thermal resistance (hot spot as a function of applied power) versus thermal conductivity for such a composition.

The metal film — an alloy of chromium, nickel and a third component — is sputtered in a vacuum-process on the ceramic surface. In the same process a layer of metal-oxide is applied to protect the thin metal film against hostile environments. Resistance value, long term stability, reliability, current noise, third harmonic index and last but not least the temperature coefficient, are determined in this process.

Figure 5 shows the temperature coefficient. It is always less than 50 parts per million per degree Kelvin. Temperature coefficient is defined so that the actual deviation is inside the straight lines. The real deviation is always smaller. In this diagram, the resistance deviation between −55°C and +155°C has to be inside the TC-straightlines. If a smaller temperature range is defined (eg: −25°C to +85°C) the same resistor accomplishes more stringent specifications.

After filming metal caps are pressed over the body-ends. A special steel with wide elastic limits is used, finished inside (and outside) with a nickel-phosphorus-alloy to give excellent ohmic contact to the metal film. It provides low thermo-electricity, high adhesion against steel, and is a perfect carrier for solder finish.

For SMT it is extremely important to find a construction to withstand the different thermal expansions of the SMD on the one hand and the pc-board on the other. Flat screened contacts on thick-film-chip resistors sometimes produce tremendous cracks between the solder contact and the ceramic carrier. The MELF-construction is an excellent solution to this problem.

The same arguments protect MELF-construction against destruction by bending or distortion of the pc-board. This is vitally important in some hostile environments, especially where vibration and heat are combined, as in the automotive and aviation industries.

The most important influence on long term stability and current-noise is the pro-

Surface Mount Resistors

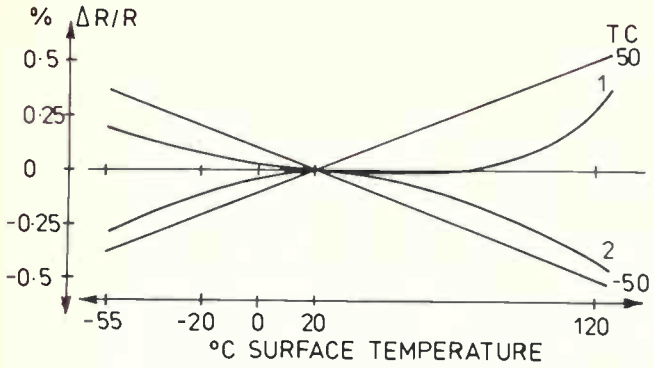


Figure 5: Change of resistance with surface temperature. The temperature co-efficient is given by the straight lines.

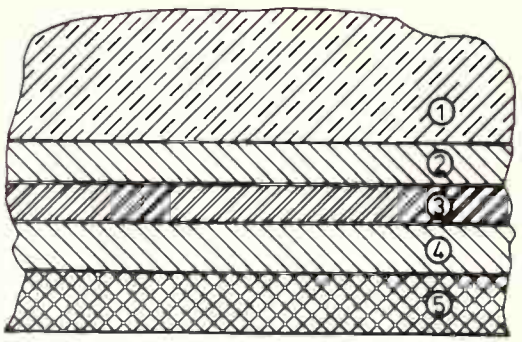


Figure 7. Cross section through the solder contact.

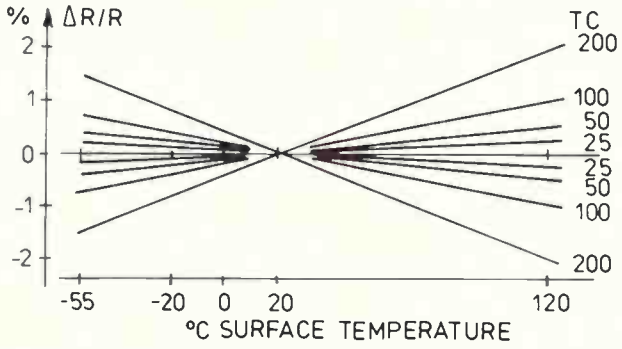


Figure 6. Possible shape of characteristic for a given thermal conductivity.

cess used to trim the resistor to its final value. Stone grinding, sand-blast and laser-helixing are applicable. For laser-trimming the CO_2-laser is easy to handle, but deep melting in the ceramic produces cracks and thus instabilities and current noise.

The best results are obtained by trimming with a YAG-laser in pulse mode.

Encapsulation

The process of manufacturing is completed by the outer sheath or encapsulation. It needs to do a number of things.

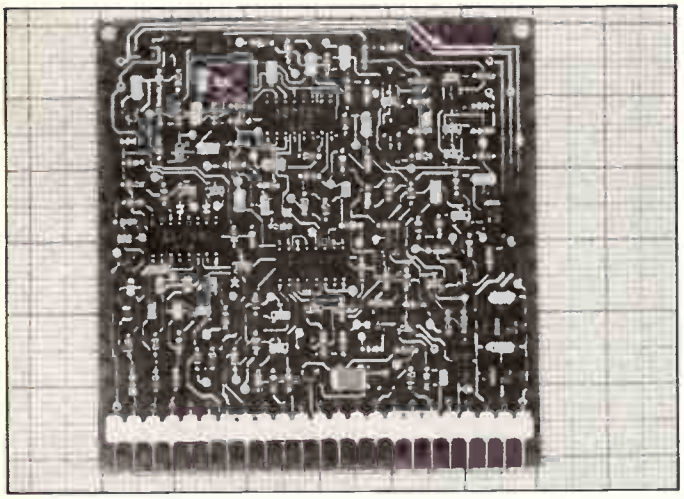


Figure 8. Example of various printed circuit patterns for MINI-MELF resistors.

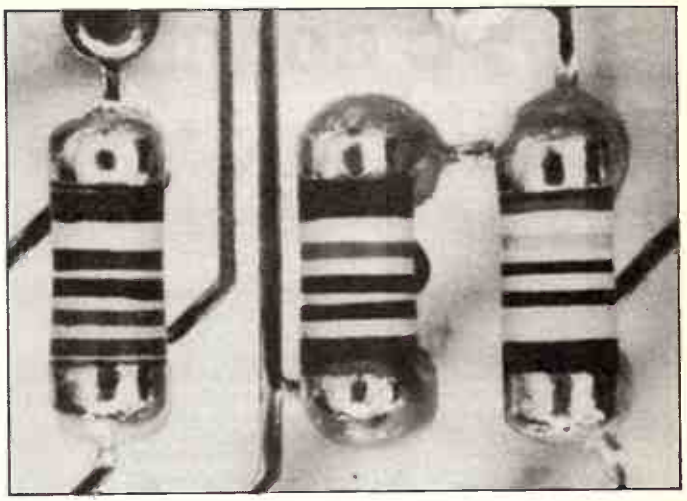


Figure 9. Section of figure 8.

— Form a perfect cylinder between the caps because a shape like a "dog-bone" is difficult to fix on the pcb-surface; a form like a barrel generates a gap between the caps and solder pads.
— to withstand the thermal shock from solder heat (e.g. dipping in liquid tin-lead at 260°C for 10 seconds).
— to protect the metal-film against humidity and other environmental attacks (tested by exposure in a pressure-cooker followed by full power load).
— No deterioration from long term exposure to high power heat-up (e.g. 10,000 hours with hot spot temperature of 155°C).
— No damage from cleaning solvents.
— must allow for colour-code-bands or markings.

All these will be provided by a filled polymer-encapsulation and the selection of pure fillers with very low alkali-content and small thermal-length-expansion. ●

The authors are with Beyschlag GMBH, Heide, West Germany. This article is based on a paper presented at the 1987 IREE convention in Sydney. Enquiries should be directed to the local Beyschlag agents, Crusader Electronics (02) 519 5030.

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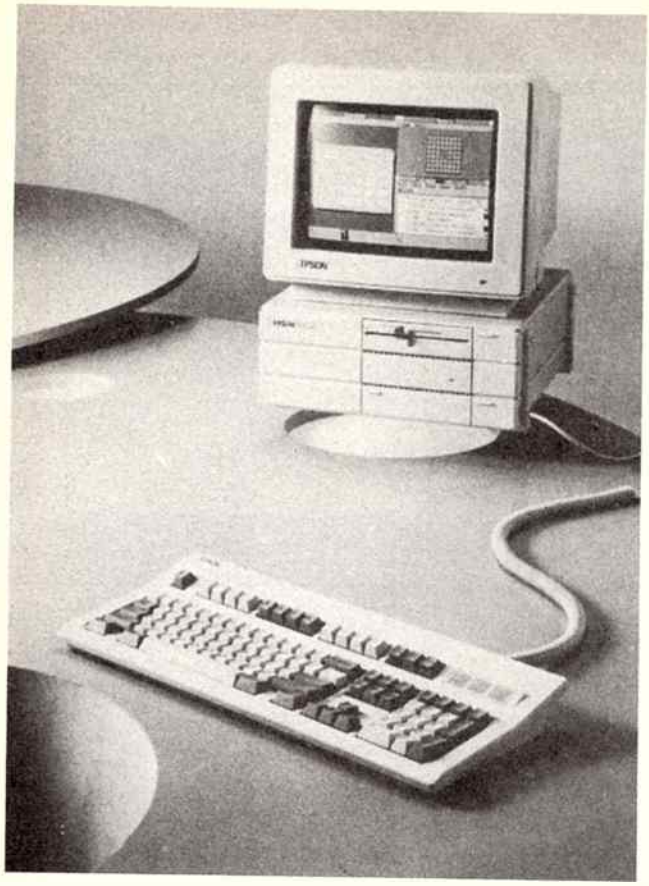

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2 Wire LANs

Standard Microsystems Corporation have announced a new family of ARCNET products for PC Local Area Networks (LANs) utilizing twisted pair cabling.

The primary advantages of this type of transmission media are cost, availability and ease of installation. All of the components — cables, modular plugs and T connectors — are less expensive and take less time to install than any other transmission media. The possibility of using existing wiring can also significantly reduce total system cost.

CSMA-type twisted pair LANs, such as StarLAN, require two pairs of wires, one for transmit functions and another for receive functions. ARCNET, on the other hand, needs only a single pair of wires to support its token-passing access method, which allows only a single node to communicate at any one time.

This new product line features an ARCNET Network Controller Board that fits in an expansion slot in any IBM PC or compatible system. Multiple PCs are connected to a single twisted pair segment in a daisy-chain or multidrop configuration. Network expansion is achieved by connecting twisted pair segments with a two-port Twisted Pair Repeater, and a twisted pair network can be connected to a coax network with a two-port Twisted Pair Link.

ARCNET is a baseband, token-passing LAN technology that permits individual computers, such as IBM PCs or compatibles, to communicate with each other. Since its introduction in 1977, ARCNET has grown to become an industry-wide, de facto standard with an installed base of over a half-million nodes. ARCNET also has a significant share of the PC LAN market. ARCNET boards represent 15% of the installed base, and one out of every four boards being installed today is ARCNET. In addition, ARCNET operates with today's most popular network operating systems, such as Novell's NetWare, Banyan's Vines, Torus Tapestry and Westem Digital's Via-Net.

For further information, please contact: Total Electronics, 9 Harker Street, Burwood, Victoria 3125. Ph: (03) 288-4044. *READER INFO No. 165*

New Graphtec Data Analyzer

The MS5100 is an all-in-one measurement system which enables input, display, calculation, recording and transfer of data. It features 1 through 4-channel input, a 32 K word memory, and 14-bit A/D converters.

Six measurement modes — direct Y-T and X-Y, memory Y-T and X-Y, direct logging and memory event — cover a variety of measurement needs. Analogue waveforms can be measured by direct recording in the DC to 80 Hz range and by memory recording in the DC to 20 kHz range.

The 217 x 98 mm (640 by 200 dots) backlighted LCD enables clear waveform and information presentation, and interactive displays, cursors and pushbutton controls make the MS5100 easy to operate. Hardcopy of the display screen can be generated in only 20 seconds by pressing the display code key.

The MS5100 has a built-in ability to calculate required physical parameters from measurement data and scale data from transducers in an arbitrary system of units (labelled by four characters from a 96-character set).

A thermal dot-array head (8 dots/mm) and a proprietary heat control system print high-quality records at high speed with very little noise. A standard GPIB or RS-232C interface transfers data to external devices.

For more information contact AWA on (02) 997 3433.

READER INFO No. 166

Venus Risen

The Webster computer Corporation has announced the release of its Venus supermini system. It's AT&T 3B-series compatible VMEbus based computer which runs the UNIX System V operating system. Featuring discs to 1.5 Gb, CPU performance to 2 MIPS, and memory to 96 Mb, Venus comfortably supports simultaneous timesharing access by up to 66 users.

The Venus central processor is a full 32-bit word, 32-bit linear address machine with both demand paged and demand segmented virtual memory support, allowing arbitrarily large programs to efficiently use limited physical memory.

Two speed ranges of CPU are available: the model VS14 is clocked at 14 MHz and has an average execution throughput of 1.5 Million Instructions Per Second (MIPS), while the 18 MHz VS18 is rated at 2.0 MIPS.

Contained within the Venus CPU board is 1 MByte of memory with byte parity, representing the minimum memory available with the Venus architecture.

This local memory is supplemented with additonal VME memory boards of 2, 4, 8 or 16 MByte with the byte parity; to a total practical limit of 97 MByte using the standard Venus 9-slot VME backplane.

However, program size is not limited by physical memory, as the CPU, operating system and disc together simulate a virtual memory space of up to 4 Gigabyte.

A choice of three high performance fixed Winchester disc drives is offered, as well as RS-232C serial interface ports with DB25 connectors. Additional serial lines are provided in banks of 16 using multiplexer boards. Up to six 16-line multiplexers may be installed in a fully configured Venus system, permitting an upper limit of 98 serially connected terminals, printers, modems etc.

Floppy discs are the 5¼ inch double sided high density standard providing formatted capacity of 720 kilobyte.

READER INFO No. 167

Colour-Graphics Printer

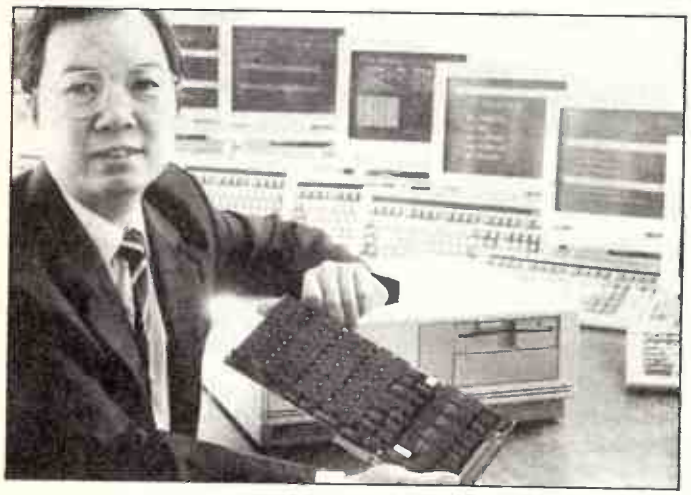
The Hewlett-Packard Company recently announced the HP PaintJet colour-graphics printer. This printer produces colour graphics for overhead transparencies and reports and has near letter-quality (NLQ), high-speed text. It is priced for personal computer users.

It produces text and graphics with 180 x 180 dots-per-inch resolution and NLQ text at a speed of 167 characters per second. The device can product a typical text page in about 40 seconds and a full page of colour graphics in about four minutes.

The printer holds four inks — black, yellow, magenta and cyan. It mixes these colours to produce red, blue and green. With appropriate software, the primary colours can be mixed to provide 330 different shades and hues.

Sixty nozzles transfer the ink to the media. Two disposable cartridges — black and colour — contain the nozzles, inks and electrical-printing elements. Cartridge life is approximately 1.1 million characters and can produce about 1,000 pages of black text and 180 pages of colour graphics.

READER INFO No. 159



PC Terminals

Sydney-based Datamix has gone into initial production of a low-cost expansion unit to convert PC-AT's into a powerful multi-user system supporting up to 10 terminals, all capable of running standard MS-DOS programs.

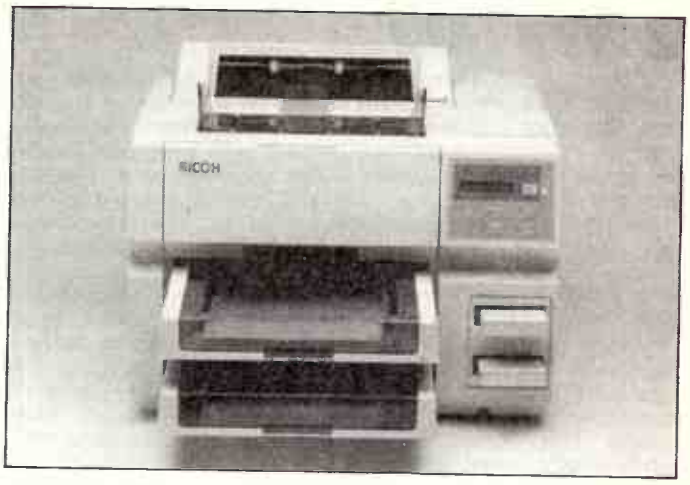
Through use of a customised version of the Digital Research Corporation's Concurrent-DOS operating system, DECATASK users would get the full benefit of concurrency — the ability to run two tasks at once — and still be fully compatible with MS-DOS.

According to Datamax, Decatask will be priced at 50% of the price of a second AT, and allows another 10 terminals to be plugged in for the cost of just the terminal and cabling."

A DECATASK-based 10-user system would cost at least $30,000 less than a 10 workstation network, he added.

DECATASK comprises a single, multi-layered expansion card containing 2 Megabytes of RAM; a compact 10 serial-port distribution box and bundled with it, the MS DOS-compatible Concurrent DOS XM operating system. The board can run on any processor up to 12.5 MHz.

For further information contact Datamax at (02) 977-6522. *READER INFO No. 160*



High Speed Ricoh Laser from Mitsui

Mitsui Computer have released a compact desktop 15 page per minute (ppm) laser printer. The Ricoh LP4150 laser printer is the top end of the Ricoh 6, 8 and 15 ppm laser printer range distributed by Mitsui Computer.

Configured with a standard 1.5 Mb of RAM, expandable to 2 Mb, it is designed to be a powerful desktop unit, suitable for word processing, spreadsheet, database, CAD/CAM, barcode and desktop publishing applications.

HP LaserJet Plus, Diablo 630, Epson FX, IBM Graphics and full HPGL 7470/75 plotter emulations are all available with the Ricoh LP415.

READER INFO No. 161

New FRA

The NF 5020 is a general-purpose frequency response analyzer covering the range 10 mHz to 20 kHz. It features a built-in CRT display and extremely simple operation.

The 5020's 5-inch green CRT screen provides displays of setting conditions and measured results. A video output is provided to enable generation of hard copies of the CRT display and for use with a larger extemally connected video monitor or VCR.

Measurement results can be displayed as a Bode, Nyquist or Nichols plot. A cursor readout function is provided to simplify accurate readings.

A dedicated video-printer output is provided to enable quick and accurate hard copies of setting conditions and measurement results. This output includes a clock signal to ensure reliable synchronization.

In addition to 10 memory locations for setting values, the 5020 has two data memories — A and B — enabling the comparison of two measurement results (A-B output: equalization function). This can be used to cancel out the premeasured sensor characteristics by subtracting them from the overall measured results, leaving only the frequency response of interest.

Both of the input channels can be floated to achieve a common-mode rejection ratio (CMRR) of 60 dB (at 1 kHz), thereby enhancing common-mode noise rejection performance.

Applications such as loop characteristic analysis of servos require a floating signal source. To facilitate the use of the 5055 Signal Injector/Probe in such applications, the 5020 provides a dedicated 5055 power supply output.

For further information ring Electrical Equipment on (02) 227-3433.

READER INFO No. 162

NEC and Standard Join Forces . . .

NEC Corporation (NEC) of Tokyo, Japan and Standard Microsystems Corporation (SMC) of Hauppauge, New York, jointly announced that the two companies have signed a technology agreement that provides for SMC's second-sourcing two of NEC's important microcomputer-related complex peripheral devices. The two NEC peripheral devices which will be second-sourced by SMC under this worldwide agreement are the uPD 7260 Hard/Floppy Disk Controller and the uPD 7262 Enhanced Small Device Interface (ESDI) Controller.

The products covered by this agreement between NEC and SMC will also be marketed, distributed and sold by Toyo Microsystems Corporation of Tokyo, Japan, the joint venture between Sumitomo Metal Industries Ltd and Standard Microsystems Corporation, which began operations in April of this year.

The agreement is part of a continuing drive by Japanese companies to move manufacturing offshore to avoid trade embargoes, particularly in Europe and the US.

For further information, please contact: Total Electronics, 9 Harker Street, Burwood, Victoria 3125. Ph: (03) 288-4044.

READER INFO No. 164

. . . and so to Ericsson and IBM

two of the world's major communication companies — Ericsson and IBM — will jointly explore a wide array of new telephone communications networking services.

The non-exclusive agreement provides for IBM to use its expertise in database and data network management with Ericsson's technology in AXE telephone switching, similar to that in Australia's Public Telephone Network.

The object of the study is to develop technical solutions for the intelligent network concept, specifically for advanced network functions — also known as features. These solutions will be based on standard IBM and Ericsson systems and specialised IBM and Ericsson software to implement the intelligent network concept.

One Meg Module

A new 1 Meg electrically-erasable programmable read-only memory (EEPROM) module in the JEDEC Standard DIP pin-out, has been announced by SEEQ Technology in the US.

According to SEEQ director of military programs David Sweetman, the model MM28C1024/B CMOS EEPROM Module, configured 128K x 8, utilizes four of SEEQ's 28C256 EEPROMs in LCC packages mounted on a ceramic co-fired substrate along with a decoder chip and decoupling capacitor. The 28C256, the world's first 256K CMOS EEPROM, has been in production for over one year and contains all the JEDEC EEPROM standards, in addition to the features of low CMOS operating and standby current, instant powerup, flexible and extended page load, and false write protection.

READER INFO No. 168

R&D on CD

An optical disc archival document storage system is currently under development in Australia by Tower Technology. The company was set up last year to handle the development and manufacture of the system, receiving a $1.25 million R&D grant from the Industry Research & Development Board with further funding coming from Advent Western Pacific.

Tower Technology's aim is to implement a multiuser optical disk-based source document management systems. It will be designed and built in Australia to international standards, by integration of modular system components and purpose developed software.

The system will allow organisations to randomly capture all their documents electronically, automatically index them, store them onto optical disk and provide multiple users with fast access to images of their documents via high resolution terminals or printouts via laser printers.

Each optical disk can store at least 40,000 documents. Multiple disks are located in a "juke-box" which automatically selects the correct disk when document access is required.

For further information contact Tower Technology on (02) 427 2999.

READER INFO No. 163

Keycorp and Mitsui

Mitsui Computer is to be the exclusive Australian and New Zealand distributor for Keycorp's Keymaster products.

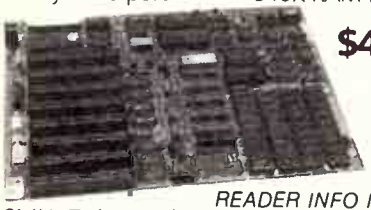
Sydney based Keycorp invented, manufactures and markets the Keymaster Keyboard and Keypad, featuring patented, "intelligent" liquid crystal display (LCD) keycaps. (See News Digest, Nov 87.) Keymaster is designed to simplify the use of computers for inexperienced people by guiding and prompting the user through a given software application.

READER INFO No. 169

10MHz TURBO PLUS MOTHERBOARD

This 10MHz, no-wait-state board is a drop-in replacement for the sluggish 4.7MHz PC motherboard.

- 8088-3 running at 10MHz/no wait states
- Turbo/normal selectable
- 4 channel DMA
- 8 expansion slots
- Keyboard port
- 640K RAM fitted



$475

READER INFO No. 80

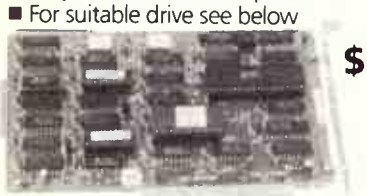
8MHz Turbo Motherboard still available at new low price. Was $450.00.

NOW ONLY $425

1.2MB/360KB FLOPPY CONTROLLER

The perfect answer for backing up hard disks, archiving etc.

- Supports both 1.2MB and 360KB drives
- Fully PC/XT, PC/AT compatible
- For suitable drive see below



$125

READER INFO No. 81

150W SWITCHING POWER SUPPLY

Drop-in replacement for IBM PC's puny 63W supply.

- Boosts PC to PC/XT specs. Essential to run hard discs and other ad-ons on PC.
- Outputs +5V/15A, –5V/1A, +12V/5A, –12V/1A.
- All cables to disk drives, mother-board etc.

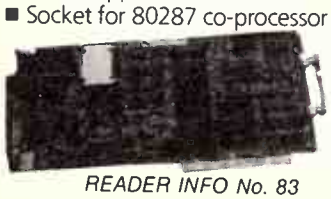
$148

READER INFO No. 82

AUSTRALIA'S BEST SPEEDUP CARD

Speed up your PC over 7 times with our superb new speed-up card.

- 80286 CPU *plus* 8088 for complete software compatibility
- Clock rate 6/8MHz (selectable)
- RAM on-board for disk cache
- DMA support
- Socket for 80287 co-processor



$545 Limited Stock

READER INFO No. 83

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FLOPPY DISK CONTROLLER

Controls up to 4 DS/DD 360K drives.

$65

READER INFO No. 84

PEGA EGA card – unmatched resolution

Get all the standards with this superb short slot EGA card.

- Supports Monochrome, Hercules, CGA, EGA and Plantronics modes. Fully Auto switchable.
- Supports 132 columns in Symphony, Lotus and WordPerfect
- Automatic monitor detection
- 256K of video memory standard
- Flicker free scrolling

$495

READER INFO No. 85

DISK DRIVES

40 Track Mitsubishi.

Very fast track-to-track. 360KB DSDD. Lowest price in Australia. **$245**

READER INFO No. 86

1.2MB NEC

Super high density. Superb construction and reliability. Works with 1.2MB floppy controller. **$275**

READER INFO No. 87

20MB NEC Hard Disk.

Very fast and super reliable. Best price in town. **$695**

Complete with controller. **$895**

READER INFO No. 88

XT Style Case with Hinged Lid

Perfect for building your own PC.

$95

READER INFO No. 89

MEMORY

512K Ram Card – Short Slot

- 512K RAM installed (41256 chips)
- DIP switches to start address

$195

READER INFO No. 90

640K Ram Card – Short Slot

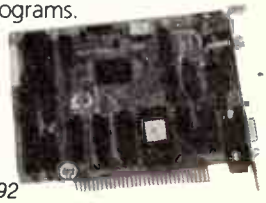
- 640K memory installed
- User selectable from 64K to 640K
- DIP switches to start address

$225

READER INFO No. 91

Colour Graphics/Mono – Short Slot

This amazing new card drives RGB colour, composite colour or a TTL monochrome monitor. And it fits in a short slot. Full CGA support. Can be used as a colour graphics card with a monochrome display and still run all the colour programs. The card even cures the dread colour graphics "flicker and snow".



$195

READER INFO No. 92

Colour Graphics Video Card

- Suits RGB and composite colour monitors
- Light pen interface
- Fully CGA compatible
- 40 x 25 & 80 x 25 (text), 640 x 200 (mono) and 320 x 200 (colour)

$115

READER INFO No. 93

Colour Graphics/ Printer Adaptor

Attaches to IBM-compatible RGB monitor; provides complete compatibility with IBM Colour Graphics Adaptor. Equivalent to the IBM colour/graphics adaptor with additional printer port to replace the video port originally supplied by IBM.

$145 *READER INFO No. 94*

Parallel Printer Card

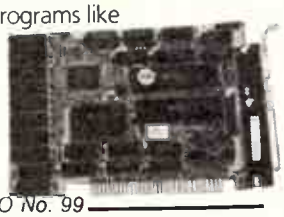
- Standard TTL level
- Centronics printer port, full IBM, EPSON compatible

$44

READER INFO No. 98

Turbo Mono Graphics/ Printer – Short Slot

If you want fast, flicker free scrolling and full Hercules compatability, this is it! Perfect enhancement for slow scrolling programs like Microsoft Word etc. The ultimate monochrome graphics card.



$175

READER INFO No. 99

Serial RS-232 Card

- Independent receive clock input
- 2nd serial port option
- Full buffering eliminates need for precise synchronisation

$55

READER INFO No. 100

2MB EMS Memory Card for PC/XT or AT

An affordable "Above Board" memory card. Fit up to 2MB of high speed RAM (0K fitted). At a low introductory price: **$495**

READER INFO No. 79

Multi I/O Card

- Floppy disk adaptor, 2 drives DS/DD
- 1 serial port, 1 parallel port, 1 joystick port
- Clock/calendar with battery backup

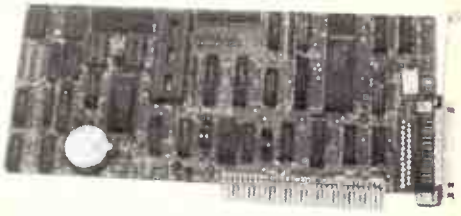
$175

READER INFO No. 78

I/O Plus Card

- Clock calendar with battery backup
- 1 serial port, 1 parallel port, 1 joystick port

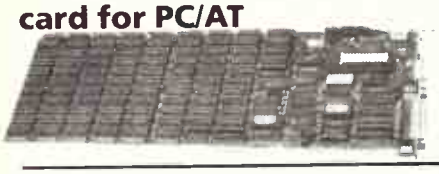
$136



READER INFO No. 77

NEW PC/XT PRODUCTS the power you're searching for!

2.5MB Multifunction card for PC/AT



Give your AT a big boost with this superb quality, low cost expansion card.

- One RS232C serial port
- One parallel printer port
- Memory expansion to 2.5MB (0K fitted)
- Fully PC/AT compatible

$495.00 *READER INFO No. 95*

180W AT Power Supply

Suits all IBM PC/AT compatibles.

- User selectable 115/230V AC input
- Outputs: +5V/17A, –5V/0.5A, +12V/7A, –12V/0.5A Overload protection
- Short circuit protection
- Cooling fan stops when voltage output falls to zero
- Top quality components used throughout

$195.00

READER INFO No. 96

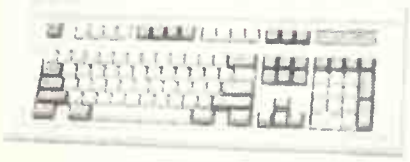
10MHz Baby AT Motherboard

Ultra high performance PC/AT motherboard outperforms all the others. Drop it into your existing PC/XT! Up to 1MByte of RAM on-board (640K fitted)

- 80286-8 running at 6/10MHz switchable.
- Speed test 11.7 on Norton Utilities
- 7 channel DMA for disk and special I/O
- 8 expansions slots (6 full AT standard)
- On-board battery backup, real time clock
- Phoenix ROM BIOS

$945

Enhanced Keyboard suit both PC/AT and XT



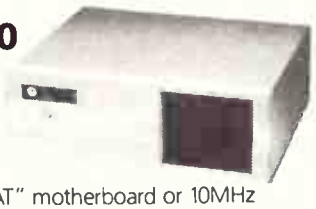
The finest keyboard on the market.

- Suits both IBM PC/XT and AT (switchable)
- Full 101 keys with separate cursor and numeric pad
- Superb key action
- Lights for caps, num and scroll lock

$145 *READER INFO No. 97*

Baby AT Case

$135.00



Suits "Baby AT" motherboard or 10MHz PC/XT motherboard.

- Hinged cover for easy access
- Keyswitch, reset/turbo buttons, indicators

SUPER SPECIALS

V20 chips	$29.00
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TTL Amber Monitor	$275.00
TTL Green Monitor	$280.00
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Computer reviews

Allan Sugar's much maligned Amstrad company has done it again, producing a technologically credible product at a price that will knock your socks off. The new PC1640 comes in three versions, a single 360 K floppy, twin floppies, or a single floppy with a 20M hard disc. Most stunning of all, it comes with EGA, Hercules, MDA and CGA graphics on board, making it one of the most versatile machines on the market.

Amstrad Shows How . . .

The processor is an 8086 running at 8 MHz, and it's surrounded by 640 K of RAM. Like its predecessor, the 1512, the 1640 comes with MSDOS (ver 3.2), GEM, Digital Research's GEM Paint and Locomotive Basic all bundled together to give you a usable tool straight out of the box. Much of the hardware configuration is also the same: three expansion slots, the mouse as standard, real time clock, serial and parallel I/O ports and a socket for an 8087 co processor just in case it's not fast enough for you.

The move towards the three graphics standards has been driven by a proliferation of standards as other manufacturers drive towards more resolution and more colour availability. The three most popular standards to have emerged over the last eighteen months are Enhanced Graphics, Colour graphics and the high resolution, monochrome Hercules format. The 1640 can be toggled between the three with a software switch.

This is all done on one chip, the Internal Graphics Adaptor (IGA). It will generate a display with 320 x 200 lines in four colours, or 640 x 200 in monochrome or 640 x 350 in any 16 out of 64 possible colours.

The review model was an HD (hard disc) version of the 1640. This has a single floppy in addition to the hard disc, and is without doubt the most convenient of the three to use. I loaded all the usual programmes I use: Wordstar, two CAD packages and a data base, together with some proprietary stuff I've accumulated over the years. It's lovely not to have to load discs all the time. Although before one throws the floppys away there are questions about backups and copy programmes to be considered. Another favourite of mine, the flight simulator, refused to load.

At the other extreme, and representing a considerable cost saving, is the single disc version. It is possible to configure part of the 640 k of RAM as a RAM disc to service the 360 k Floppy, still leaving you considerable memory to run programmes.

One thing I still do not like is the organisation of the manual. As with the 1512, this is a huge 700 page best that is almost impossible to assimilate. Remembering where information is located, going back to where you were before, these things are almost impossible. It would be much better broken into a number of different books, and I would like to see a better exposition on BASIC, instead of instructions to buy yet another book from Amstrad.

It's available for $2500 (single disc), $3000 (twin disc) or $3700 for the hard disc version.

. . . and Tandy stays with a winner

The world's first lap top computer, the Tandy T100 was introduced in 1983 and replaced by the 102 in 1985 According to Lyall Jones of Tandy, it's still an extremely strong seller.

In fact, it's not all that surprising. The 102 compares well in many respects with other laptop devices, although sadly lacking in others. It runs an 80C85 with 24k of memory on board, and facilities for an extra 8K of RAM if required. With this kind of memory it obviously can't compete with the big IBM compatible machines like the Amstrad, but it doesn't really try.

The 102 is tailored to do certain simple functions, and it does them rather well. There is a simple word processor. It doesn't have all the fancy attributes of the real thing, but on the other hand, most people don't need more than the ability to delete and do a few simple block moves. Tied to the word processor is a simple mailmerge-like program that will record address and schedules.

One of the most impressive things about it is its communications facilities, which include an auto dial modem. It has a terminal mode tht allows one to access bulletin boards very conveniently.

Finally, if you don't have all the applications you need, there is BASIC on board that will allow you to write your own. All these programmes are held in ROM on board, and you can save up to 19 files in RAM. If you need more storage space, Tandy supply a disc drive to do with the unit. It is also portable, and contains a single 5¼ inch floppy.

There is no doubt that it's all undeniably primitive. However, it does have some advantages that make it worth thinking about. For a start it's very small and very light. It will run for 16 hours from four penlight batteries, or from mains. It sell for $999, by far the cheapest laptop on the market. However, one must ask how much longer it can go on for, given that fully IBM compatible machines are now available for much the same money.

READER INFO No. 135

No. 7

ONLY $1.00

SOUND INSIGHTS

eti

AUSTRALIA'S HIGHEST CIRCULATING HI-FI MAGAZINE

THE YEAR IN REVIEW

JAPAN SHOW: THE FUTURE OF HI-FI!

ADCOM TUNER/PREAMP COMBINATION

January Sight and Sound lifts the lid off the tape pirates and examines the state of play in the DAT war

Sight and Sound News

Professional Speaker System

All the latest releases seem to be speakers. Another new series, the SR, comes from Celestion. These, however, are a professional speaker system, comprised of three units, the SR1 loudspeaker, SR2 coupled-cavity bass bin, and SRC1 controller.

The key selling point of the SR1 is a strongly reinforced hemispheric dome radiator. This is directly coupled to a reinforced Kapton former which supports a 16 mm voice coil. These elements compose the 8-inch cone driver. Manufacturer's specs are 500 watt power rating, 97 dB sensitivity and 50 Hz to 20 kHz frequency response.

The SR2 employs an 18-inch driver, capable of handling 1000 watts. Sensitivity is 98 dB, frequency response 40 Hz to 150 Hz.

The SRC1 offers line and feed level monitoring. Both mixer and power amp feed pass through it.

READER INFO No. 151

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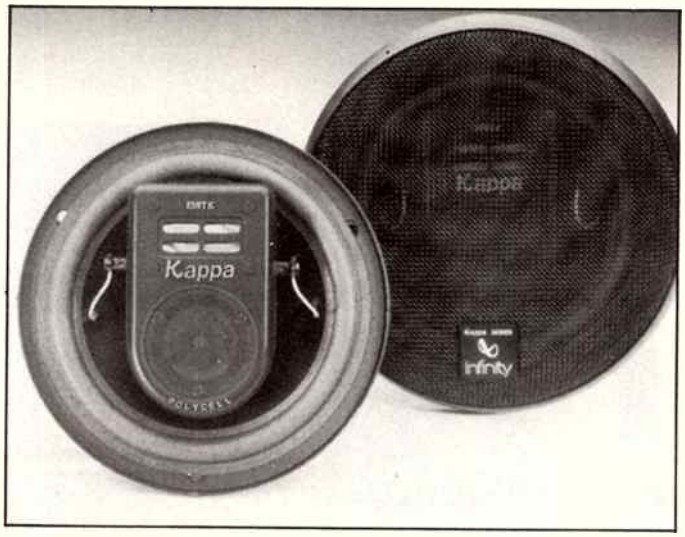
Infinity Automotive Speakers

A new range of Infinity automotive loudspeakers is now available which incorporates the recently developed Kappa drivers.

Using polypropylene/graphite fibre cones, neodymium magnets, computer-designed crossovers, top quality components, and specially-designed cabinets, Kappa technology has managed to eam the esteem of audio reviewers particularly in Europe. Priced between $2500 and $6500 they are out of the range of most of us, however, the new automotive range is a lot more accessible, ranging from $199 for 2-way 4-inch speakers (the RS Kappa 42) to $799 for separate 3-way 6-inch by 9-inch woofers, two mid-ranges and two emit tweeters (the CS 1 Kappa). In between are the RS 52 2-way 5¼-inch, RS 62 6½-inch, RS 63 3-way 6½-inch with emit tweeter, RS692 2-way 6-inch by 9-inch and RS 693 3-way 6-inch by 9-inch with emit tweeter.



Other claimed design features of these Kappa speakers are a new 'pod' mounting for the midrange and tweeter (3-way units) for a more linear performance, heavier duty frames for proper alignment of the magnet structure, and a more appealing overall appearance. Heavier duty frames also mean less resonance in the cabinet.

The improved emit tweeter has a thinner diaphragm and the neodymium magnets are claimed to extend frequency response to 45 kHz, however, this is not quoted in the specs. The top-of-the-range CS1 quotes 34 Hz to 32 kHz frequency response, 110 watts power, 87 dB sensitivity 1 watt, 1 metre. At the bottom the RS 42 quotes 98 Hz to 16 kHz, 30 watts power and 87 dB. In between the RS 52 ($299) quotes 63 Hz to 22 kHz, 55 watts, 88 dB; the 62 ($349) 58 Hz to 22 kHz, 55 watts, 88 dB; RS 63 ($449) 58 Hz to 32 kHz, 55 watts, 88 dB; RS 692 ($399) 38 Hz to 22 kHz, 75 watts, 90 dB; and the RS 693 ($499) 38 Hz to 32 kHz, 75 watts, 90 dB.

READER INFO No. 152

Boston Acoustics Speakers

Speakers are flavour of the month and among the varied Boston range are two floor standing units and a suspension speaker.

At $799, the A150 Series III 3-way floor-standing is the cheapest. It is an update of the Series II with new drivers, a 10-inch copolymyer cone woofer, a 3½-inch copolymer midrange set in its own internal sub-enclosure and the Boston Acoustics CFT 5 1-inch ferrofluid cooled tweeter. Tweeter and midrange are mounted asymmetrically, at ear level, and cabinet height is 81 cm. Frequency response is reported at 38 Hz to 20 kHz ± 3 dB, 15 to 125 watts power handling and 90 dB sensitivity.

A jump up in price at $1299 is the T830, a 3-way tower system, with similar cabinet height, position of tweeter and midrange, and similar driver materials. Drivers are the same size except for the woofer which is 8-inch. The speaker occupies 25 x 24 cm floor space and specs are 45 Hz to 20 kHz ± 3 dB frequency response, 15 to 100 watts power handling and 88 dB sensitivity at 1 watt, 1 metre.

The A70 Series II 2-way speaker is the most expensive at $1499. This speaker uses an 8-inch woofer with copolymer diaphragm and CFT 5 1-inch ferrofluid cooled dome tweeter, asymmetrically placed on the baffle and mounted flush. Specs are 45 Hz to 20 kHz ± 3 dB, 15 to 150 watts power handling, and 90 dB sensitivity.

READER INFO No. 150

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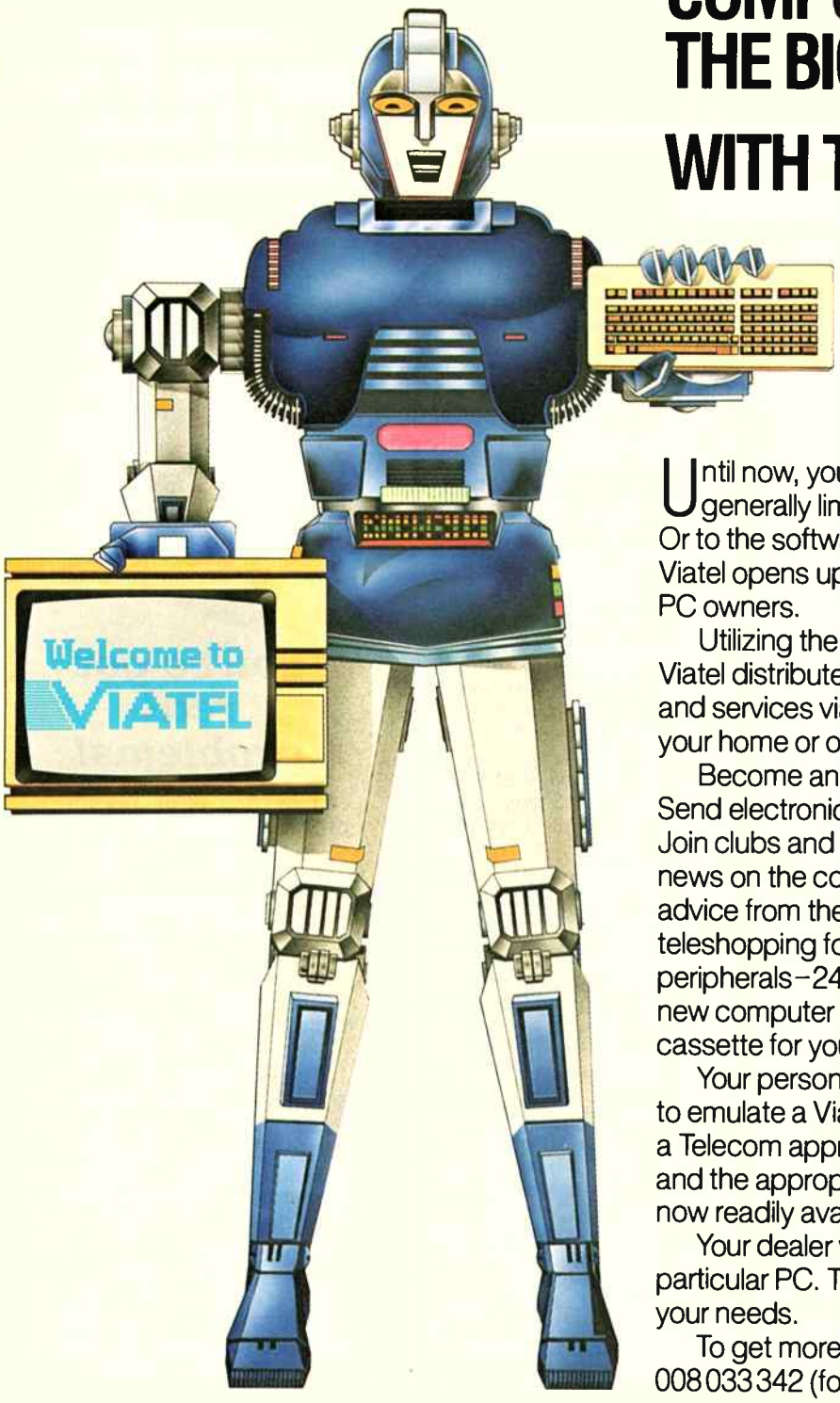

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Briefs

Sonata Turntable

New from Alphason is the update of the Sonata Transcription turntable with solid hardwood plinth and heavy platter. The one-piece platter is shrunk on to the spindle for absolute rigidity. A one-piece sub-chassis armboard is hung on three springs adjustable from the top. Two diametrically opposed synchronous motors are driven by a quartz-locked synthesised pure sine wave. The turntable is designed to accept any arm but the Alphason HR-100S-MCS is recommended. It comes in black finish at $2990 and gold and wood at $3190.

READER INFO No. 170

Onkyo Tuner and Cassette

Onkyo has released a new top range tuner, the T-9090 MKII. It features an anti-microphonic current (AMIC) intended to eliminate distortion from microphony, a 31-key remote control which sounds like hard work. It retails for $1499.

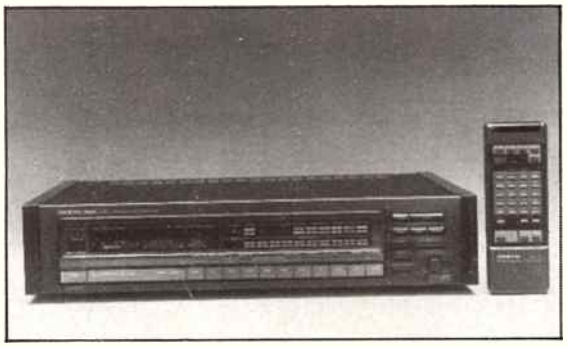
The other release from Onkyo is the TA-RW490 auto-reverse cassette deck. The deck is equipped with Dolby HX-Pro as well as B and C noise reduction systems. The computer-controlled synchro dubbing facility automatically cues songs for editing and the real time counter gives independent readings for A and B cassettes. Full integration with a remote control system can be achieved through a serial port at the rear. Retail price is $1199.

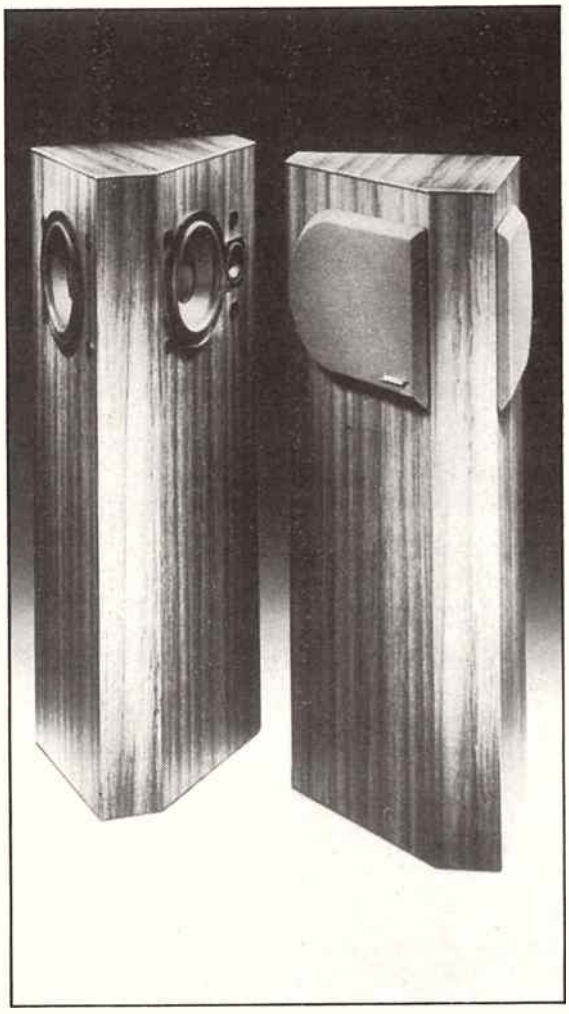
READER INFO No. 155

Bose 401 Speaker

Using 'direct/reflecting speaker technology', Bose has produced the 401 system with qualities like "full stereo", "even sound distribution" and "lifelike spaciousness". Each speaker has two long excursion 6½-inch woofers that operate in a computer-designed ported enclosure and a 2-inch tweeter. They retail at $1200.

READER INFO No. 156





1987 Japan Audio Fair

Above: Panasonic car audio system.
Top Right: Inside a Japanese CD store.
Bottom Right: The giant Mitsubishi speaker.

AS I ARRIVED at the Japan Audio Fair Ground in Tokyo last October, the headlines on the papers were screaming "Consumer Prices in Tokyo Rise for Sixth Straight Month." With that forewarning, I was not surprised to find that the price in yen for the vast range of equipment that I subsequently saw was generally much higher than expected.

The Harumi Fair Ground in Tokyo was crowded by excited Japanese, and much to my surprise quite a few foreign visitors, most of whom happened to be reviewers judging by the photos that they were taking.

DAT Commotion

Of all the exciting components released at the Fair DATs were obviously the biggest talking point. There were more than 20 different manufacturers offering DAT machines including Onkyo, Sony, Technics, Sanyo, Mitsubishi, Yamaha, Kenwood, Sansui, Denon, Aiwa, Toshiba, Luxman, JVC, NEC, TEAC, Marantz, Philips and Pioneer. Most of these manufacturers had working units on display using pre-recorded DAT tapes. On most of the stands you could listen to their performance at monitoring points using large numbers of quality headphones. Two of the manufacturers, Sony with their TCD10 portable battery operated DAT selling at A$2500, National with their RP-MD1 selling at A$3000 took everybody by surprise.

Both of these units are comparable in size to the Sony TCD5PRO cassette recorder which has until now been the most popular lightweight professional stereo recorder for TV stations and Radio journalists working in the field.

The TCD 5 has a frequency response of 30 Hz to 16 kHz ±1 dB (with the right tape). However, it only has a 55 dB dynamic range. By contrast both of the new Sony and Technics DAT recorders have frequency responses of 5 Hz to 22 kHz ±1 dB and which type of tape you use is no longer an issue. With dynamic ranges of greater than 90 dB and no need to use Dolby, amateur (and professional) field recording now enters a new era.

Technics DAT

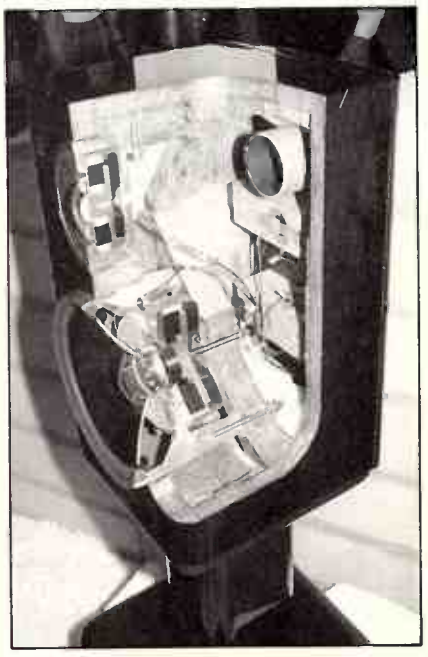
The Sony TCD10 recorder utilises the same type drive system as the recently released 1000ES recorder. I learnt that the Sony professional recorder (which is about to be released in Japan) will also use the same tape drive, but obviously with more advanced and improved electronics. As great as the TCD10 is however, the big surprise was the Technics model RPMB1 portable (battery operated) DAT. This unit is the most advanced machine of its type yet developed and was one of the talking points of the show. It utilises a brand new 15 mm diameter rotary head which is almost half the size of their mains operated unit.

This is a brave step for a company which has not yet seen worthwhile sales from their mains operated DATs. The word at the show was that top management gave the order "Produce a machine that will be well in advance of any of our competition."

These two exciting, portable, battery operated machines offer a performance

Louis examines the latest offerings from the land of cherry blossom

Louis Challis



Above CD juke box.
Above right cut away speaker box.
Left Sasaki "Creative Crystal Sound" speakers.

which in all respects is superior to that provided by a Nagra 4SJ. More significantly they weight almost the same as the existing TCD5 portable operated cassette recorder.

With the capability to record with a flat frequency response that is better than most professional microphones and a 90 dB dynamic range, these machines are currently the hottest electronic component to be released in Japan. Although both Sony and National have received many enquiries from the public (and the trade) to purchase these machines, they were not scheduled for general release until at least early November.

Software shortage

Other exciting DAT releases were the Alpine 9700 car DAT player at A$1380 and the Mitsubishi DAT player with no stated selling price. I heard the Alpine unit working and was impressed by one salient factor. Nobody can use its dynamic range with the engine working (or even idling). I asked a number of the marketing and technical engineers on other stands whether they were working on car DAT players and many indicated that they too were in the process of evaluating or developing them. Based on the response I received, we can expect at least another five or six to be released either by the winter CES in Las Vegas or at the latest before the Chicago CES next year.

The availability of software to back up the market for DATs was very disappointing. Only four commercial pre-recorded DAT cartridges were available at the show, together with the Japan Audio's Society audio check DAT tape selling at approximately $40.

Loudspeakers

Whilst DAT recorders, car DAT players and even battery operated DAT recorders were of interest, I must admit that I found the wide range of new and unusual loudspeakers at the Fair far more exciting.

The first speaker system to really catch my eye was the BOSE Model ASCS1 'acoustic cannon' system. This particular model looks more like a Bazooka than a loudspeaker and provides the critical 25 Hz to 125 Hz low end response to complement Bose's conventional speakers, like their Model 403's and their BOSE Pole sound system, both of which were also on display. This loudspeaker system aparently uses a conventional long throw driver placed at the 'heart of the cannon'. The rear end of the driver is coupled to a short equivalent 'LC' circuit which provides the loading capabilities for the high pass end (125 Hz cut off). The much longer section of the unit is attached to the face of the driver providing the low frequency coupling and loading for the 25 Hz cut off frequency.

By providing appropriate acoustical coupling, the ASCS1 is able to convert a small cone movement into a much larger air movement. The system provides only moderate electro acoustical efficiencies of 90 dB for 1 watt input at 1 metre (at 30 Hz). The ASCS1 is capable of handling 150 watts of input power, which means that it can produce about 112 dB of sound pressure level at the bottom end of the audible frequency range. I saw other exciting

Cut away view of a CD player.

sub-woofers on display at the Show, all of which were smaller, squatter and some of which were considerably cheaper. Even so, this particular sub-woofer still appears to be one of the most unusual speakers to be released at the Show.

One particularly novel display was the 'Alpine Super Lincoln Coupe' with a mind (and ear) blowing built-in power capability of 1,500 watts. The boot of the car not only contains 14 amplifiers, but also contains a 'tapered' sub-woofer with two 375 mm drivers. The unusual speaker line-up also included two 250 mm woofers, two 160 mm mid-range drivers and 12 other speakers cunningly positioned around the doors, panels and bulkheads of the car.

The electronics used included the new top line Model 5930 Alpine CD player feeding into the massive amplifier system. My impressions were of an exceptional degree of enveloping sound rarely matched in my many years of reviewing. Needless to say there was a long queue of Japanese enthusiasts waiting to get into the car to have their turn at listening to the sound environment.

Some of the car's parameters are worthy of note. Notably the frequency response of the system which was effectively flat (±2 dB) from below 10 Hz to beyond 20 kHz. Not surprisingly the system could develop internal sound pressure levels in excess of 130 dB. That's what I call mind blowing! When they turned up the level I moved on!

Mitsubishi Offerings

Another very unusual speaker system which caught my eye was the Mitsubishi Diatone PW1600 loudspeaker. This gigantic speaker has an external diameter of, 1600 mm and is the biggest woofer (sub-woofer) that I have ever seen.

The speaker can handle 5 kilowatts of power and is capable of producing sound pressure levels in excess of 140 dB at 1 metre. Properly mounted the low frequency response extends from frequencies below 10 Hz up to a high of approximately 100 Hz. Regrettably the speaker was not demonstrated at the Show, but apparently there are some practical uses for it and Mitsubishi do intend to use it.

Mitsubishi also displayed two other large speakers, the D80S and the D80E selling at the staggering prices of $20,000 and $15,000 respectively. These professional speakers are designed to operated from 10 Hz to 500 Hz and 15 Hz to 500 Hz respectively producing a phenomenal 100 dB per watt at 1 metre. These have impressive power handling capacities of 2000 watts peak and 700 watts peak continuous and 1000 watts and 300 watts continuous, respectively.

The D80S and D80E are somewhat smaller than the PW1600, but are nonetheless capable of producing unusually high peak levels of 136 dB at 1 metre and 130 dB at 1 metre. Quite frankly I wouldn't want to be around when they're playing at those sort of levels.

On the National/Technics stand they were showing the newly released AFT1000, AFT100 and AFT10 loudspeaker systems which are sonically amongst the most outstanding speakers to be released at the Japan Audio Fair. Their design is based on the concept of large area, flat panel diaphragm drivers with exceptionally large and very efficient radiation areas.

The three different models designated as AFT1000, AFT100 and AFT10 are basically very similar, with AFT100 having four equivalent AFT10 units and the AFP100 having two equivalent AFT10 units stacked vertically.

With Japanese prices of $25,000, $15,000 and $5000 one would think that there would not be too many buyers for these speakers, particularly as the face dimensions of each AFP1000 is 2.2 metres x 2.25 metres with a depth of 1 metre. Even the AFT10 has dimensions of 1 metre x 1.2 metres and a depth of 52 centimetres so it would take up a lot of space in your living room.

However, don't be fooled by the dimensions, as these speakers really are 'something out of the box.' They have frequency responses that are just about ruler flat from below 20 Hz to 25 Hz. They also have the capability to produce sound pressure levels well in excess of 130 dB with remarkably low distortion. I listened to a set of the AFT1000s in Osaka and was extremely impressed by their reproduction. Were it not for their size, I might have considered placing an order for a pair. The quality of the sound that they produce is absolutely brilliant.

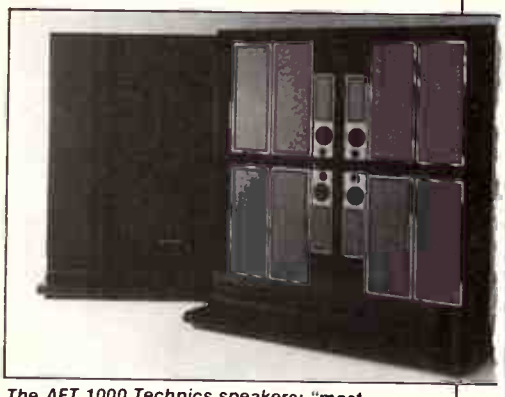
A very different speaker system released at the Show were the Sasaki Acoustics 'creative crystal sound' speakers. There were four different models of spherical blow glass 'speaker cabinets' that you can see right through. The two way speakers driver mounted in the faces were rather conventional looking and the speakers were resting on tubular glass support structures with rubber rings to provide structural decoupling at the interface.

These speakers, although very simple in appearance, were selling at $5000 for a pair of CD500S's, $2000 the CD500R's, $700 for the CP300M's and $1,100 for the CP300M's. The Sasaki speakers are also available in coloured glass, as well as clear, and in spite of their gimmickry, produce a reasonable quality sound. The Japanese are most probably naive enough to buy them in spite of their inflated price.

Diano Speakers

On a more practical note, Yamaha with their NSX10,000 natural sound speaker system with their giant crystal Berylium mid-range and tweeter domes and their well proven carbon fibre laminate base drivers, Sony with their SSG777Es speakers systems and Kenwood with their LSP9000X speakers systems are now all espousing the benefits of woven carbon filament diaphragms in low frequency or woofer drivers. A number of other manufacturers have either jumped or are currently in the process of jumping onto the same bandwagon and these include such well known manufacturers as Mistubishi, Foster, Sansui, Denon and rather surprisingly, Audio Technica who have only just entered the speaker field.

Another strange speaker that caught my eye was the Kraft Alpha 'wood diaphragm' speaker system. These sell for $7000 a pair and utilise a fairly shallow wooden panel structure that's somehow meant to duplicate the characteristics of a



The AFT 1000 Technics speakers; "most outstanding".

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READER INFO No. 43

AUS 0070

violin or a piano (or at least that is what their literature would have you believe). Although to the uninitiated the idea might sound great, in more prosaic terms, a loud speaker is not meant to behave like a violin shell (or even like a piano casing) and consequently the fidelity is not quite what the designers may have expected. Anyway at $7000 a pair the number of takers could not be comparable with the better speakers like the Yamaha NSX1000.

There were other exciting speaker systems for cars on show including the Carrozzeria Pioneer 'extra car' component system which featured an exciting looking Italian car on the literature and a Japanese car on the display stand.

Pioneer were demonstrating the frequency linearity that these speaker systems can achieve and I believe that they really have mastered the necessary P's and Q's to achieve a superlative system. More significantly they were producing graphs of the one-third octave band frequency responses produced in the car to demonstrate how well they had overcome the problems.

CD Juke Boxes

Pioneer also had lots of exciting new car components including CD players, cassette players and even a DAT player designed for the next generation of cars. It was intriguing to note that quite a few of the other CD manufacturers have now accepted Yamaha's concept of specialised cartridge holders for car CD's.

In a similar vein there were at least five manufacturers offering either six or 10 cassette cartridges and matching CD players for home use. These players have obvious attributes for use in restaurants, hotels and other public places and I believe that they will capture a significant segment of the market. There were at least two CD Juke Boxes on display. Seeburg intend to market them in America and most probably in Australia as well.

Apart from Pioneer, JVC were showing their XLM700BK and the M500BK, CD players both of which take six CD magazine cartridges. Hitachi were displaying their LOD compact disc player type DA30N that takes two discs side by side. This concept is new and offers a degree of flexibility which will see obvious market potential for mobile disc jockeys providing entertainment at parties.

The most significant advance in CD technology of course was from Yamaha and National who were both offering 18 bit technology with their 'high bit' CD players providing an effective 100 dB plus, dynamic range. I heard some of the latest high bit players on demonstration at Yamaha and subsequently at Osaka with National and was very impressed by what these players can produce.

There were many other interesting things on show at the Audio Fair which caught my eye. One of these was an exciting range of multi-directivity microphone systems from National. These were primarily designed for use with portable VCRs, but have obvious applications for other professional users including sound recorders and acoustical engineers.

CDV

Another major talking (and viewing) point at the Audio Fair was CDV. A consortium of more than 30 hardware and software companies had launched another new technology, CD-V (or CD-Video) with gold coloured discs measuring 125 mm in diameter which provide 5 minutes of analogue video and 20 minutes of digital audio. These were supplemented by the new CD-Single discs which are the up-market replacement for the 45 RPM singles. Longer playing CD-V discs were also on show. Two types of CD-V players were observed. One, a so-called dedicated CD-V player, handles standard CD's and the CDV-Single; the other, which the industry is describing as a combi-player, accommodates standard CD's, all CD-V discs, and 200 mm and 300 mm diameter laser video-discs. Most of the large manufacturers including Sony, Denon, Hitachi, Magnavox, Pioneer, National, Mitsubishi, Sansui, JVC and Yamaha were showing both types of players.

Despite the launch of CD-V and the united front of its supporters, many people questioned the thrust of this product, which appears to be squarely targeted to the teenage market.

The prices of these combi-players was far more reasonable than I would have expected, at around $A1500. The quality of the video signal displayed on the monitors at Harumi is of course not comparable with the quality that we have grown used to seeing in Australia. This is because of the Japanese video systems are using the NTSC system with only 525 line resolution, rather than the PAL-D video system that we have adopted here with its 625 lines resolution. The software on display was predominantly Japanese oriented, and thus of little interest to Australians. However I did notice that both Sony CBS and Philips had also released a range of titles with American and European musicians that would be of real interest if available in Australia.

I questioned the design and marketing people at both Sony and at Matshushta about their intentions in relation to producing a PAL version of the system. They politely answered that this is unlikely to occur for at least a year and it may be as much as two or more years before we see CDV discs and material in Australia.

New Audio-Technical components.

Laser Disc Players

The laser disc players and appropriate software that I saw being displayed was exciting and would undoubtedly create a demand in Australia. It's questionable however whether too many people would buy a player suitable for just CD singles or just for any one of the four formats (other than CD). Now that there are players that can replay all four formats and at a price that is not much more than a good CD player costs today, I think the market should readily re-assess its attitude. I believe we will find that all of the four formats would gain increased sales volumes and that the market would grow appreciably.

One major Japanese manufacturer who has really been forced to change direction in the last two years is Audio Technica. Having visited their plant and research centre only four years ago, I was accutely aware of their marketing problems. For the last six years they have been the world's largest manufacturer of record player cartridges, a field that is undergoing a form of forced atrophy, whilst nominally still in the 'prime of life'. They have been forced to find other avenues in which to use their renowned technical and manufacturing resources. This has not been an easy task.

Audio-Technica's new product range included exciting peripheral units like solar powered battery supplies for radios and an innovative range of new headphone, microphones and amplifiers for home recordists. Some of their equipment was directed to the 'would be professionals' and were, to say the least, avante garde. Their semi-professional and amateur recording equipment included very small disco mixers,

preamplifiers, amplifiers and miniature loud speakers which were the tiniest loudspeakers on display at the show.

Conclusion

The Japan Audio Fair catered primarily for Japanese domestic requirements, and not for the international market as do the CES (Consumer Electronic Shows) in the USA. This may seem strange to us, but they have a huge captive market which they understand far better than we do. Peculiarly Japanese items which were being marketed in a big way included modular sound absorbing units for reducing the reverberation time of small listening rooms in apartments. These were relatively inexpensive and, it would appear, quite effective from an acoustical standpoint.

Daiken were displaying composite room absorption systems including isolated floors and special wall treatments to reduce noise transmission from one room to the next (as well as from one apartment to the next). These were quite effective as I subsequently observed at their research laboratory in Okayama.

The release of DATs closely following the release of the Video-8 format has of course helped the tape manufacturers. There were a wide range of new DAT tapes as well as advanced conventional cassette and video tapes from the major manufacturers including TDK, Sony,Matshushta, JVC, THATS Maxwell, Philips, 3M and BASF.

It appears that the Japanese high fidelity industry is alive and well, and although its prices may be too high by our standards, the technical advances that were visible leave me with the firm impression that Japan is still leading the field, and will continue to dominate Hi Fi for the foreseeable future. ●

All the music equipment reviews of 1987

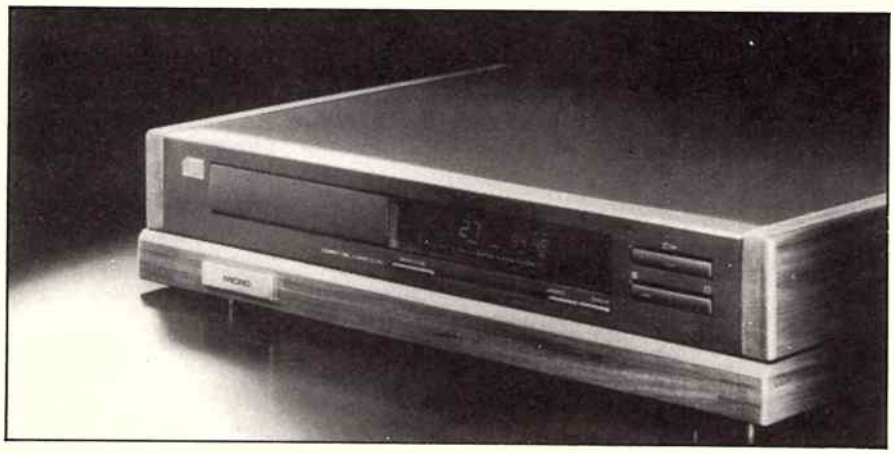
A year in review

Digital TV

ITT have released the first digital TV in Australia. The new set is said to destroy such interference as 'snow and speckle' and eliminate ghosts.

In order to push the technology ITT have packed the set full of features such as the PIP (Picture In Picture) facility which permits viewers to monitor their video cameras whilst still watching TV. A small picture simply appears in the corner of the larger screen.

— Jon Fairall



Micro Seiki CD

The Micro Seiki CDM2 weighs no less than 22 kg and is the most expensive unit to hit the Australian market so far. It produces a sound superior "to anything else I have previously heard".

The channel separation was the best yet seen from any CD player. The worst resonant frequency detectable on a real time analyses was 90 dB down, even at 115 dB sound pressure level. It's worth hearing, even if you can't afford it.

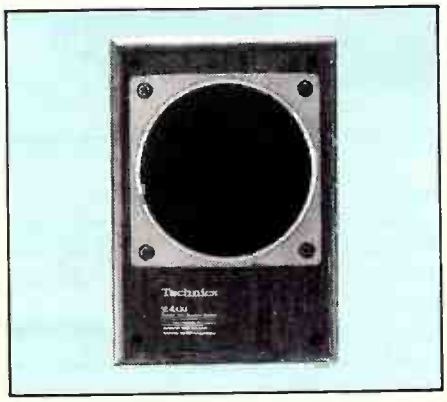
— Louis Challis

Orpheus Apollo Speakers

The Apollo speakers are made by Orpheus, another Australian hifi firm hoping to make it big.

They have a frequency response between 130 Hz and 15 kHz "with a number of intriguing peaks and dips" but "can easily handle high level inputs with a general aplomb that belies their size". With a few improvements these units should provide stiff competition to imported hifi equipment.

— Louis Challis



Gallon Performance In A Pint Pot

The Technics SB-R100 speakers measure only 300 x 480mm and weigh 16.5 kg yet produce a sophisticated response.

The overall results of this review were inspiring, for although the low frequency performance of the speakers measured under anechoic conditions is plainly between 6-10 dB down over the range 30 Hz to 150 Hz the subjective appraisal of their output belies the figures.

— Louis Challis

Richter Oracle Loudspeakers

These are the latest offering from the Australian Richter company. The Oracles stand 480mm high x 216 wide and 412 deep.

One of their most pleasing aspects is their flat tweeter response up to 12 kHz. The woofer response is "relatively smooth" from 75 Hz to 2 kHz. They also produce relatively uniform frequency response over the 30 Hz to 16 kHz range.

The Oracles appear to offer the most cost effective performance in their price range.

— Louis Challis

Roland D50 Synthesiser

The sounds produced by Roland's new D50 synthesiser unit have a warm analogue feel with a distinctive digital touch.

Apparently this effect is achieved by Linear Arithmetic Synthesis developed in a custom VLSI chip. The DSO could set a new standard in digital synthezisers.

— Terry Kee

The NAD 6300 Cassette Deck

Does the 6300's performance justify its reputation and cost? The makers have included three new features into this unit: the Compensated Automobile Reproduction circuit which provides both conventional dynamic compression characteristics and supplements these by a low level loudness boost, the play trim circuit which provides a simple means of adjusting frequency response to compensate for variations in record head azimuth and high frequency losses due to tape saturation, and finally the HX pro-head room extension circuit which eliminates the need to have fixed levels of bias.

The NAD 6300 is the best cassette recorder NAD has yet produced.

— Louis Challis

The Kiwi That Roared

The latest tuner from the Perreaux company of New Zealand, is the EU1 FM stereo tuner. It is available here through Eurovox.

After testing it seems that the tuner is able to deliver smooth, uncoloured sound on the better stations. However, one is able to miss-tune stations by as much as 100 kHz in the mono muted mode. It also lacks an AM stereo tuner system.

— Louis Challis

Kef Reference Series 107 Speakers
Among the classiest units on the market the new Kefs 107 Speakers use pairs of 250mm diameter woofers operating in a push pull unit. These drivers have a common rod interconnecting the two magnet systems so that the non linear forces are effectively cancelled. The Kefs also feature an active low level equaliser known as a KUBE.

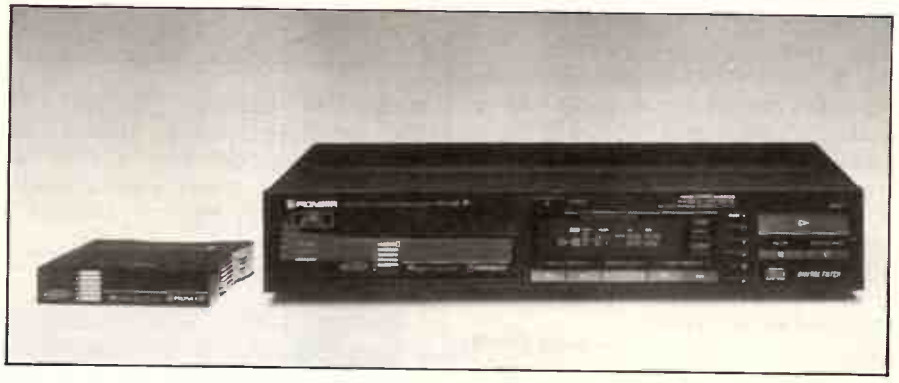
The Kefs have a remarkably smooth frequency response from 120 Hz to 20 kHz. They are one of the most outstanding speaker systems available in Australia.

— Louis Challis

Pioneer D1000
The first-DAT player to be reviewed in ETI caused much excitement. It features superb sound of CD equivalent frequency response and dynamic range, without the noise or wow and flutter. In addition, it has full recording features and will outperform the microphone used to drive it.

The big questions are when will DAT be released, and how much will it cost? The answer lies in the hands of the US recording industry.

— Jon Fairall



The Pioneer PS-M40 MultiDisc CD
Pioneer's new multidisc player features a magazine that can hold six CDs at a time.

The frequency response of the new player is remarkably flat from 5 Hz to 2 kHz. Channel separation is better than −73 dB and linearity is perfect all the way to −60 dB.

Its a well designed unit carefully configured to cater for a somewhat unusual market.

— Louis Challis

Video Camera Comparison
The JVC GR-C7 is pitched against the Sony CCD-V30E. The JVC camera uses small VHS cassette. It comes with an adaptor to use in a video replay unit. The Sony unit uses the new video 8 format which Sony hopes will become the standard in video recording.

Both cameras are top of the range and our reviewer claims that they are of near broadcast quality with the Sony having a slight edge.

— Phil Witchett

Award Winning Sound Processor
The Yamaha DSP-1 breaks new ground in Sound Technology. This device is designed to transform the audio qualities of your loungeroom into those of everything from the old Frankfurt Opera House to Munster Cathedral.

A series of different (standardized) early echo and reverberation characteristics for several performance spaces and auditoria have been encoded in read only memory. When the type of environment the user wants has been selected, the DSP-1 uses the encoded information to process the incoming sound signal so as to simulate the characteristics of the space. Audio Magic.

— Louis Challis

Sennheiser Infra Red Headphones
Freedom from extension cords is provided by these new headphones from Sennheiser. The new headphones operate by means of an infra red radio link. The transmitter section of the unit has a frequency response from 50 Hz to 8000 kHz. This makes them ideal for TV use but limits them for hifi.

— Jon Fairall

Whoever heard of a serious tuner-preamplifier? Well, I hadn't until I received the Adcom GTP-500. Its execution appears to be 'just right' for the most descriminating audiophiles.

Adcom GTP 500 tuner/preamplifier

THE IDEA OF packaging a tuner and a high quality preamplifier into a neat single box without the amplifier has some real merits. Amplifiers generate considerable heat that often gives rise to variability of performance in both the preamplifier and tuner section, especially if it's in a powerful receiver. Adcom's idea has even more merit given the tuner's above average sensitivity and selectivity. The preamplifier has exceptionally good linearity, low distortion and a matching high signal to noise performance.

The designer's may have intended that this unit be used with one of the 3 matching Adcom amplifiers, but as I found, it could readily be used with any quality amplifier to achieve exceptional results.

Appearance

The frontal appearance of the GTP-500 is particularly neat, with the primary preamplifier controls set out in a row at the bottom of the front panel, and the tuner controls and display set out in a row at the top. A large rectangular power On-Off switch is at the left hand end of the panel with the remote control sensor and standard head phone sockets adjacent.

Below the frequency display are 3 rotary controls with centre indents for BALANCE, BASS and TREBLE. In the centre of the panel are 5 circular push buttons for TONE-IN, to activate the tone controls, CONTOUR, for adding a loudness bass boost, a LO and a HI cut filter and a MONO switch. On the right hand side of the panel are two buttons labelled RECORDING and LISTENING which flank pairs of bright light emitting diodes (LED's) which light up sequentially when PHONO, CD, TUNER, TAPE 1, or TAPE 2/VIDEO are selected. This is a

good way of avoiding either two rotary controls or 10 buttons.

As the extreme right hand end of the panel is a reasonably large sized rotary volume control which has a bright LED to show where it set. As nice as this feature is, the addition of a remotely controlled motorised rotator makes it even better.

The top row of controls from left to right are two TUNING buttons next to the bright blue plasma display. This indicates FM or AM (as selected) and station frequency in kHz or MHz. At the left of the display is a 5 bar red LED signal strength meter, whilst at the right is another small red LED display bar to show if the received signal is in stereo. In the centre of the panel are ten self illuminating push buttons, each of which has a small LED at its centre. The first button is labelled FM SCAN. When selected and used with either the upward of downward tuning buttons, the tuner will search out and find the next FM station which it will lock onto. In the AM mode, this control doesn't work, which is rather a shame. With the FM SCAN switch inoperative the tuning controls can be used manually to set the tuner frequency wherever desired in 500 kHz steps for FM or in pre-use 9 kHz steps for AM tuning. This means that you are always correctly tuned to your AM station but you could be out in manually tuning to an FM station. The adjacent control is labelled ENTER and together with one of the adjacent 8 tuning buttons allows you to memorise the selected station frequency. Eight AM and eight FM stations can be memorised and generally speaking that's about enough to satisfy most tastes.

At the extreme right hand end are two control buttons. One being for AM/FM selection and the last labelled MUTE/HI-BLEND. This switch disconnects the interstation muting circuit which protects you from being assailed by noise when manually tuning between stations. By activating the controls a weak station can be received (in spite of the noise).

On the back of the receiver are 300 ohm balanced terminals and 75 ohm unbalanced socket AM terminals and a mounted AM loop antenna. Gold plated coaxial sockets are provided for phono, CD, Tape 1, Tape 2/Video as well as two sets of output sockets labelled LAB and NORMAL. The LAB sockets are directly coupled without capacitors for very wide band amplifiers, whilst the NORMAL sockets use coupling capacitors and are intended for connecting "normal" amplifiers. Two other 5 pin DIN sockets are provided for optional remote control units, which allow this unit to be remotely controlled from anywhere in the house (if you purchase the plug-in receiver units).

The measured performance of the preamplifier is far better than indicated by the manufacturer's data sheets and is amongst the best of the preamplifiers that I have recently tested.

Objective Performance

The frequency response at the NORMAL output for an input on the CD terminals is 3 dB down at 1.8 Hz and 240 kHz. This is well within the −0.1 dB quoted for 20 Hz and 20 kHz in the manufacturer's literature.

The sensitivity for 1 volt output on CD, tape 1, tape 2/video is 76 mV and for the phono input is 9.8 mV. The input overload signals are 10 volts for CD and a healthy 110 mV for the phono input.

The noise and hum levels (re 1 volt output) are extremely good with −95 dB(A) levels for CD and an excellent −92 dB(A) for the phono input. The harmonic distortion figures are equally good with total harmonic distortion figures of less than −100 dB at each of the test frequencies. Because of the voltage output capabilities of the preamplifier section, I decided to evaluate the IEC High Frequency Total Difference Frequency Distortion characteristics for peak signals between 1 Volt and 24 volts. As the graph shows, over the range 1 to 7 volts peak to peak, the distortion is less than 0.002%, which is particularly good.

The lo cut and hi cut filters are not as sharp as I would like and should be reconfigured to provide at least −20 dB attentuation at 10 Hz and far better attenuation at supersonic frequencies. The contour circuit provides effective bass boost to duplicate the low frequency equal loudness contours, but not the rising high frequency characteristics that I would have liked. The tone controls provide ±10 dB effec-

DIMENSIONS	Width	430mm
	Depth	340mm
	Height	80mm
	Weight	6kgm
	RRP	$1599

MEASURED PERFORMANCE OF ADCOM GTP 500

SERIAL NO 708-34239

HARMONIC DISTORTION :

AT AN OUTPUT OF 1V INTO 100k OHMS

INPUT = 0.5V

	100Hz		1kHz		6.3kHz	
	Read.	Actual	Read.	Actual	Read.	Actual
2nd	-116.7	107.0	-114.0	104.1	113.5	102.9
3rd	-115.6	109.8	-115.2	109.3	112.0	105.6
4th	-123.6	119.6	-	-	-	-
5th	-	-	-	-	-	-
T.H.D.		0.0005		0.0007		0.0009
= dB		105.1		102.9		101.0

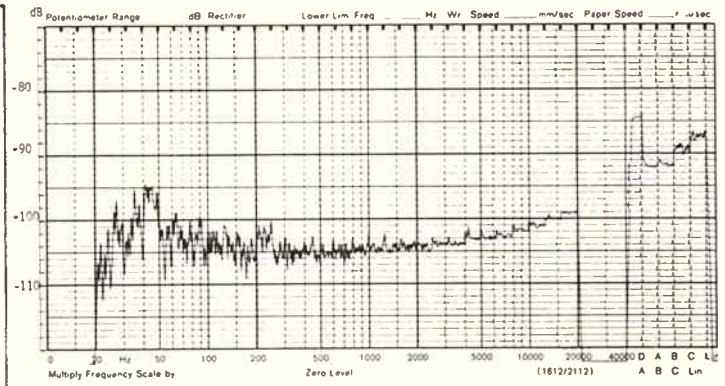
IEC HIGH FREQUENCY TOTAL DIFFERENCE FREQUENCY DISTORTION

8 kHz and 11.95 kHz mixed 1:1

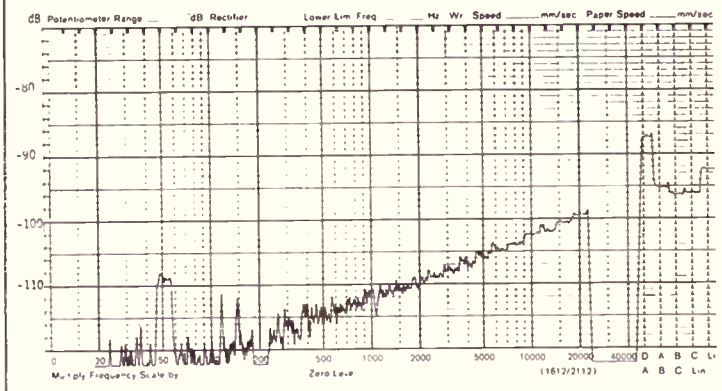
At 1V RMS Output 0.0012 %

(GAIN AT MID POSITION)

MAXIMUM OUTPUT VOLTAGE AT CLIPPING POINT = 12V RMS



Signal to noise ratio with a one third octave band noise generator. At top reference to a 5mV input. At bottom, a 500 mV input.



FREQUENCY RESPONSE (-3dB) (NORM OUTPUT)

		Tone Controls Defeated		
Input to CD = 0.5V	Left	1.8 Hz	to	240kHz
	Right	1.9 Hz	to	240kHz

SENSITIVITY (for 1 volt output) :

		Left	Right
	CD	76 mV	76 mV
	Tape	76 mV	76 mV
	Video/Tape 2	76 mV	76 mV
	Phono	0.8 mV	0.8 mV
OVERLOAD	Phono	110 mV	110 mV
OVERLOAD	CD	10 V	10 V

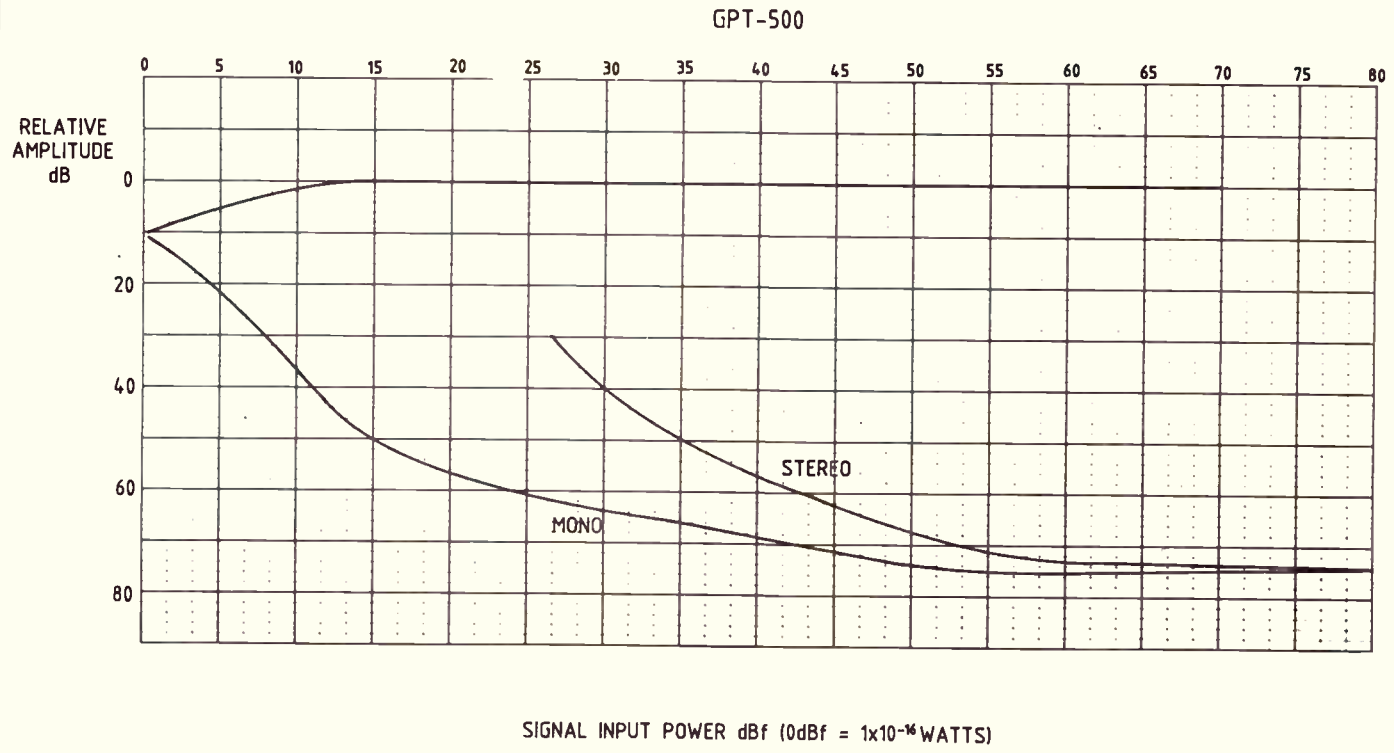
INPUT IMPEDANCE (@ 1kHz)

	Left	Right
CD	21k ohms	22k ohms
Tape	21k ohms	22k ohms
Tape 2	21k ohms	22k ohms
Phono	48k ohms	48k ohms

OUTPUT IMPEDANCE (@ 1kHz) : 470 ohms

NOISE & HUM LEVELS (re 1 volt out) :

Input 0.5 V	CD	-92.5 dB(Lin)	-95.0 dB(A)
Input 5 mV	Phono	-87.0 dB(Lin)	-92.0 dB(A)



Relative amplitude against signal input power in dBF (0 dBF = 10 $^{-16}$W).

tive bass boost and cut at 20 Hz and ±10 dB treble boost and cut at 20 kHz.

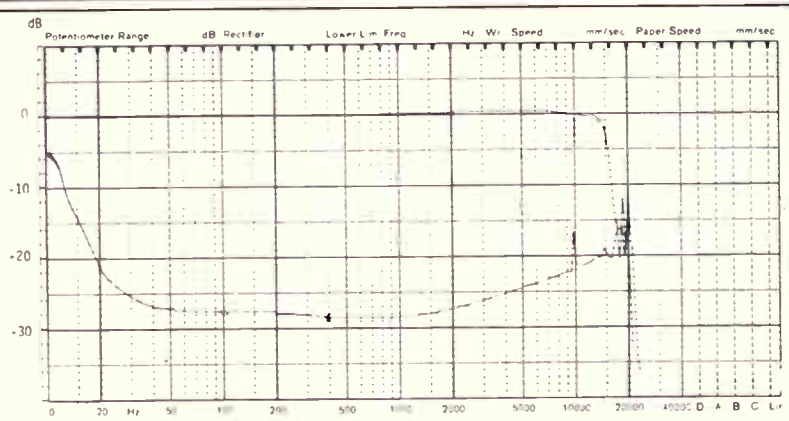
I have extended these contour results down to 2 Hz and up to 200 kHz, because of the wide dynamic range of the preamplifier current.

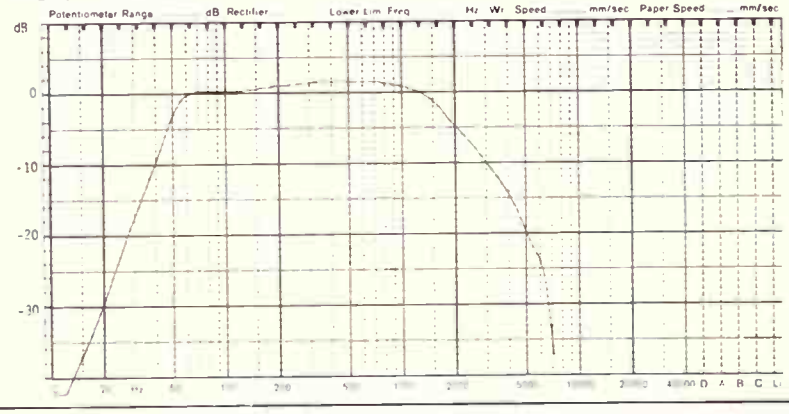
The graph of one third octave band noise for the CD and phono inputs reveal what a great job the designers have done. This preamplifier really is capable of extracting the best noise performance from most quality amplifiers.

The FM tuner provides a frequency response that is almost ruler flat from 10 Hz to 13 kHz (±0.5 dB) and is only 3 dB at 15 kHz. The measured channel separation is 28.5 dB at 1 kHz and although reasonably good, is not quite as high as claimed. The sensitivity is however good at 15 dBF for −50dB of quieting (mono) and is equally good with 35 dB on stereo. By contrast the AM bandwidth is poor with −6 dB points of 45 Hz and 2.2 kHz, with useful, but not outstanding sensitivity provided by the loop stick.

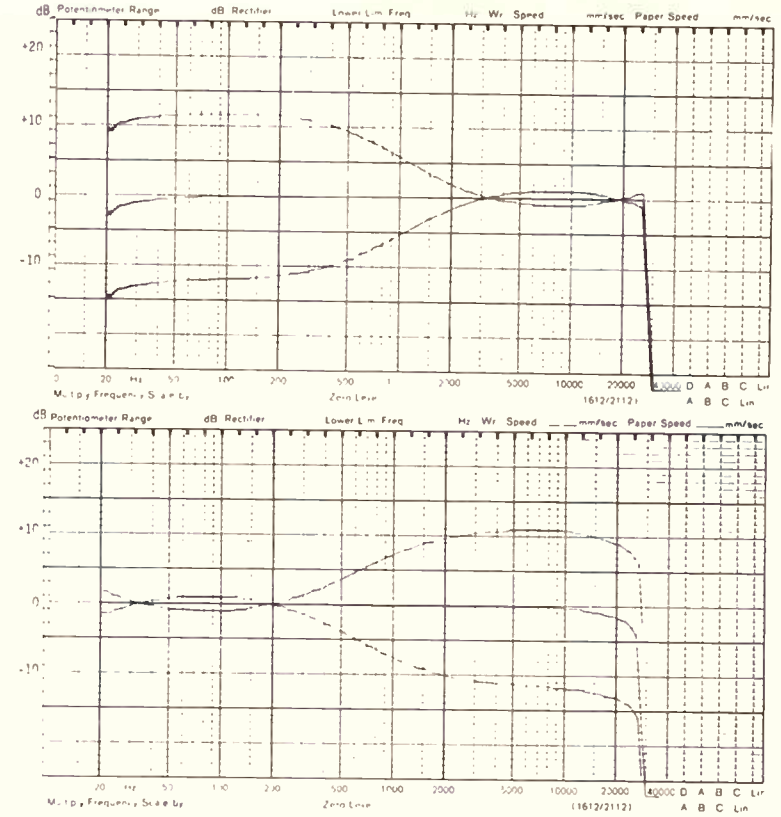
Subjective Performance

The subjective performance of the GTP-500 is however far better than indicated by the measured 'good to outstanding' objec-

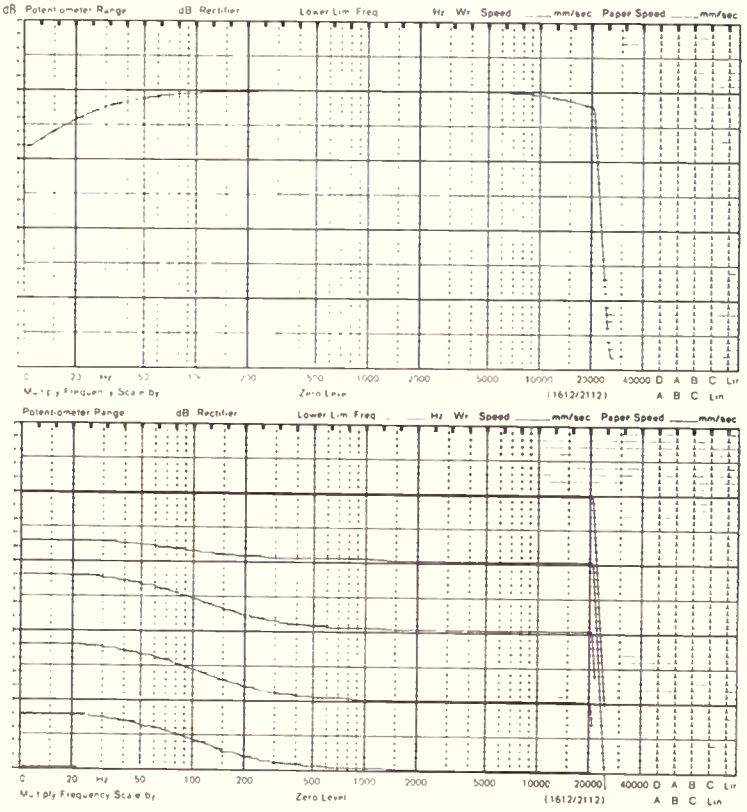




The response of the tuner. Above: the FM section; below: the AM section. The lower trace in the FM graph is channel separation.



The Adcom's output can be conditioned with a number of input controls. At top: the effect of tone control max boost and cut between 2 Hz and 200 Hz. Above is the same thing but shown between 200 Hz and 200 kHz. Below is shown the effect of low and hi cut filters. At bottom is the effect of the contour control. In all cases the vertical axis covers 50 dB.



tive performance figures.

When connected to both a good CD player and a first class record player and cartridge, the results were exhilarating. One feature I liked was the provision of a remote volume control, as this feature is not provided by other tuners or preamplifiers, and is a real winner. The motorised control is a trifle quick in its action and a 2 dB step is about the smallest increment that I could achieve through a 'momentary jab' of the buttons. The remote control provides an enhanced flexibility with the tuner, that I enjoyed right from the outset. Whilst the ability to select 16 stations 8 AM and 8 FM is useful, unquestionably the best feature is the remote volume control, which is a real winner. Even without the station tuning capability the volume control capability endeared itself to me while I had the preamplifier.

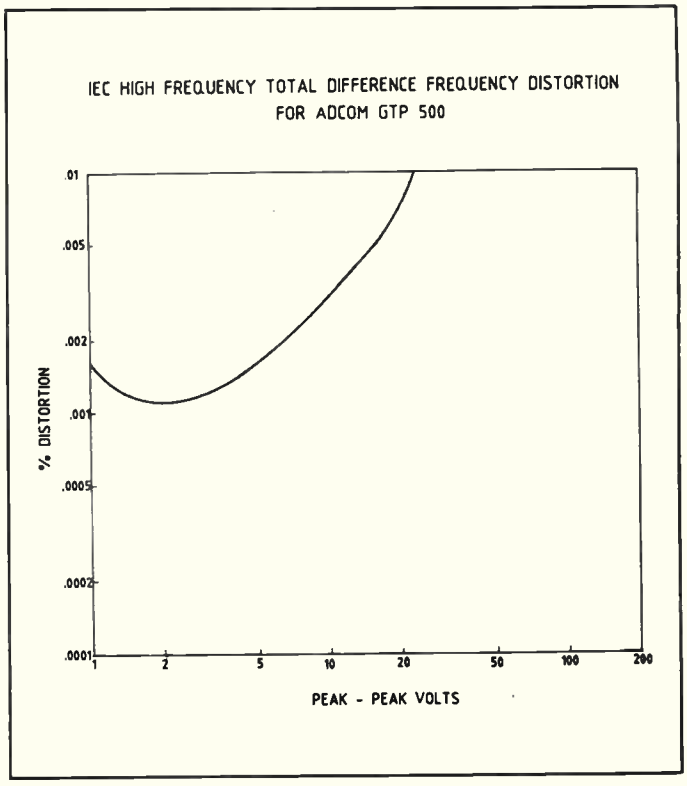
I enjoyed the sound quality provided by the GTP-500 and the matching GFA 555 amplifier, which I used to feed a pair of B & W 801 F speakers. The sound was absolutely scintilating, Indeed, I started to wonder how long I would be able to resist the temptation to keep the preamplifier, especially as I had some brilliant new discs from Denon.

These included Knud Vad playing J.S. Bach's Organ Concert (33CO-1590) Eliahu Inbal conducting Frankfurt Radio's Symphony orchestra in Mahler's Symphony No. 7 (60CO-1553-54) and the Suk Trio in Beethoven's Archduke Trio (33CO-1586) each of which is a real gem. I listened to some discs using the excellent phono circuit and although the better noise figures didn't show up, the quality of the sound did and I regretted that I had no new discs to extract the real advantage.

When I switched to the tuner I was greeted by a useful signal without any antenna, and a superlative one with the addition of some rabbits ears. On FM the signal was sharp and clean. On AM the signal was clear but lifeless and only highlighted the magnitude of the difference between AM and FM.

After two weeks of exciting listening and lots of good music, I decided that this unit has more attributes than vices and provides a quality of reproduction which you will just have to experience. This is an outstanding unit that has the attributes I've been looking for. It will make the other manufacturers reassess their design philosophies as to what the public is likely to want and how to package it. At a recommended RRP of $1500 this is not a cheap unit, but good things seldom are. ●

Louis Challis



Reviews

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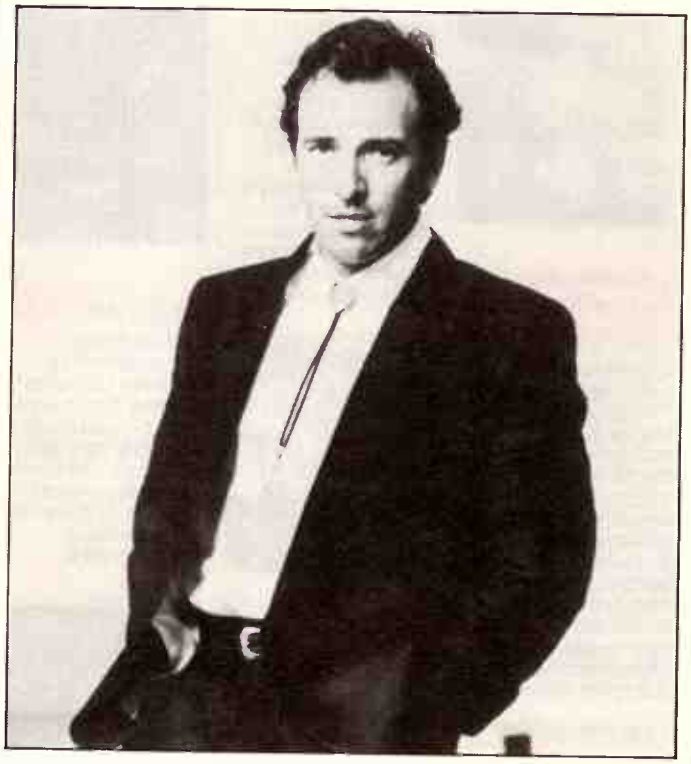
DISCS



Artist — Bruce Springsteen
Title — Tunnel of Love
Producers — Bruce Springstreen, Jon Landau, Chuck Plotkin
Label — CBS
Cat no. CDCBS 460270 2

Tunnel Of Love represents a radical departure in musical structure from Springsteen's last album *Born In The U.S.A.*

Where *Born In The U.S.A.* was an often misunderstood shout to the wilderness of the American psyche, this release is a more introspective and personal statement.

All the songs are quieter in feel but Springsteen's acute and often brilliant observationary prowess is utilised to the full. His considerable ability on the acoustic guitar, which is the most dominant instrument, is also much in evidence.

Best songs are: *All That Heaven Will Allow*, a bright upbeat catchy tune with a positive lyric, *Spare Parts*, a more electric tune with harmonicas, is a typical Springsteen poem of love and it's ramifications; *Cautious Man*, a poignant slower song with acoustic guitar and vocals; *Tunnel Of Love*, the biggest production number with classic bittersweet lyrics.

All tracks deal with the many aspects of love and relationships and Springsteen, as you would expect, handles them with a maturity and poise that befits his status as a serious contemporary rock artist.

This release will probably not be as successful as his last, but for insights into Springsteen the man it is certainly more rewarding.

Recommended.

Mark Lewis

Artist — Bryan Ferry
Title — Bête Noire
Producers — Byran Ferry, Patrick Leonard, Chester Kamen
Label — Virgin
CAT No. CDV 2474

Bryan Ferry, the smooth as silk purveyer of musical 'cool' is in fine form on this marvellously produced CD.

Although two years has elapsed since his last solo offering, *Boys and Girls*, and five years since Roxy Music's *Avalon*, Ferry continues in their tradition with his seductive vocal style and hypnotic use of rhythm.

Best tracks are *Limbo*, a rhythmically percussive tune with haunting choral vocals; *Kiss And Tell*, a classic Ferry song with solid drumming, strong vocals and complex

rhythm guitar; *Newtown*, a slower, darker synth dominated number with excellent swirling lead guitar; *The Right Stuff*, an upbeat big production song with terrific bass and drums and great vocal harmonies.

Over the years Ferry has consistently produced excellent inspiring original music, this release is more of the same.

Recommended. **Mark Lewis**

Title — Dancing With Strangers
Artist — Chris Rea
Producer — Chris Rea
Label — Magnet Through Polygram
CAT. No. 833 504-2

Dancing With Strangers is Chris Rea's ninth album and is one of the most interesting releases of this year. On this one disc Rea includes about four popular styles including folk, blues, pop rock and slow love ballads.

This is not to say that he is a master of every style. Some tracks such as *Gonna Buy a Hat* are distinctly tedious. However, if *Dancing With Strangers* contains some failures it also contains a large number of successes among which are *Que Sera*, *Let's Dance* and *Windy Town*. The two instrumental tracks included at the end of the disc *Donahue's Broken Wheel* and *Danielle's Breakfast* are very pleasing tracks done in the Irish style featuring the now ubiquitous uilean pipes.

Rea has waited some time for international success. *Dancing With Strangers* might well be the album which brings it to him.

Simon O'Brien

Title — My Fair Lady
Artists — Various
Producer — Paul Myers
Label — Decca
CAT. No. 421 200-2

My Fair Lady marks another excursion by Dame Kiri Te Kanawa into the field of popular musicals. She is supported by a group of well known actors including Jeremy Irons who sings the part of Professor Higgins, Warren Mitchell in the role of Alfred Doolittle and the 83-year-old John Gielgud who sings the part of Colonel Pickering.

It would be nice to say that this unusual collaboration works well but frankly it never quite comes off. There are several reasons for this, not the least of which being the performance of Dame Kiri who sings the role of Eliza Doolittle like the primadonna she is. The problem here is that one never quite gets the merry singalong feel that this and almost every other role in *My Fair Lady* requires. On the other hand however we have Jeremy Irons. Irons is a great actor but has a long way to go in his singing career. His voice is not up to the task of giving life to the austere professor Higgins. In fact by far the best singing on the album comes from Warren Mitchell who delivers his tracks with exactly the right amount of hale heartiness.

For those who have never heard *My Fair Lady* and want a good recording of it, this album should fit the bill. However, those familiar with the Lerner and Loewe classic will probably be disappointed.

Simon O'Brien

VIDEOS

Title: Miss Mary
Distributor: Crystal
Length: 96 minutes
Rating: M
Standard: ★★

Julie Christie plays an English nanny employed in the privileged surrounds of Agrentina in the 1930s. When something eventually happens in the movie, the viewer has either fallen asleep or given up on the whole game in desperation. Julie falls foul of her family by (pant pant) falling prey to her previously hidden passions, but she certainly takes a hell of a long time to do it. Too long, if the bald and naked truth be known. This is certainly a good looking film, but the plentitude of good looking films with little or no story whatsoever, makes one wonder about the direction of the modern movie industry.

Peter Brown

Title: Heavenly Pursuits
Distributor: Crystal
Length: 82 minutes
Rating: M
Standard: ★★

Now normally I am a sucker for anything even faintly smacking of the supernatural, the divine or the inexplicable. So, when this movie about miracles occuring in a Scottish town flopped onto the desk, I was agog. Not for long. Tom Conti mumbles his way through the lead role of the sceptical teacher who refuses to believe in the intervention of the supernatural. A few allegedly miraculous events have the townspeople wanting to register their very own saint, but our Tom is still unconvinced. I suppose he comes to some sort of conclusion at the end of this turgid piece, but certainly not the same conclusion as your 'umble reviewer. Give this dog a wide berth.

Peter Brown

Title: Curse of the Black Widow
Distributor: Crystal
Length: 97 minutes
Rating: M
Standard: ★★★★

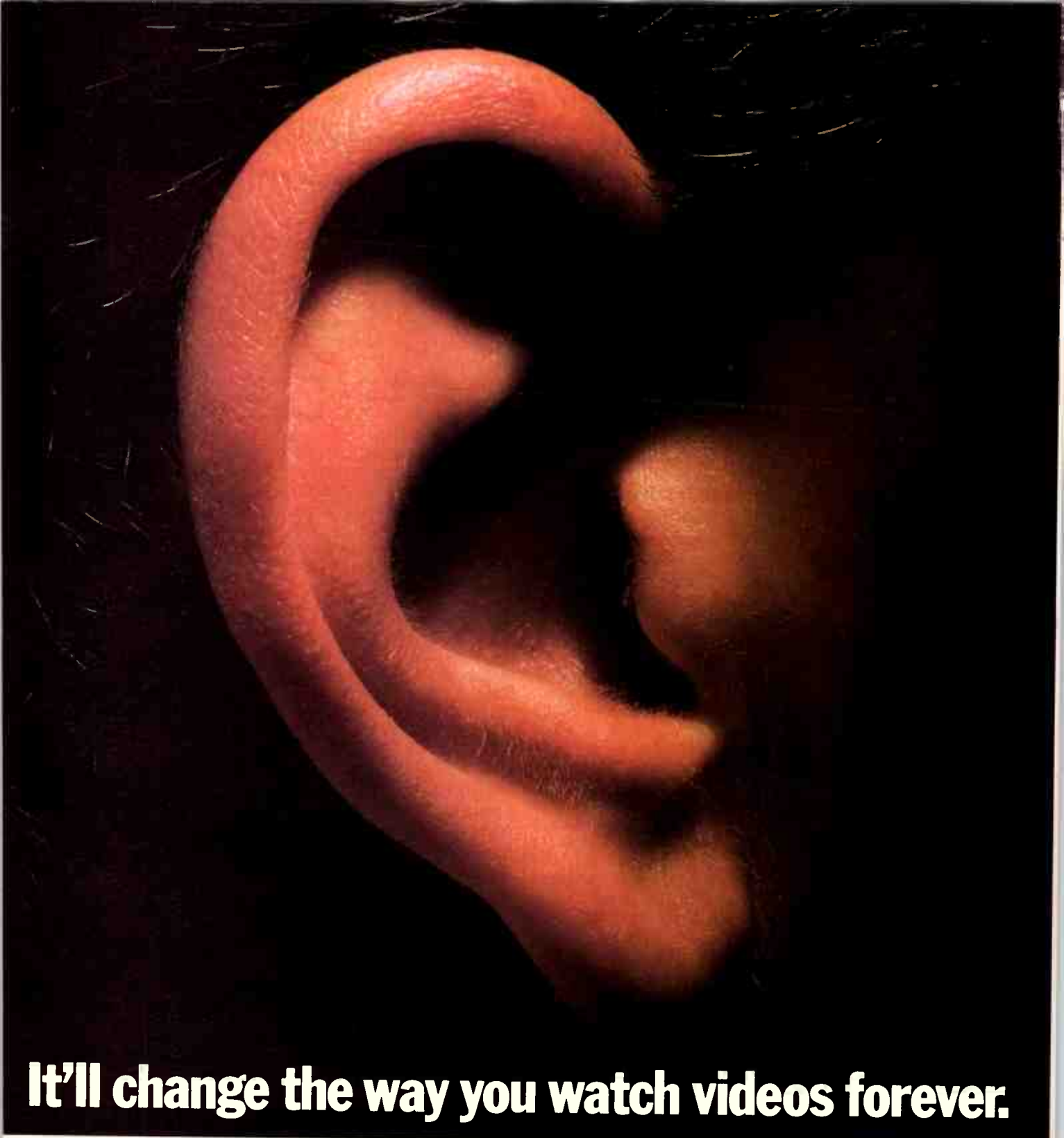
Holy arachnids Batman . . . Here we have the spectre of former Miss Goody Goody, Patty Duke Astin, transforming herself into a two-storey high black widow spider. Perhaps the strangest thing about this offering is that even though it is ridiculous, there are actually some scenes which are chilling. I started off rubbishing this film, but half-way through, was forced to turn off the video because of my admittedly low terror level. Evidently made for television, this has to be one role Patty would rather forget. Other stars include Donna Mills, Tony Franciosa, June Allyson, Vic Morrow, June Lockhart and Sid Caesar.

Peter Brown

Title: The Haunting Passion
Distributor: Crystal
Length: 92 minutes
Rating: M
Standard: ★★★

At last, I can deliver a decent review. Here we have a ghost story with a difference. Jane Seymour and her husband move into a new house, unaware it is haunted. However, the ghost does not want to hurt Jane, it has simply fallen in love with her. Superb special effects, a more than decent story (at last), great photography and an ending with a difference render this offering one of the better to haunt the shelves this month. Certainly not in the class of "Trooper", but this modern offering can hold its head high as good entertainment and a film to remember.

Peter Brown



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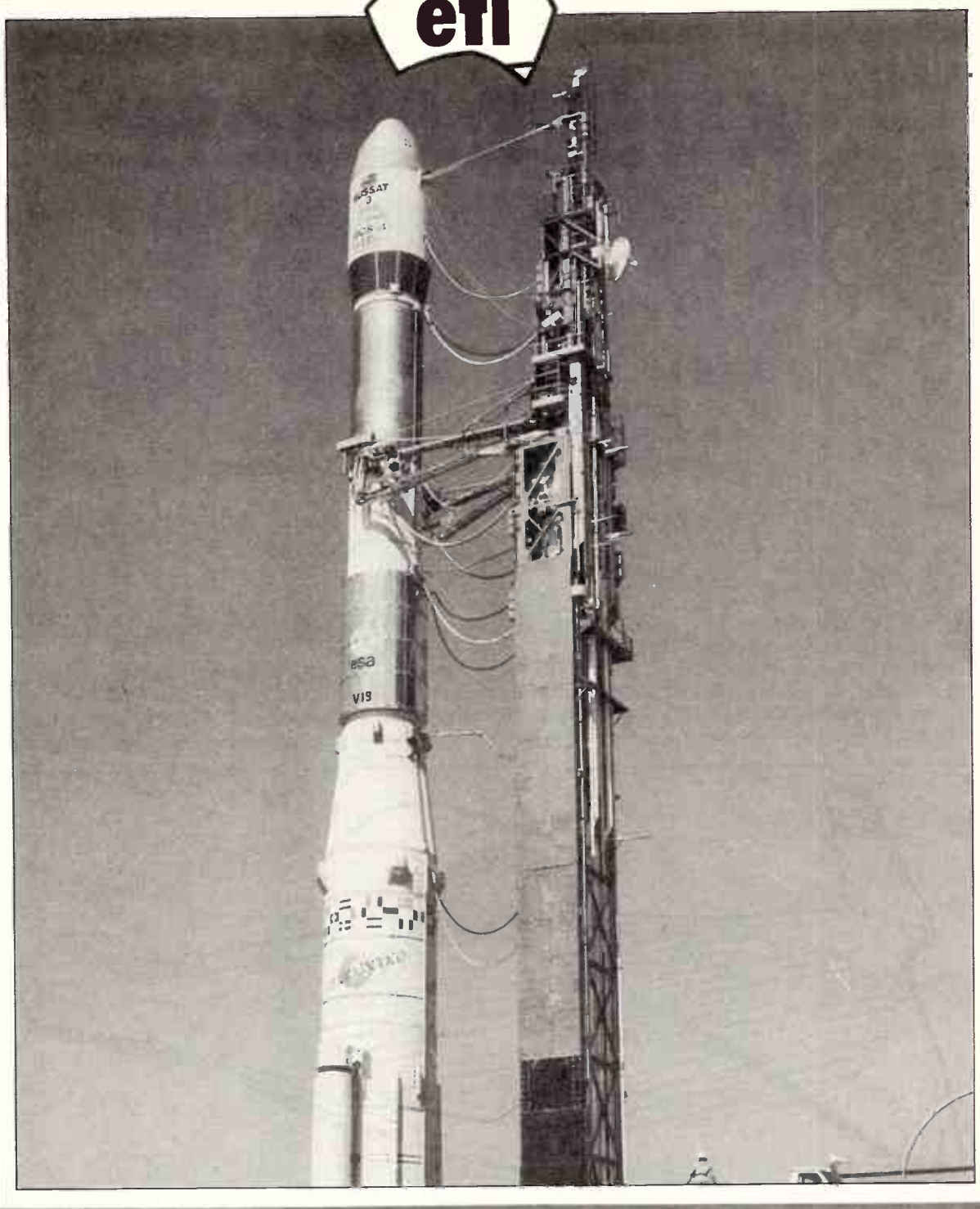


Space Technology

AUSTRALIAN VTOL

A West Australian company has developed a revolutionary new VTOL aircraft, but where is the R and D money?

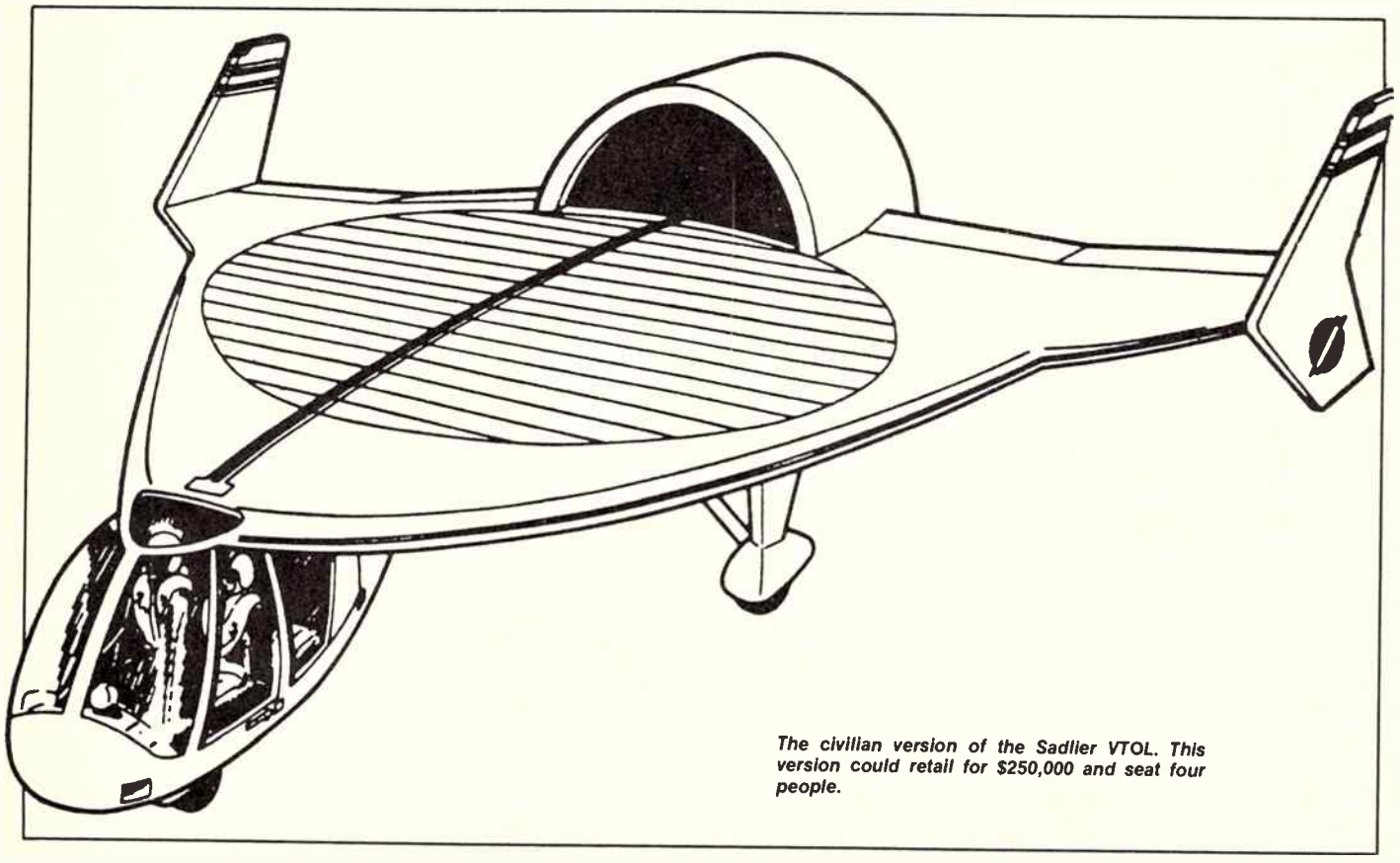
Simon O'Brien

One of the most obvious drawbacks of modern aircraft is their need for runways. In the military sphere this failing is especially acute. In the decades following the Second World War the problem was supposedly overcome by the development of helicopters.

In the Vietnam war the American armed forces used helicopters extensively in the close support role. In fact the sight and sound of these craft remain one of the most enduring images of the conflict.

Background

Unfortunately however, helicopters were found to suffer from a number of problems of their own, one of the most obvi-



The civilian version of the Sadlier VTOL. This version could retail for $250,000 and seat four people.

ous being their slow speed. This is limited because as the vehicle moves forward, the rotor tip on one side must move considerably faster than the helicopter itself. In fact, modern military machines find their rotor tips limited by the speed of sound. Speed is also hampered by the fact that helicopters cannot be aerodynamically efficient because of the rotor and hub assembly. In fact the maximum speed of most helicopters is only about 180 knots. This makes them easy targets — another lesson gained from the Vietnam war.

A final drawback is the fact that helicopters are inefficient flying machines. A typical helicopter engine needs to develop four times more power than the engine of an equivalent aeroplane. This also means that helicopters have a very restricted range as they use four times as much fuel.

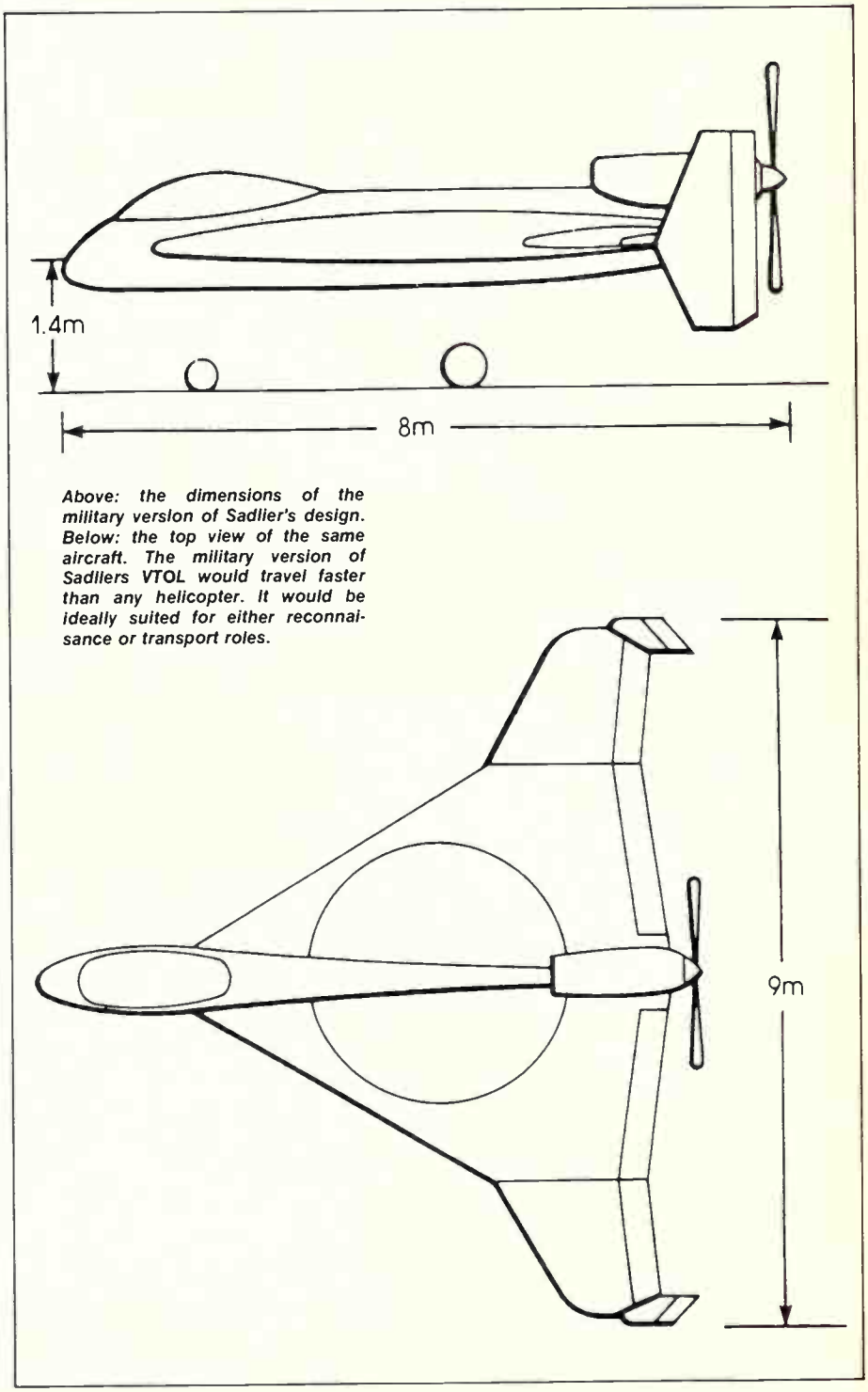
The inherent problems of helicopters have inspired designers to search for an effective Vertical Take Off and Landing (VTOL) craft. Such a machine would be able to take off from small launching pads but fly like an aeroplane once in the air. Many weird and wonderful VTOL's have been designed. Some have involved a tilting wing system where the propellers on the wing are turned upward to raise the craft into the air and are then turned horizontal. Others have combined both worlds with a helicopter rotor on top and horizontally mounted engine units on the wing or fuselage. The latest X wing design from Bell is an example of this type of aircraft.

To date however all these inventions have suffered from either all or some of the following problems: insufficient power, insufficient control, complicated mechanics, noise hostility, minimal efficiency and utility. The most successful VTOL currently in existence is the famous Harrier jump jet which distinguished itself in the Falklands' campaign. Even this VTOL however suffers from a lack of load capacity, and its rotating jets, which create the necessary lift off power, make it incredibly noisy, totally precluding its use as a civilian aircraft.

Recently however in Australia the Sadlier Aircraft Company has come up with a design that may make VTOL aircraft a far more viable alternative. Responsibility of the invention rests with the head of the company Kim Sadleir and his

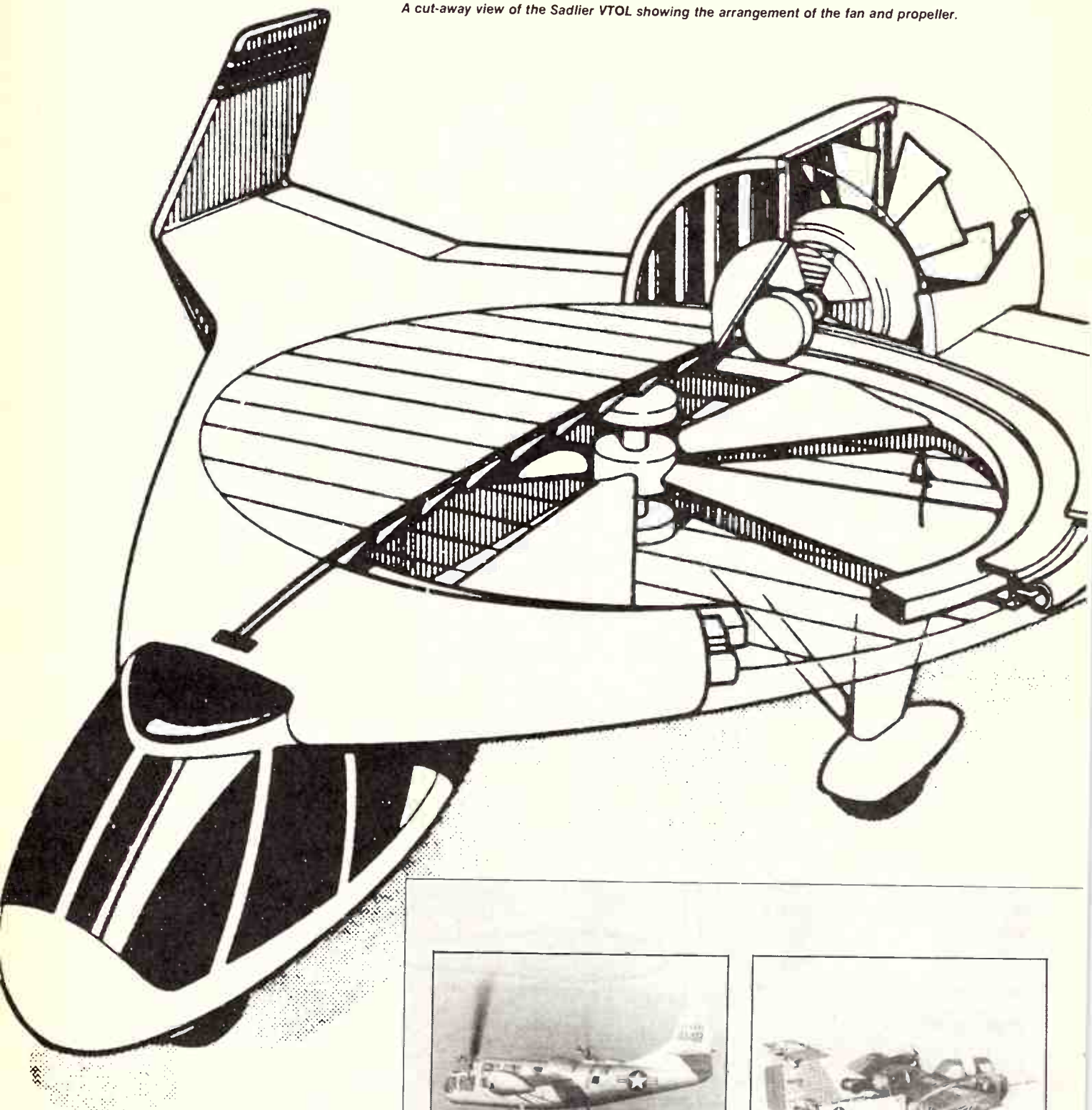
Projected Performance

DIMENSIONS	
span	9.0 m
length	9.0 m
wing area	30.0 m^2
aspect ratio	2.7
PERFORMANCE	
installed engine power	800.0 kW
fan power at lift off	630.0 kW
max. speed	240.0 kts
transition speed	55.0 kts
max. VTOL weight	1700.0 kg
payload	350.0 kg
range using VTOL at max. weight	200.0 nm
FAN DATA	
diameter	3.5 m
no. of blades	7.0
fan speed	600.0 rpm



Above: the dimensions of the military version of Sadlier's design. Below: the top view of the same aircraft. The military version of Sadliers VTOL would travel faster than any helicopter. It would be ideally suited for either reconnaisance or transport roles.

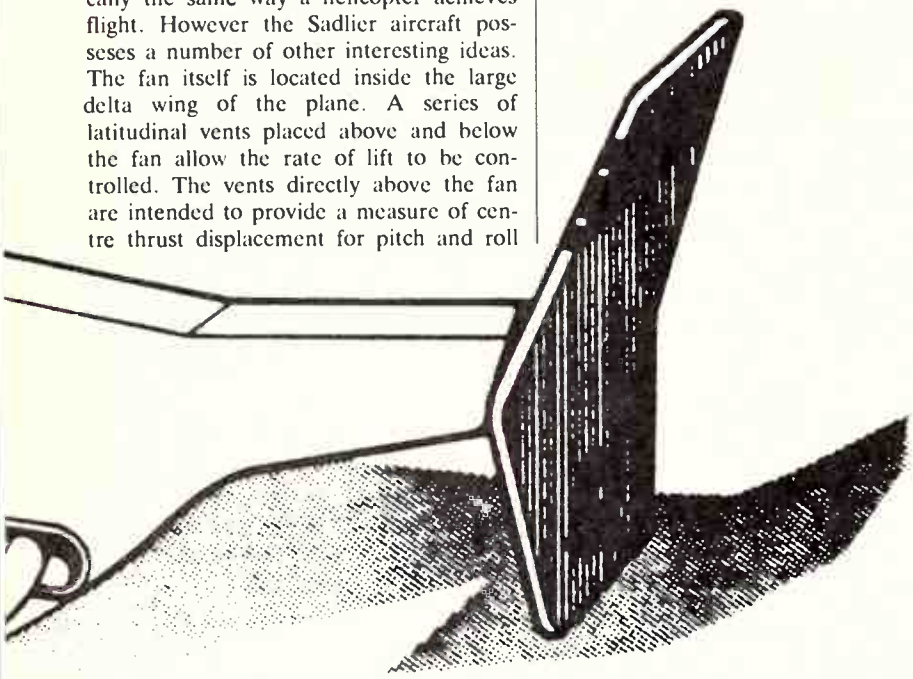
A cut-away view of the Sadlier VTOL showing the arrangement of the fan and propeller.



consultants Don Devenish and Graham Swannell.

Problems

The Sadlier design involves using a fan to raise the craft into the air where it would then be powered by a conventional propellor mounted on the back of the machine. The use of a fan to raise an aircraft into the sky is not new, in fact it is basically the same way a helicopter achieves flight. However the Sadlier aircraft posseses a number of other interesting ideas. The fan itself is located inside the large delta wing of the plane. A series of latitudinal vents placed above and below the fan allow the rate of lift to be controlled. The vents directly above the fan are intended to provide a measure of centre thrust displacement for pitch and roll control. The vents below the fan provide fore and aft thrust reactions. The vents are an important aspect of the Sadlier design since one of the most enduring problems of VTOL planes is their relative lack of control whilst taking off.



As interesting as these features are, however, the truly revolutionary aspect of the Sadlier design lies in the nature of the fan itself. It is joined at the tips like a spoked wheel and is driven from the rim rather than from the centre as with most similar propulsion units. Friction is avoided by pumping compressed air around the ring before flight so the tips are carried on a bed of air. The engine which drives the fan also powers the conventionally mounted propeller on the rear of the craft. The use of one engine to do both tasks adds to the lightness of the aeroplane.

The joining together of the fan blades at the tips gives the Sadlier craft a number of advantages. First off it means that the blades will not cone, or droop, as happens to helicopter rotors. This in turn means that the housing in the wing does not have to be very thick. Consequently the wing can be made quite light. Furthermore the fan blades themselves can be made extremely light which increases the efficiency of the fan as a propulsion unit. Since the fan is driven from the rim, weight is also saved by the fact that there needs to be no heavy rotating axle in the hub.

Markets

Two markets for the craft are envisaged. One, fairly obviously is the military. Any aircraft with the flexibility of this one would be a tremendous asset to an air defence system. Unfortunately the response of the defence department to the Sadlier concept has not been a happy one. Defence minister Kim Beazley wrote in May last year that the development of VTOL was "not a priority". The second market is thought to lie in the commercial world. A four seater version of the aircraft would cost about $250,000, well within the range of most top businessmen and executives. The vast increase in the number of heliports in the world's major cities would also point to a strong commercial market.

To date Sadlier's company has already spent more than $350,000 on VTOL research. Full development of the project however has been hampered by an increasing lack of funds available for R and D. However Sadlier is approaching several overseas interests with an eye to overcoming this difficulty. By January next year it is hoped to test the load bearing capacity of the fan by building a fifteen bladed device powered by a 69 kilowatt engine. The fan has already been tested as regards manouverability and control. If all goes well a scale model of the machine will be built by July. Sadlier stressed that if sufficient interest is shown in the project by his overseas contacts then this rough schedule could be considerably shortened. His company does not intend to actually make the VTOL's but simply licence the design to some other manufacturer. ●

Various hopeful designs of the past from left to right: the Bell XV-3 the first tilt rotor VTOL, the Vercol 76 the first tilt wing VTOL, the Sikorsky ABC compound helicopter and lastly the Harrier Jump Jet.

SPACE TECHNOLOG

Ken McCracken

THE space industry will always be relatively small compared with many of the other industries of Australia, or the world.

With a projected annual Australian expenditure of $370 million — $500 million by the mid 1990s — the space industry is much smaller than the information or entertainment industries, and has an annual turnover that is also much smaller than those of many individual commodities in the mining or agricultural sectors.

However, this doesn't mean a space industry is not worth having, or that it won't have important implications for the Australian economy.

Aims And Policies

In the 'Policy Statement On Space Industry' released by a Federal Cabinet decision of 1986 the stated aims of Australia's space industry were to:

- create the opportunity for spin-offs from space activities to extend to the manufacturing and services sectors as a whole through intersectoral transfers of technology; and
- provide a focus for innovation to take place in a number of industries including aerospace, information, telecommunications and scientific equipment.

Furthermore, the government has charged the Australian space Board with 'the section of projects likely to have significant spin-off benefits for other industries'.

The government identified several other aims. It is important for us to recognise that these were not 'either/or' goals. Our Australian resources are too precious to allow that. Our activities in space must be chosen to meet simultaneously *all* of the strategic goals set by Cabinet.

The government's strategies apply equally well to individual companies and individual research laboratories. A careful choice must be made at all organisational levels. Relevance will mean different things to different organisations however. In each case, relevance will be determined by the existing competence, the organisational goals for the future, and the occurrence of opportunities to make an appropriate contribution to the national program.

Spin-off to other non-space activities will be vital. We must ask 'what organisational arrangements *maximise* spin-off?' The right choices by the Australian Space Board, or the board of a private company, will have far-reaching consequences on the non-space industries well into the new millenium.

Choices

Against the background of the Australian Space Policy, the relevance of a space activity or technology could be determined by the following criteria:

- the space technology should provide know-how and market advantage to non-space activities and industry;
- a significant fraction of the manpower and capital items should be capable of being utilised efficiently in the non-space activities of the company concerned;
- research into applied space technologies must be central to Australia's own operational space needs and must be suitable as contributions to international spacecraft;
- in those cases where new technologies are being developed in a fundamental or applied space program, world markets should be a prospect, and Australia must have a comparative advantage in the development and commercialisation of the technology; and
- there should be a symbiotic relationship between the chosen space technologies and other technologies that are on a long-term growth curve.

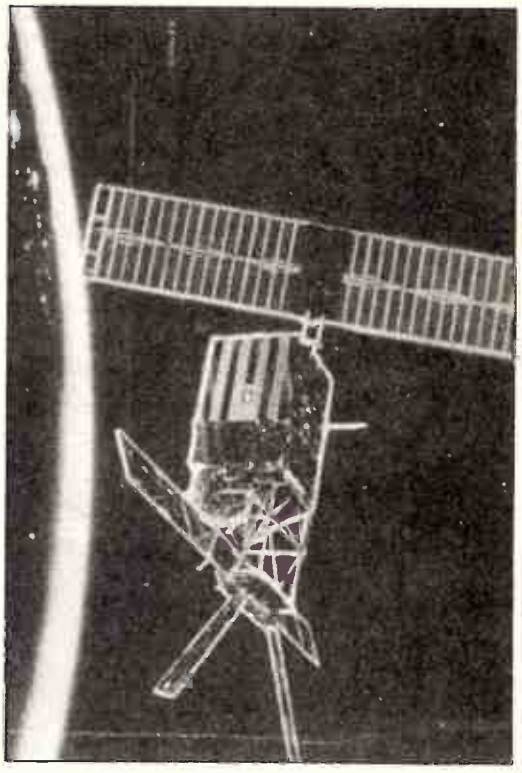
Spins

This is absolutely vital. The word used in the joint statement by Senator Button and Mr Jones was 'leaven', and it is an excellent choice that describes the task.

Spin-off is not someone else's responsibility — all organisations involved in space must see that it leavens their non-space activites. The prospects for commercial spin-off must be vital components of all proposals and all decisions. The identification of commercial spin-off must not — as has sometimes been the case in the past — be an afterthought once the decision has been taken. Nor can it be someone else's problem.

Let me emphasise the role of fundamental science in this scheme of things. Fundamental space science — astronomy, solar physics, plasma studies — can meet this spin-off criterion.

In fact, fundamental science often demands a technical performance that has never been attained before. In so doing, it provides enormous spin-off to industry,



One of the more significant Australian space experiments will ride on ERS1.

provided that such competence already exists in a viable and competitive form in the country. A cold start, with a requirement of international competitiveness within five years, say, would not be an acceptable decision.

Let us not forget that all of the other countries in the space business focus on spin-off benefits.

It will not be enough for just one of the various participants in Australian space business to concentrate on spin-off. The laboratories must provide spin-off concepts; the ASB must pursue consistent and supportive space programs; government must make tactical and purchasing decisions consistent with its decision that space is a component of a much greater industrial whole; and industry must assiduously seek the fastest form of spin-off, namely, that which occurs within their own company.

The commercial space market is cyclical. A company must anticipate that it will experience periods in which no space contracts will be available.

We must develop the ethos in which the management, engineering, and technical resources of a company would be capable of transfer to non-space projects. In my

Y AND AUSTRALIA

opinion, this should be by design, as a means of generating the spin-off that I mentioned earlier.

Such versatility is well known in overseas industry. For example, space activities are used as the training and retraining grounds for engineering staff. Only 10% of the activities of the French company Matra are in space, but 50% of its engineering staff has been in its space division at some time. That is spin-off in action.

Furthermore, it is important that we all recognise what the Australian space program is to do, as well as what it is not to do. It is *not* a safety net to generate work between other space contracts. It *is* an upfront industry stimulus program, designed to extend, qualify and demonstrate the capability of Australian industry.

Technologies

Clearly, our activities should be directed towards applications in which our own needs provide us with a distinct comparative advantage in the international market. Applications that we ourselves would not take through to (at least), the demonstration stage are not appropriate.

The exploitation of our comparative advantages cannot be stressed too highly. Consider, for example, remote sensing. We have many opportunities to excel in remote sensing in the tropics and in deserts. Already we have used the Great barrier Reef as an enormous laboratory for the development of the low-cost, user-friendly remote sensing system, Micro-BRIAN, which is now widely used in Australia and the Asian-Pacific region. This further enhances its value to the user.

By directing our space R&D to such applications, in which a wide range of experience is available in Australia, we can aspire to excel, and we will also have an extensive shop window in which to show our wares to overseas buyer.

Finally, it is important that, having developed the technologies we need, we should then use them. Too often in the past, Australia has failed to have the courage to exploit its own technology. Too often government and industry have taken the seemingly soft option to purchase new or experimental technology from overseas, leaving local R&D to go to waste.

I am pleased to say I see evidence that recent government and private sector decisions show that this reluctance, this technological cringe, may be diminishing with time. Let me cite three examples:

- the purchase of a locally designed and manufactured meteorological satellite reception system by the Bureau of Meterology, and also by members of the Australian research community;
- the purchase of locally designed and manufactured antennae by OTC for use in the provision of our international communications via INTELSAT; and
- the purchase of the locally designed and manufactured Micro-BRIAN by many public and private users throughout Australia.

It is crucial that, having leavened the mix, government should than taste and eat the resulting bread. This will involve risks — but that is what is implicit in all forms of industry stimulation.

Stimulations

It is instructive to look back over the past 20 years. Satellites gave us a million-fold increase in communications band width. The integrated circuit, the computer, television, etc., provided the market for that band width. Each technology stimulated and fed the other.

The countries and companies that prospered the most were those that anticipated the symbiotic relationship between these several technologies.

So it will be in the future. Our space activities must anticipate major changes in non-space activities and benefit from them — not fight them.

Thus we must, for example, recognise:

- the complementary nature of the optical cable and satellite communications systems in the future — each technology will play its part, one on the thick routes, the other on the thin routes — we must regard them, from both an industrial and an operational point of view, as part of a total communications system — deregulation will force these attitudes upon us in the short term;
- that satellite to satellite, and satellite-ground communications will develop using optical lasers, instead of microwave transmitters — this will have substantial organisational, and technical implications, fuelled, once again, by deregulation;
- that sweeping changes in computing and solid-state hardware will continue to drive the market for both communications band width and primary data — high-resolution television, the real-time fast-fourier-transform chip, and gigabyte memories;
- the enormous changes in national management that will be introduced by remore sensing — remote sensing of the oceans provides a million times more data than did the pre-space technologies — this will have a profound effect, and drive a rapidly evolving ground sector technology;
- the profound changes that the wedding of the navigation satellite and the video disk will have in a country such as Australia.

Conclusion

The changes in the space business in the next two decades will be very substantial, and that gives Australia its chance.

If the space technologies were mature, we would have left our run too late. We would get neither the technologies, nor the spin-off we seek. But the space technologies are not mature. The enormous contemporary changes in other technologies, plus the new space technologies themselves, guarantee that.

Moreover, the world is still learning how to use the new technologies such as remote sensing. New attitudes and management techniques will develop based upon the new forms of data. Change will be the norm for several decades to come.

A relevant national program would exhibit the following characteristics:

(i) target a window of opportunity for commercial involvement that will open some 10 years ahead;

(ii) make maximum use of Australia's comparative advantages (size, location, environmental conditions) to develop its technology and to secure its position in international consortia;

(iii) recognise that the greatest benefits will derive, ultimately from the spin-off from management and technical skills to the non-space industries.

These, I submit, are the characteristics that will determine relevance.

Finally, what companies are relevant to the Australian space program? The government has made its view clear. Technology spin-off to the non-space industries is vital. Companies with a good mix of space and non-space activities are therefore relevant.

Clearly we are building the future industry of Australia. The companies that are relevant are those that have a long-term commitment to being good corporate citizens of Australia, prepared to take risks, and to work towards long-term goals. ●

Dr Ken McCracken is chairman of the CSIRO's Office of Space Sciences and Applications.

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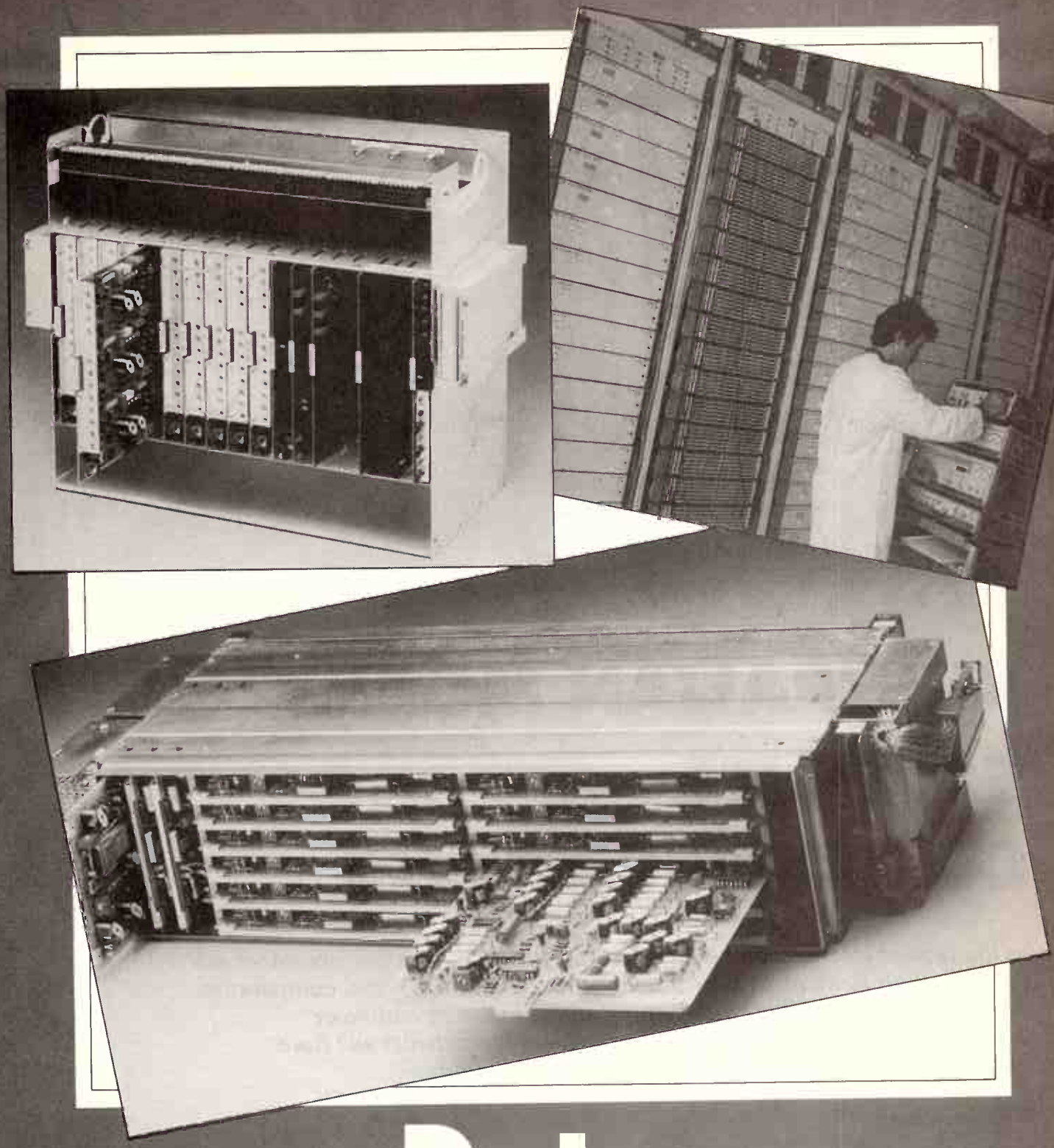

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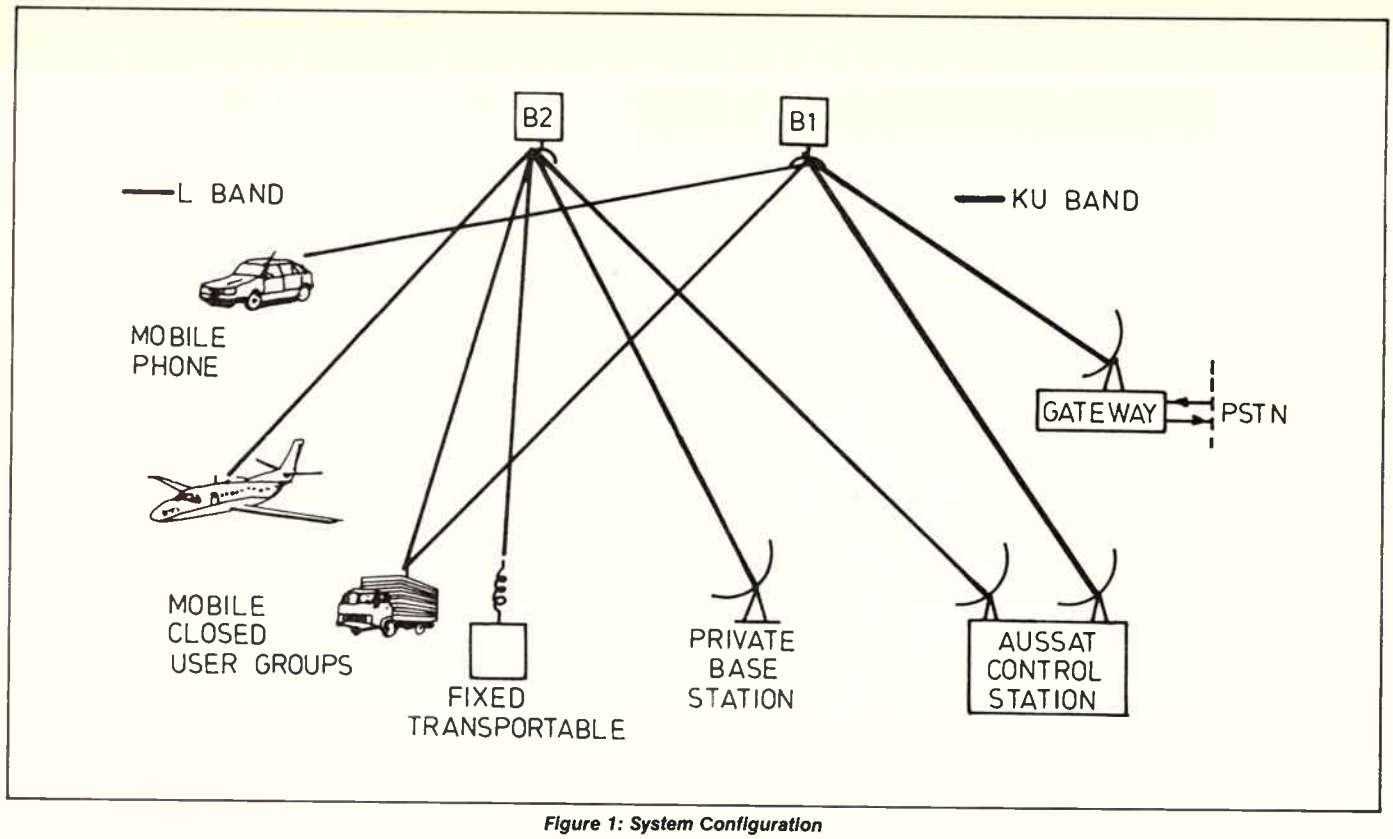

Figure 1: System Configuration

AUSTRALIAN MOBILE SATELLITE COMMUNICATIONS

In the face of intense competition for optical fibres, satellite operators are tailoring their systems to applications where they have some comparative advantage. One of these is communications between mobile or temporary stations. AUSSAT's second generation satellite will have extensive mobile capabilities.

Michael Wagg

The recent decision by AUSSAT to proceed with the inclusion of an L Band transponder on board the second generation or B series satellites has opened the door to the introduction of a domestic mobile communications system for Australia. Depending on the implementation time frame for the second generation system, this may well be the first domestic mobile satellite system in the world.

The current market requirements have been identified as predominantly the replacement of the remote HF radio voice services but with a range of other requirements such as remote monitoring, mobile data collection, remote mobile public telephony, etc. This paper provides an overview of the proposed AUSSAT system and outlines the technology areas that are being addressed to meet the service and market needs.

Today

Mobile communications throughout Australia are currently serviced by a range of technological options. Within the urban

areas VHF and UHF radio currently caters for requirements of police, taxi networks, etc, with more than 250,000 radios in use. The Telecom Mobile Radio and the recently introduced cellular mobile system provides public switched mobile telephony services within the major cities with a planned expansion to 42 centres and over 150,000 users by the mid 1990s.

Once outside the major population centres the current options for mobile communication services rapidly diminish. VHF radio systems are utilised along major routes by linking together individual base stations, which have a 30 to 50 km range, by fixed communications means. However, outside the corridors provided by VHF repeaters the only available low cost system currently available is HF radio.

HF radio provides for the complete spectrum of mobile requirements including land, air and sea services. HF radio can provide an Australia-wide coverage capability, depending on the transmitter power, but suffers in the quality and reliability of the service it can provide.

The AUSSAT Mobile Satellite System (MSS) has been designed to cater for those users of mobile communications who:

(a) are required to be involved in field operations away from major urban areas;
(b) have a need to communicate with a fleet of field vehicles or remote monitoring stations;
(c) are involved in field operations outside the range of the terrestrial communications infrastructure.

The MSS will provide voice and low speed data communication services between low cost mobile terminals and base communications stations. The voice communication is to be either a radio or telephony link with quality similar to or better than current telephony services. The mobile voice terminals will be similar in features to existing cellular mobile telephones, while transportable and semi fixed services will incorporate separate higher capacity antennas.

The data services will range from conventional low speed synchronous or asynchronous links, typically up to 9600 bps, to a variety of services not readily available on the terrestrial communications network. These will include data broadcast and data collection services which both exploit the features of a satellite network. The mobile network will also be able to provide messaging and paging services.

Table 1 summarises the current mobile communications usage throughout Australia and provides an assessment of the impact that the MSS will have on the different applications.

The new system

The AUSSAT mobile satellite system will comprise an L Band package on-board each of the AUSSAT-B satellites and ground segment communications equipment comprising L Band mobile terminals, Ku Band base stations, and a Ku Band control and monitoring centre. The basic components of the system are illustrated in Figure 1 which shows the L Band mobile-to-satellite links and Ku Band satellite-to-base station links. No provision is made in the system design for direct single-hop L Band to L links in order to avoid unauthorised and uncontrolled communications will therefore operate with a double satellite hop via an intermediate base station.

Figure 1 also illustrates a closer user group consisting of a base station and several mobile terminals. Additionally, the mobile system could provide thin route technology services, accessing the public switched telephone network (PSTN), in which case, a suitable gateway station, possibly operated by Telecom, would be used to provide PSTN interconnection.

TABLE 1: AUSTRALIAN MOBILE SERVICES

	TELECOM MOBILE RADIO	CELLULAR "MOBILENET"	HF RADIO	VHF/UHF RADIO
APPLICATION	Urban UHF Mobile Telephone service	High capacity UHF	Land, marine and air mobile voice communications networks requiring wide area coverage	Voice communications, predominantly with base stations over limited coverage areas.
PRESENT CUSTOMER BASE	6,000	150,000+ by 1995	15,000 land mobiles in 1987, growth at approx 1,000 per year	. 100,000 UHF radios in 1985 . 145,000 VHF radios in 1985
COVERAGE	Metropolitan in Sydney/ Melbourne	. All capitals + 42 centres . No coverage outside centres	. Depends on frequency and power . Several hundred km to all of Australia	. Limited to 30-50 km from base station . Dead spots in rugged terrain
COSTS	. $4K terminal . $720 annual fee . 40 cents/min	. $3-5K terminals . $720 annual fee . up to 60 cents/min	. $3.5-5K typical radio cost . No usage charge	. Radio cost <$1K . Base station/repeater costs depend on network size . Some networks include interconnecting microwave links between VHF/UHF cells
IMPACT OF MSS SERVICE	NO. System being replaced by Cellular Radio	No, but MSS could provide nation-wide mobile PSTN overlay on Cellular system.	YES. HF replacement market is the Key opportunity for MSS. Penetration dependent primarily on MSS terminal costs. Key benefits of MSS over HF are reliability, security extended coverage and availability of service.	YES. Partial Penetration by MSS where coverage range & service reliability limitations exist, or where businesses decide to rationalise operations.

Under the ground concept, control of the total network would be performed by AUSSAT from its main tracking and control centre at Belrose. The network control system would dynamically assign channels in order to optimise the utilisation of the system capacity, control access to the system to limit jamming and unauthorised use, monitor the whole network and permit optimisation of the system performance, and perform service billing.

The mobile terminals would in general, provide voice and low speed data communications capability and would be similar in configuration and concept to either a cellular mobile unit for telephony applications for a push-to-talk HF/CB radio for radio applications. The fixed and transportable terminals would provide for a broad range of applications including data collection for which a streamlined unit will most likely be developed.

Space Segment

The L Band payload is planned to be provided as an "add-on" package on the AUSSAT-B satellites. The mass and power requirements for the payload are anticipated to be around 10% of the satellite's payload power and mass resources. The L Band service area will be the whole of Australia and the surrounding coastal waters with specific coverage of the North West Shelf, the Great Barrier Reef and the Great Australian Bight areas. Circular polarisation will be used for the L Band links.

For operation at L Band with Australian coverage and minimum spill-over into adjacent areas, a spacecraft antenna about 2.5 metres in diameter will be required. This is about the maximum size solid reflector that can be accommodated in current launch vehicle envelopes for spacecraft envisaged for the AUSSAT-B designs. Alternate antenna configurations could employ a phased array antenna for both L Band transmit and receive functions.

The multicarrier edge-of-coverage effective isotopic radiated power (EIRP) required is 46 dBW which is consistent with the power and mass limitations of an add-on package. Figure 2 shows the coverage of Australia provided by a simple circular beam. On the receive side, a dish of 2.5m in diameter should be able to provide a satellite G/T of −1 dB/K at edge-of-coverage.

Ground Segment

A variety of terminal designs will be required to provide for the range of applications expected including fixed installations, transportable terminals and mobile terminals. The terminal will probably be equipped with a microprocessor to handle protocols for system access as well as control of the frequency agile receiver and transmitter for channel assignments. To permit the ready use of more than one encoding or modulation technique it is expected that digital signal processing will be incorporated into the terminal unit.

The antenna design for the terminal unit will have a significant effect on performance. For simple omni-directional antennas, gains of around 5 dBi will be relatively straightforward but will require significant satellite EIRP to achieve acceptable downlink performance. Further, the transmitter power required by the terminal will be substantial to produce the required uplink EIRP.

A more desirable situation will be to have a mobile antenna gain of around 8-10 dBi with the consequent increase in system capacity and reduction in required uplink and downlink transmit powers per carrier. However such a gain can only be achieved at the expense of having to include a tracking capability as the beam would have some directivity in both elevation and azimuth.

Extensive overseas research and development effort has already been directed towards the design of both mechanically and electronically steerable mobile antennas that can be produced at an affordable cost. Fixed terminals would employ high gain antennas around 20 dBi or more which could take the form of dishes or arrays of helicies.

Opportunities for Australia

As Australia is likely to be the first country to implement a domestic satellite system with a number of countries, particularly the US and Canada, implementing services with one or two years of the Australian system, the opportunity exists for Australian industry to develop an expertise in mobile terminal equipment which will provide a major export potential to a growing worldwide market. Planned initiatives for the development of control and monitoring equipment and mobile terminals in the period prior to the commencement of the service will provide a major thrust and focus for local industry and should enable Australian industry to develop both expertise the world superiority in a number of key areas in the mobile terminal world.

However, it is important that the significant levels of research and development that have been carried out by various overseas organisations are carefully reviewed and, where applicable, incorporated into the development of the Australian MSS. This will avoid reinventing the wheel and will ensure that the Australian system is carefully aligned to the system used elsewhere in the world.

The mobile terminal is considered to be the major development area. Tasks that need completing include:

— the development of low cost steerable high gain antennas;
— the choice of optimum modulation and access methods;
— the choice of optimum voice and data encoding schemes;
— the development of a cost effective terminal unit.

The successful development of Australian mobile satellite terminals and the commercial availability in time for the Australian MSS will both provide for a major export opportunity and will enhance the growth capability of the domestic system. ●

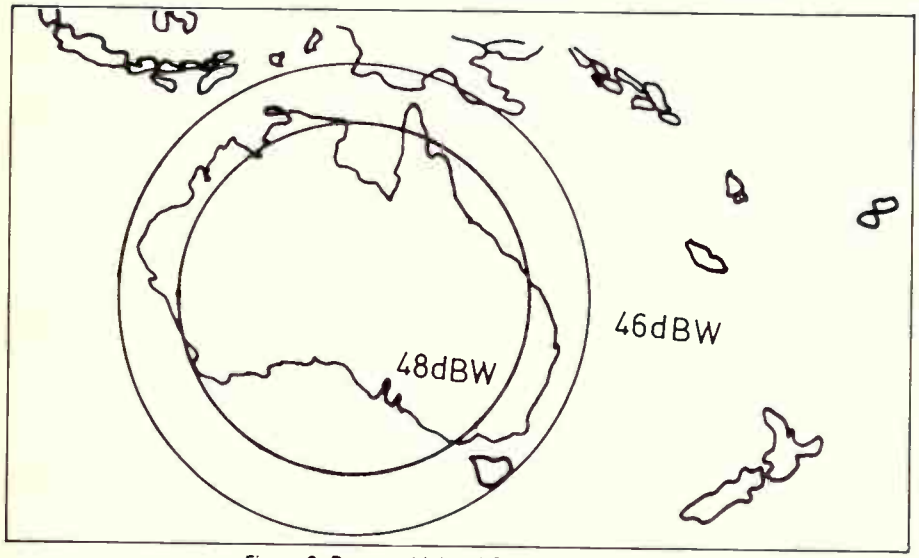

Figure 2: Proposed L band Coveage of Australia

Dr Wagg is service development manager with AUSSAT, Carrington St, Sydney, NSW

The end of manual directory enquiries is in sight.

ELECTRONIC DIRECTORIES

J. P. Nakulski, P. C. Craig, R. Exner

There is currently a major collaborative effort underway between the International Telegraph and Telephone Consultative Committee (CCITT) and the International Organisation for Standardisation (ISO) to develop a single standard for Electronic Directory Systems (EDS). This will make possible the automation of one of the last manual aspects of telecommunications — directory enquiries.

The intention of the standardisation work is to develop a distributed directory system, composed of interworking autonomous local directories. Users need not be aware of which local directory contains the information that they require; every local system is equipped to resolve the query by "navigating" to the correct system automatically. The total system is referred to as *the Directory*.

The evolving standard will allow Electronic Directory Systems to provide a high degree of functionality. Each of the directory entries in the EDS database may hold arbitrary information about a person, organisation, a computer process or a group. These entries may be located from a description, allowing a single system to support both traditional "white pages" and "yellow pages" queries. Also supported are aliases (alternative names), local access control mechanisms (to restrict access to sensitive information), and operations on sets of objects (allowing the retrieval of the entries of all Psychotherapists in East Melbourne, for example).

Standards

Since 1984, CCITT has been actively developing a standard for Electronic Directory Systems. The need for such a standard first became apparent during the Message Handling work of the 1981-84 study period, when it was realised that a global, distributed directory of message handling users was need to provide an adequate messaging service. Such was the importance of the need for electronic directory systems that three interim meetings on directories were held before the official 1985-88 plenary period. Since then, the planned applications of Electronic Directory Systems have increased substantially and a great deal of work has been done by the CCITT Study Group VII.

In parallel with the CCITT activity, ISO perceived a need for electronic directory systems as a component of its own work on Open Systems Interconnection (OSI) and began their own standardisation activities.

In April 1986, CCITT and ISO began to hold joint meetings to develop a common international standard for electronic directory systems by 1988. The first of these meetings was held in Melbourne, and was hosted by Telecom Australia. The two groups have different, but overlapping requirements. The CCITT perspective is a directory service which will provide directory information about customers for a range of telephony-based and telematic services that the PTTs each provide. This may be used either as a reference source of directory information or offered to customers as a value added service to support both white pages and yellow pages style searches. The viewpoint of the ISO experts is somewhat different. Their interest is in providing a directory function to support both name-to-address mapping and network management in OSI networks and also to support the manufacturing automation protocol (MAP) and technical office protocol (TOP). Thus the ISO requirement is for simpler functionality.

The plan for completing the standard by 1988 meant that ISO needed to develop a draft proposal by early 1987. The first draft proposal was produced at the September 1986 meeting in Egham, UK. A second was developed at the Munich meeting in February and completed at the Tokyo meeting in June 1987.

After the Tokyo meeting, the standard was considered to be technically stable although it will not be officially published as

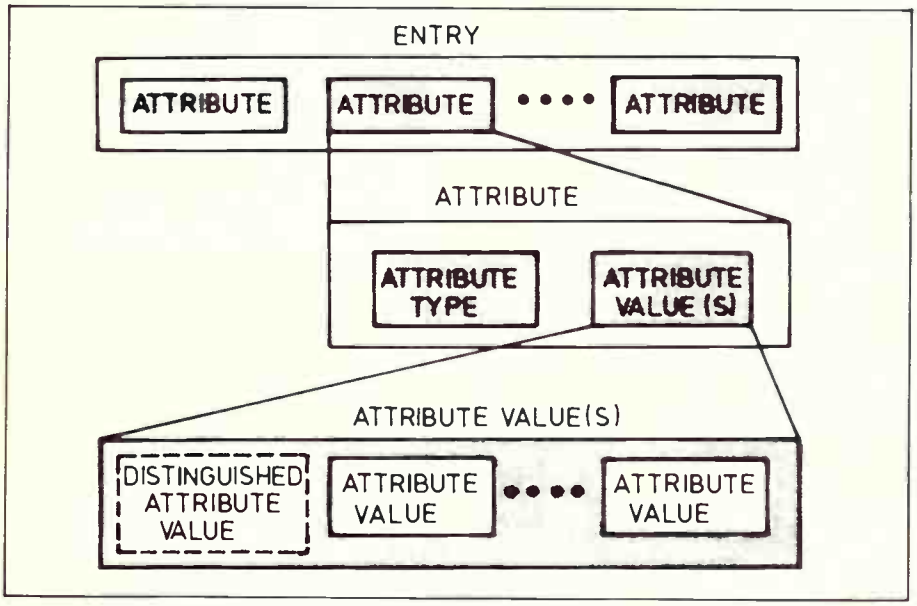

Figure 1: The structure of an entry in the proposed electronic directory.

an International Standard until 1988. There will be opportunity to further enhance the standard during CCITT's next study period, lasting until 1992.

The CCITT/ISO directory system offers a wide range of service features to the end user. The user may read and verify directory entries, or search for a partiuclar set of entries across a number of different indexes (for example, the user may request to read all names and telephone numbers of all Pscychotherapists in East Melbourne). The user has the option of restricting the search by using a number of constraints or service controls, for example, the amount of information returned on a request may be limited. Subject to local access controls, the user may modify a Directory entry.

The Directory is capable of holding any type of information about a person, an organisation, a computer, or in fact any real world object.

For example, it would be possible to store business, name address, telephone number, telex, teletex and telememo numbers, as well as business-specific information such as a description of the business type, its daily opening hours, product catalogues and service of advertising details. The general structure of an entry is illustrated in figure one.

To allow for different names for the same object, an alien mechanism is provided. Each object has a distinct, unambiguous name (its distinguished name) but users may know objects by alternative names called aliases. An alias may be considered a pointer to another within the directory.

Users may protect directory information using an access control mechanism. This mechanism is supported by an authentication framework which allows the Directory to verify the identity of the originator of a request.

The Model And Information Framework

Basically, the directory system operates as follows. Each local directory within the system is known as a Directory System Agent (DSA). Users interact with the Directory via a Directory User Agent (DUA). The DUA helps the user to formulate a directory query and sends this query in an appropriate form to a DSA. The DSA then tries to answer this query if it can; otherwise it communicates with other DSAs to find the requested information before replying to the initiator of the query with either a result (and answer to the query), or an error accompanied by an explanation of why the query could not he satisfied.

The information contained in the directory consists of a number arranged in a directory information tree (DIT). The DIT can be viewed as a hierarchy of entries with the root entry at the apex of the tree. An entry may contain information about an *object* (such as a person, an organisation or a computer process). Alternatively, an entry may represent an *alias* of another entry, in which case it simply contains the name of the entry which it represents.

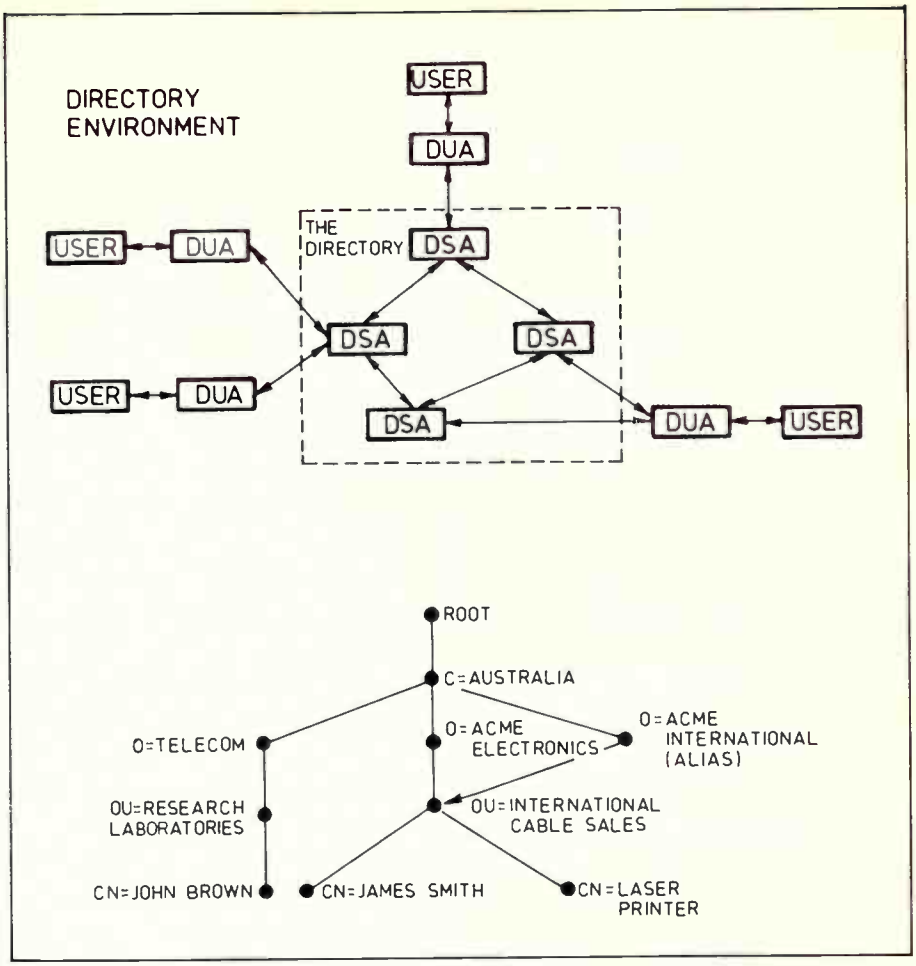

Figure 2: The relationship between the various parts of the directory organisation.

Each entry may have only one unique name, called the *distinguished name*. The distinguished name, as the term implies, distinguishes the entry from all other entries in the DIT. An entry's distinguished name is composed of its superior entry (its parent in the hierarchy) plus it own *relative distinguished name*.

Each entry contains an arbitary number of attributes, which may represent any useful information such as names, telephone numbers or telex numbers. An attribute consists of a type (e.g: telephone number) and one or more values for that type (in this case, several telephone numbers).

The current version of the standard does not specify a standardised mechanism for controlling access to entries. The specification of access control mechanisms would provide a uniform method of controlling access to the directory for the purposes of reading and modifying directory information.

In a large, distributed directory system, it is advantageous to keep local copies of certain directory entries in order to efficiently answer queries relating to entries held by remote DSAs. Two DSAs may establish a bilateral agreement to manage the initialisation and subsequent update of such copies. The standardisation of these agreements would permit different directory implimentations to establish such agreements quickly and automatically.

Distributed Operations

In order for the directory syste n to successfully answer a query, individual directory system agents (DSAs) must co-operate. Each DSA is responsible not only for answering queries relating to entries that it holds, but also for correctly and usefully handling all other queries that it may receive. Therefore, the standard specifies the complex procedure that a DSA must use in handling queries.

When a DSA receives a query relating to an entry which it does not hold, it must either *chain* (pass on) the query to a DSA which is in some sense closer to the desired entry, or else return a *referral* to the initiator. This referral directs the initiator

Electronic directories

of the query to one or more DSAs that are in a better position to answer the query. Thus, it is ensured that all queries will eventually reach the DSA holding the desired entry by this process of *Directory navigation*.

In order to guarantee the success of navigation, each DSA must hold a certain amount of information relating to the portion of the Directory Information Tree (DIT) that it does not hold. This information is called *knowledge* and guarantees that a DSA holding an entry be able to navigate to the DSA holding that entry's *immediate superior* (parent) and *immediate subordinate* (children) entries. This entails holding *references* to the entry's immediate superior and immediate subordinates.

A reference to an entry consists of at least the name and address of the DSA holding that entry, or alternatively the name and address of a DSA that is able to direct the query to the DSA holding the desired entry. Through these references, each DSA holds knowledge about directory entries. This knowledge represents a DSA's view of the world and enables the directory as a whole to navigate to any entry within the directory information tree.

A set of rules, the *navigation procedure*, describes the method for navigating to an entry using knowledge in order to satisfy a directory request. There are two steps involved in this procedure. The first step requires navigation to a DSA holding some superior of the target entry. *Knowledge* is used to navigate up the directory information tree to reach a superior of the target entry (this may be an entry between the root entry and the target entry).

The second step involves the use of knowledge to navigate down through the Directory Information Tree to reach the DSA holding the target entry. In navigating from an entry to its subordinate, a DSA may *multicast* the query to several DSAs to which it holds references.

For some reason, a DSA may choose not to chain or multicast during navigation. In this case, the DSA uses its knowledge to return a *referral*. The referral consists of the set of information necessary for the initiator or some DSA to continue the navigation procedure from where it stopped. Thus, knowledge guarantees successful navigation to any entry in the directory information tree.

Application

The emerging directory standard is likely to be implemented first as a support function in a message handling system such as Telecom Australia's Telememo product. This is the role for which the directory standard was originally intended. The next likely application is in the support of OSI networks. Such applications will start to appear within the next few years. As more services are provided with an associated electronic directory, there will be increasing pressure to integrate these service-specific directories into a single directory system. The emerging directory standard provides an ideal framework for this to occur in the future.

The French PTT has had an electronic directory system running for several years. The system is based on a videotex services and grants users on-line access to telephone numbers via a *Yellow Pages* style search. While they report that this has supplanted paper telephone directories, this has only been possible because of their strategy to provide the videotex terminals (Minitel) free of charge and to provide a range of other non-directory information services accessible by the same terminals.

It is intended by the French PTT that the French Minitel system will be modified to be compatible with the CCITT/ISO Directory standard. For this reason, representatives from the French PTT have recently become involved in the international standardisation activities.

There are also several experimental implementations of the directory standard under investigation in a number of organisations. One such implementation is the THORN project, which implements an early intercept of the directory standard. This is a co-operative effort by a number of institutions in Europe.

The GMD, a research institute associated with the West German Bundespost, are currently working on an experimental implementation of some aspects of the Directory. Televekert (Sweden) are currently designing an experimental directory and we expect to have a demonstration system available by the end of 1987 without full OSI support. Dialcom, a US company owned by British Telecom, have been working on directory systems for several years and are likely to have one of the first CCITT-like implementations which will be used in conjunction with their messaging system.

The Telecom Australia Research Laboratories are currently implementing an experimental electronic directory system. This involves examining both the definition of the service provided to the end user and issues related to the performance of DSAs and their operation in a distributed directory environment. There are a number of issues, presently under investigation, in the software architecture of such a system. ●

The authors are at Telecom's Research Laboratories, Clayton, Vic.

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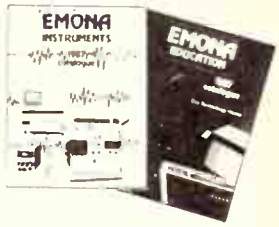

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INTERNATIONAL STANDARDS FOR COMPUTER COMMUNICATIONS

The information processing industry is in the midst of an accelerated evolution. Guided by the forces of natural selection (ie, the market place) a new species of information processing system is developing. Emerging from the present diversity of incompatible, isolated cells, whole communities of computer systems will be interconnected using standardised forms of communiction to create more competitive systems.

G. J. Dickson

As computers proliferate, the ability to inter-connect models from different manufacturers has become essential to improve the flow of information within an organisation and between different organisations. This has become critical as computer-based information systems have been accepted in many organisations as invaluable tools for the improvement of business effiency.

Incompatibilities between different types of computers place barriers to the electronic exchange of information between organisations and fragment the market for computer products. Standards to overcome this have been proposed for some time and have emerged in the Open Systems Interconnection (OSI) model. Standards are also being formulated within that model for specific applications such as electronic messaging, document interchange, electronic funds transfer and manufacturing.

While these standards are emerging in the computer industry, there have been major advances in telephone systems which will mean eventually all telecommunications activities, including voice, image and data transmission, may be handled over one network as a series of digital data streams. Standards for these Integrated Services Digital Networks (ISDN) are being implemented internationally.

The combination of OSI and ISDN holds the hope of new business opportunties through improved productivity, the creation of new services and the integration and expansion of local and export markets for systems and services. To the horror of those who are unable to adapt and innovate, the industry will be profoundly changed by the evolution away from single vendor solutions towards a multi-vendor computer environment. The nature of the cultural change to the information industry wrought by the introduction of OSI is the subject of this paper.

International Standards and Cultural Change

The driving force behind the creation of the OSI standards at the start of this decade, came from a small group of users and the communications industry. They were users who had the foresight to realise that standards for communications protocols were essential to give them freedom of choice between different types of computer systems. The communications industry has long recognised that standards were crucial to the successful merger of computer and communications systems in the so-called "Information Age".

Now that the implementation of the OSI standards is a reality, the computer vendors are actively promoting OSI. Vendor acceptance of OSI is so strong that industry rivals have formed collaborative organisations to promote OSI and to reduce the costs involved in implementing and testing the complex software required for the OSI protocols. The formation of the Corporation for Open Systems (COS)(USA), the Standards Application and Promotion Group (SPAG)(Europe), the Promoting conference for OSI (POSI) (Japan) and the OSI Community (OSICOM) (Australia) are unprecedented examples of co-operation between computer vendors.

This acknowledgement that multi-vendor distributed networks are a formal part of present and future computer systems sales represents a significant change in the corporate culture and marketing approach of the vendors.

Benefits to Users

In the long term, OSI offers greater freedom of choice and lower costs for users.

The need to conform to a proprietary communications architecture unique to an individual vendor will be of much lower importance than in current networks. The flexibility to tailor hardware and software systems from multiple vendors to solve business needs will ease the growth of innovative applications and services.

Adoption of the standards will eventually lead to lower costs because of the associated economies of scale and increased competition between vendors.

Benefits to Vendors

Vendors will gain from the integration and expansion of local and export markets for systems and services. It will also be easier for new companies to enter the market.

An indirect benefit is the gradual alleviation of the present acute shortage of skilled staff. In the long term, the need for specialist knowledge of proprietary communications systems will be replaced by a wider pool of knowledge about the standard communications protocol.

Opportunities for Industry

When adopted, the international standards would benefit the information industry through improved productivity and creation of new value-added services. The benefits will flow to many sectors of the nation, as the standards are concerned with activities where the interests of many sectors converge.

The business opportunities opened up by the standards are behind the intense effort now directed at the development of distributed applications based on OSI, eg:

- X.400/MOTIS — standards for a store and forward system for interpersonal electronic mail (text and image) and other business documentation.
- ODA/IF — Office Document Architecture and Interchange Format — for interaction between word processing systems and exchange of business forms (eg. orders, invoices, shipping documents, financial papers). These systems will decrease the cost of and delay of processing business transactions between different organisations.
- MAP aqnd TOP — Manufacturing Automation Protocol and Technical Office Protocol — for productivity gains on the factory floor and in the engineering office.
- Directory Services — a distributed database to facilitate the identification and location of information and services.

Horror

The period of innovation and change accompanying the introduction of OSI systems may be a time of challenge and difficulty for many organisations. The long term benefits of OSI are offset by short term cost penalties during the transition away from proprietary systems.

Data processing departments with large investments in existing systems will naturally be reluctant to change. Typically, it will be the smaller organisations, unencumbered by existing systems, which will seize the opportunities that a period of basic innovation

creates, thereby increasing competitive pressures on established organisations.

Corporate strategies to meet these challenges and avoid uncertainty should address the following issues:

- A change in corporate culture toward further integration of information systems into the mainstream business system.
- Increased co-operation between different organisations eg, between trading partners to improve communications or between vendors to ensure that different products interwork.

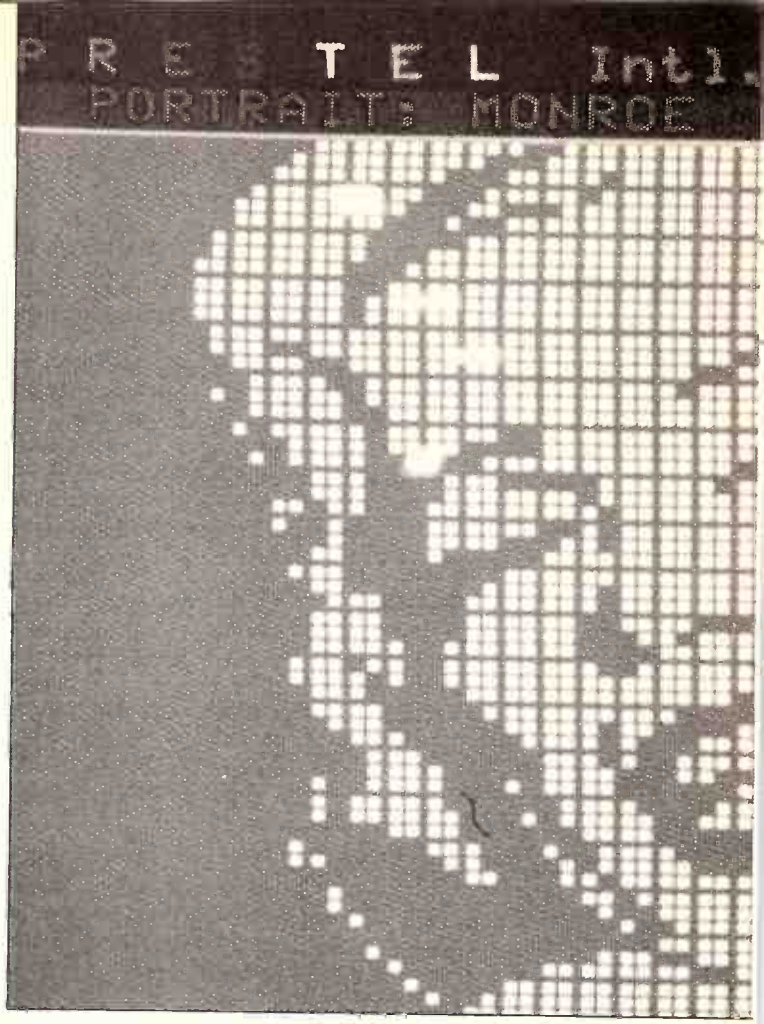
Technical staff, including those with expert knowledge of proprietary systems, will need education and training to equip them with the skills for work with the standard protocols.

The Role of the NPSC

It is critical that Australian systems and communciations products are fully compatible with overseas development for us to benefit from the rapid expansion of the computer communications market place.

The NPSC intends to serve as a catalyst for evolutionary change in the information and communication industry. Its activities are directed towards:

- raising awareness of the issues, opportunities and challenges associated with the international standards for OSI and ISDN;
- disseminating and interpreting information about the latest developments in the application of protocol standards;
- the provision of training and educational services targeted at OSI and ISDN, and;



The key to transferring images and data between computers efficiently is the establishment of standards like MAP, TOP and ODA.

- tranferring expertise to system implementers and product developers through the provision of consulting services, protocol conformance testing and the participation in trials and joint projects.

The NPSC is now in operation with seven permanent staff. The currently available services are an informative newsletter and professional consulting. In house training on a variety of data communications topics can also be provided. An OSI training course is being developed with the assistance of advisors from industry and academia, and further services, including protocol testing, will be introduced after a period of market research and development.

The NPSC is funded by grants from a number of public and private sector bodies and will derive revenue from subscriptions and fees for the various products and services. It will operate as an efficient, independent, innovative flexible and commercially oriented organisation, self funding to the maximum extent possible.

Conclusion

The OSI standards have evolved to fill a new environmental niche — multi-vendor, distributed, peer-to-peer networks and for eletronic communication, between different organisations. In this respect it is not a a direct competitor to established proprietary communications architectures.

The success of OSI shall be measured in terms of the numbers of innovative applications and services which would not have been created otherwise. The success of the NPSC shall be measured in terms of the adoption of OSI in products, systems and services developed in Australia. ●

The author is with the national Protocol Support Centre Ltd. 2/28 Albert Road, South Melbourne. The Centre has been established to help the industry keep pace with rapid overseas innovation and to avoid the creation of evolutionary curiosities for which this continent is well known.

BUILDING A VOICE SECURITY SYSTEM

There are many applications for scrambling voice communications traffic so that the unwelcome cannot eavesdrop, as a local politican or two has found to his cost. So a Victorian company spent two years developing a product that would beat the bugger, and wound up with a winner on its hands.

A. J. Anderson

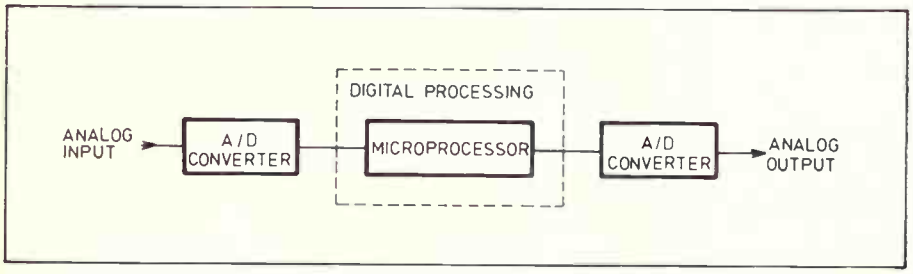


Figure 1: Basic block diagram of a digital processing system

As interception tools become more sophisticated, or at least, more readily available, the need to secure wireless conversations, and even conversations within waveguides, has grown in proportion. In 1985, the Melbourne based radio importer, Imark identified this market and began research into a new product that would take advantage of the demand.

The project commenced in mid 1986. The first several months were spent researching various scrambling techniques and addressing the relative cost and performance of each system. The main design goals were as follows —

- Low cost (less $500).
- Medium to high security (more than 10,000 codes available).
- Single +12V supply.
- Good performance in situations where large amounts of mobile flutter exists.
- Little or no degradation of the range or audio quality of the two-way system.
- Simple installation.

The first design decision to be made was to choose between analogue or digital processing. As the Digiscram had to work down an existing 3 kHz communications channel an entirely digital system was not considered practical because the data rate required would exceed the channel bandwidth. On the other hand, if completely analogue techniques were used, the complexity of the system would be enormous because many codes are required on any one channel. Obviously some compromise had to be struck between the analogue and digital approaches. The approach adopted is as used in digital signal processing systems. The basic block diagram is shown in figure 1.

The idea was to have the best of both worlds incorporated into the one system. It is possible to perform complex analogue functions while having the ability to generate code combinations by digital processing, all on one circuit board.

The next basic design decision was to decide between time domain scrambling or frequency domain scrambling or a combination of both. Time domain scrambling involves re-arranging parts of the audio signal making them occur in a different sequence on the scramblers output. Frequency domain scrambling involves re-arranging parts of the frequency spectrum of an audio signal to make input and output frequencies different. It is also possible to use both systems at the one time or in a predetermined sequence to improve the overall security. Frequency domain systems are most easily achieved using analogue techniques while time domain systems are most easily realised using digital processing. The system chosen was a time domain system which can be enhanced in the future by modifying the microprocessors software to accommodate a greater level of security.

Now that the major system decisions had been made it was time to design the hardware to implement it. The microprocessor chosen was the Z80.

It's not modern, but it is adequate, with

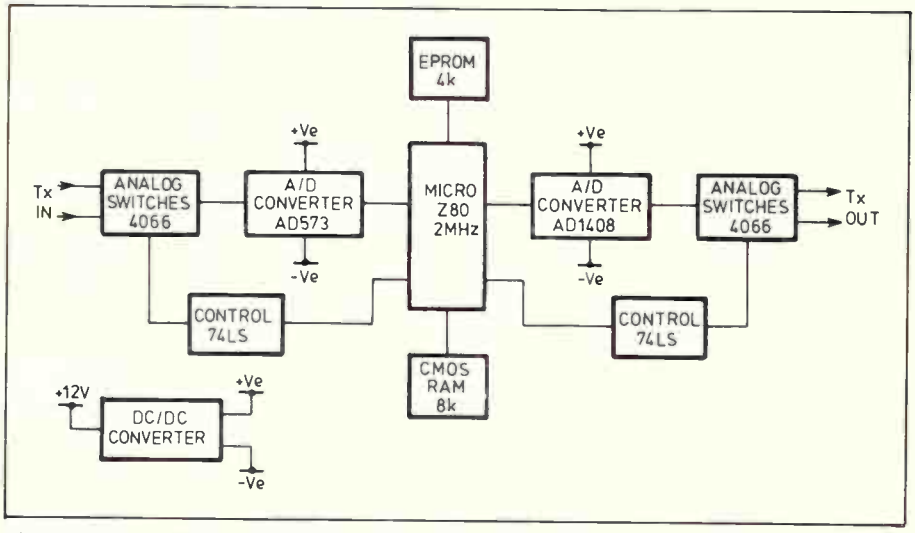


Figure 2: The block diagram of the mark one version of the voice security system.

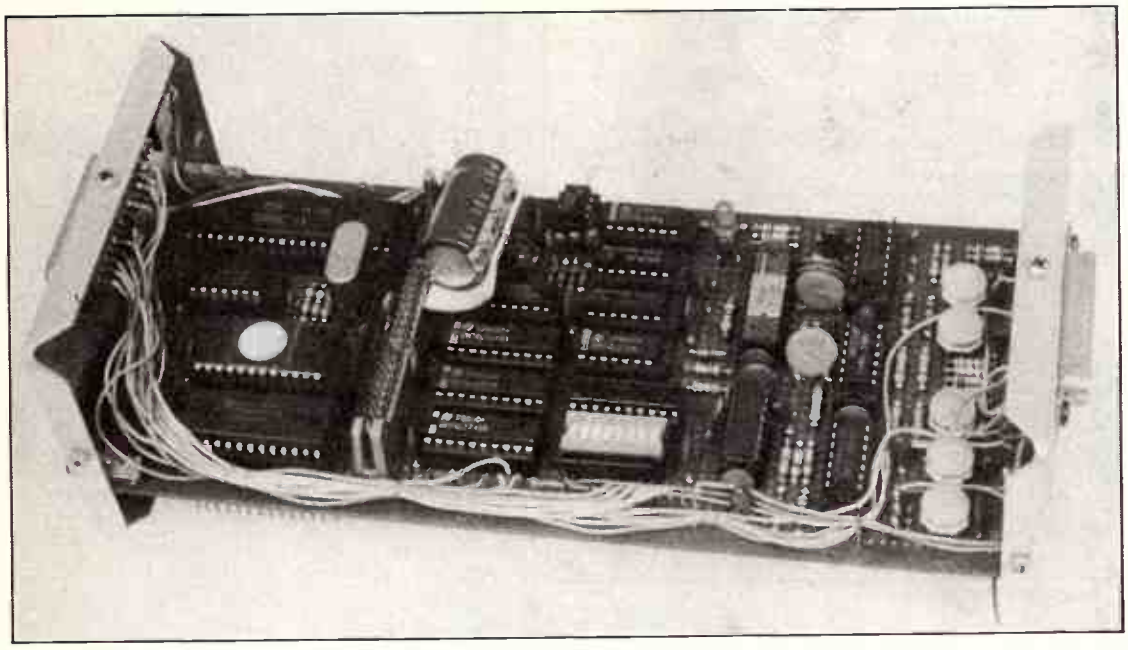
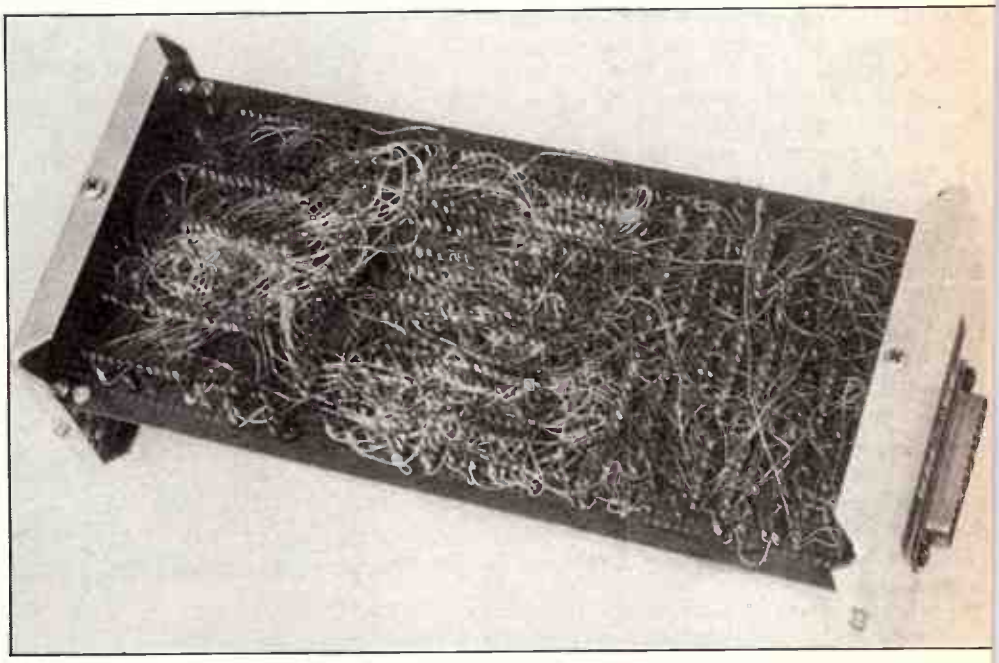


Figure 3:
Top: the prototype board of the mark one. Below is the reverse of the same board. It was constructed using wire wrap. An invitation for rats to set up shop, perhaps!



a powerful instruction set and large addressing range. Selection of the ADC and DAC was somewhat of a problem as most devices required a negative supply which would mean adding a DC/DC converter to the circuit to maintain the design goal of a single +12V supply. When the Mark 1 model was built, unfortunately, a negative supply was included as the chips used required it. They were the AD573 ADC and AD1408 DAC, both from Analogue Devices. The basic block diagram of the Mark I model is shown in figure 2.

The prototype Mark 1 board was built using wire wrap. The actual board is shown in figure 3.

As only one board existed at this stage all testing was done with the aid of a tape recorder. To test the system, audio from a microphone was fed through the system and the scrambled audio was recorded on tape. When this was completed the scrambler was switched to the receive mode and the recorded audio was played back through to a speaker and the results were recorded. Many different versions of the software were written and a practical working system was soon in use. The results were quite impressive and it seemed it would be possible to meet all the design goals easily. During the several months of testing of the Mark 1 board more advanced ADC's and DAC's became available at reasonable cost. These were the AD670 ADC and AD558 DAC, again both Analogue Devices chips. Best of all they both only required a positive supply and were actually faster than the previous chips used in the Mark 1 model. It was decided to use these new chips in a second wire wrap prototype system with an enhanced micro architecture so the system could be evaluated in real time. The Mark 2 board was built and was soon operational. It had all the features of the Mark 1 board but also included ports for text transmission and sub audible tone signalling (C.T.C.S.S.). All these features were exercised during the following months and both units (Mark 1 and 2) were interfaced to transceivers and tested on air. The results were excellent, over fixed stable conditions, but during mobile operation performance was poor due to Raleigh fading (mobile flutter).

This poor performance was due to the fact that a small burst of FSK (frequency shift keying) data was transmitted with every block of encoded audio to allow the receiver to lock or synchronize itself to the transmitter. As this occurred several times per second the receiver relied very heavily on having a continuous channel. Mobile flutter causes very sharp and narrow losses of signal on a channel so it was almost impossible for the receiver to remain locked in sync.

The decoding software was entirely rewritten to overcome this problem by locking sync only once and relying on the

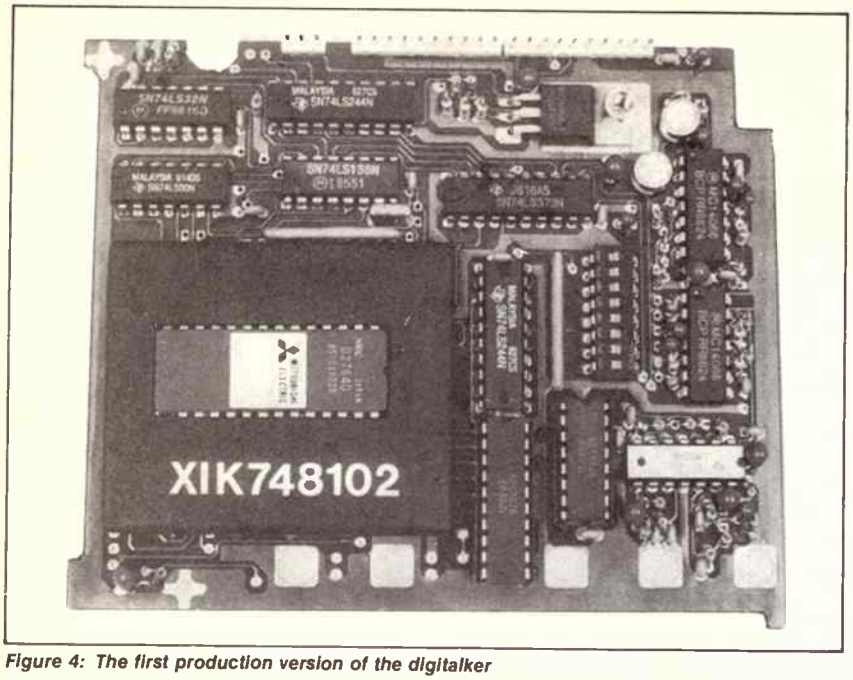
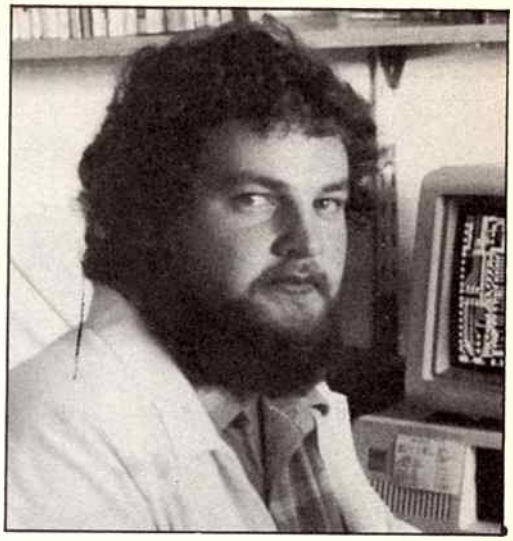


Figure 4: The first production version of the digitalker



The author with the computer aided design system used to produce the final board.

microprocessors crystal to maintain syncronism between transmitter and receiver. During this re-write the added feature of Q/B (Quiet Base) was included in the form of selective calling to enhance the systems overall performance.

A practical design was very close and design of the circuit-board was started. As a very limited amount of space was available for the board it had to be multilayer. It took three revisions of the artwork to get to a production model which is shown in figure 4. All artwork was prepared using the "Smartwork" software package run on an IBM PC. The boards were manufactured in Sydney by Printronics.

During final software development a major problem was encountered. The microprocessor was not fast enough to perform the complex decoding algorithms required by the decoder. The microprocessor was upgraded to 4 MHz and later to CMOS 4 MHz to increase speed and lower power consumption. The final prototypes were completed in February 1986. The first production run was completed in March 1986. Production was, and still is, carried out in house, at IMARK in West Melbourne and is increasing each month. All the software for the scrambler was written on a custom built real time emulator controlled by an IBM PC (also at Imark). The software was written in Z80 mnemonics and then compiled by the emulator. The completed machine code program is just under 2k long.

The story however, does not finish here. A completely new hardware design is currently on the drawing board using a custom hybrid integrated circuit to reduce size and power consumption and make the system more suitable for inclusion in other types of radio equipment. A photo of the first prototype of the new model is shown in figure 5.

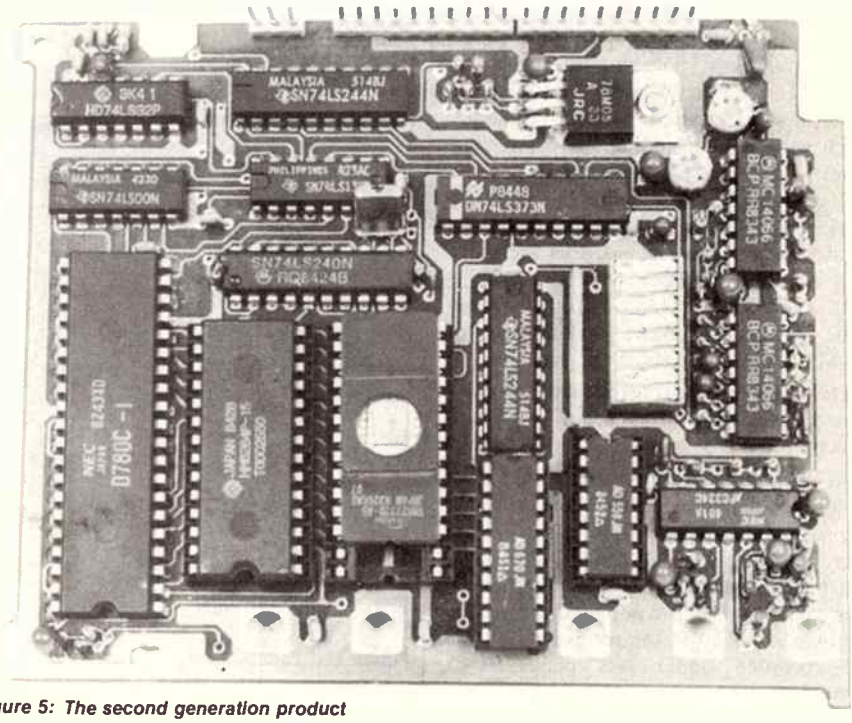


Figure 5: The second generation product

All the original design goals for the Digiscram were achieved with the production versions. In fact, the Digiscram board proved to be so powerful it has found its way into other areas and is also manufactured with modified software as a morse code identifier for use on two-way radio repeaters and as the Digilert remote alarm system. New uses for the board are also being investigated. ●

Andrew Anderson is chief engineer at Imark in Melbourne.

WHO'S WHO IN DATA COMMUNICATIONS

This list covers all the main players in the construction or distribution of data communications equipment. While we have tried to be reasonably comprehensive, note that omission from our list merely implies our data base was incomplete at the time of going to press.

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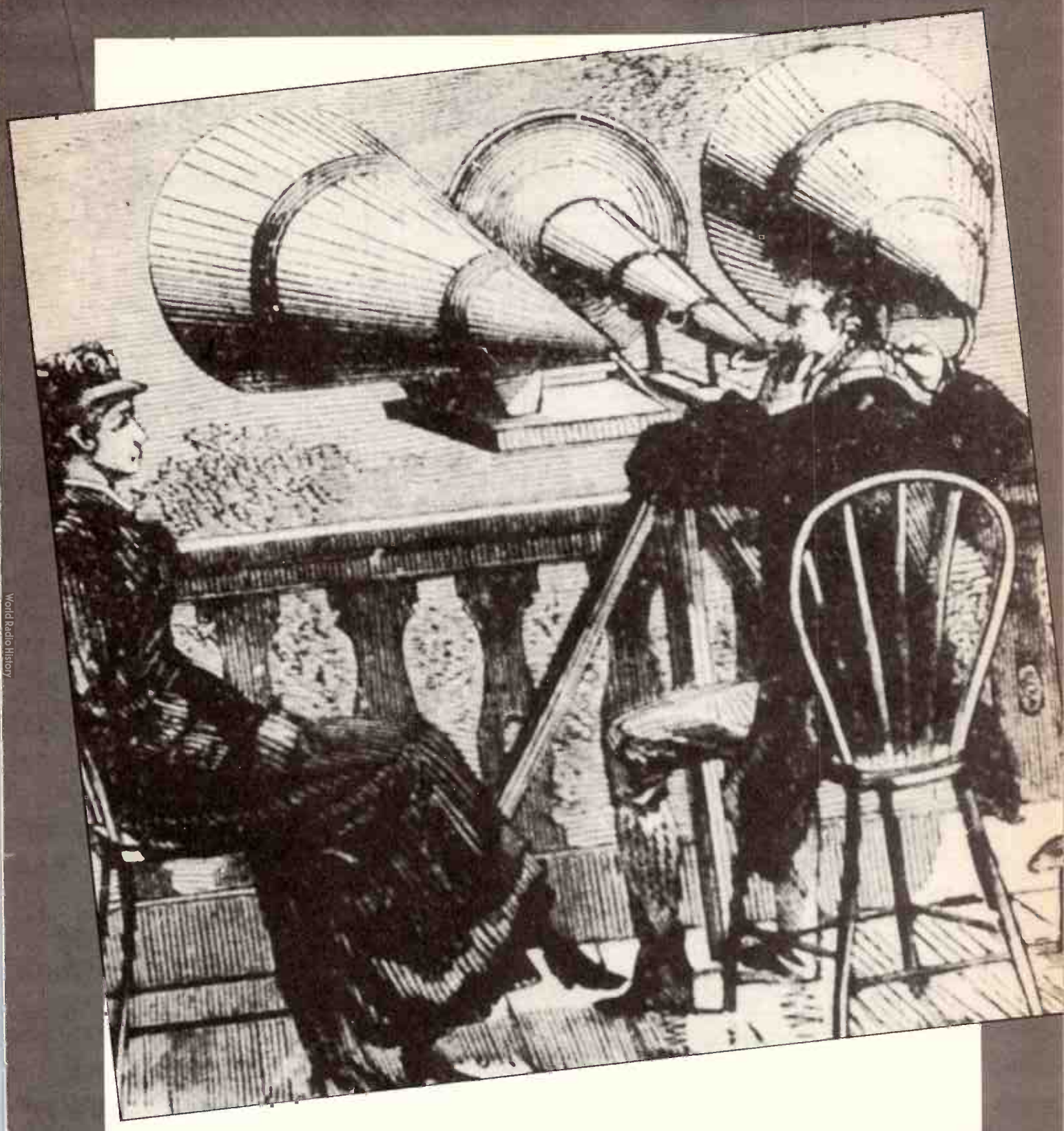
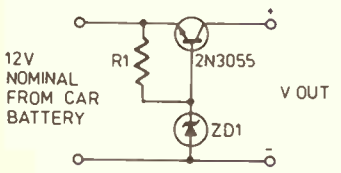


Hobbies



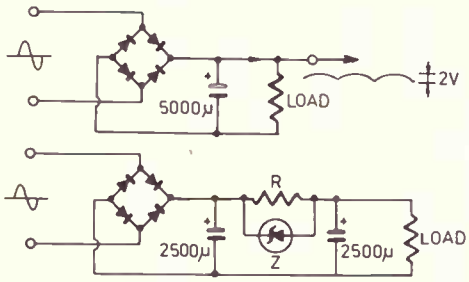
12 V — 9, 7.5, or 6 V Converter (automobile)

Many transistorised items such as radio, cassettes and other electrical items operate on batteries. usually these are in the 6-12 volt range and sockets are provided for external power supply.

This circuit enables these devices to be operated from a car's electrical supply.

The table gives values for resistors and specified diode types for different voltages. Should more than one voltage be required a switching arrangement could be incorporated. For high currents the transistor should be mounted on a heatsink.

OUTPUT VOLTAGE	9	7.5	6
R1 (½ WATT)	180Ω	270Ω	330Ω
ZENER DIODE ($\frac{250}{mW}$)	10V	8V1	6V6

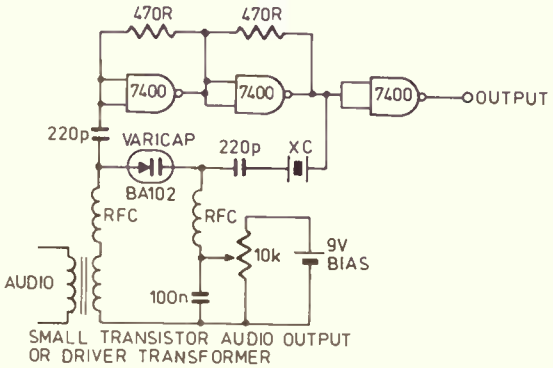


Reduced ripple at low current

In the normal circuit (Fig. 1) the ripple at 1 amp is at least 2 volts. Cheap power amps use this circuit (with low supply ripple rejection) and produce annoying amounts of hum at low signal levels.

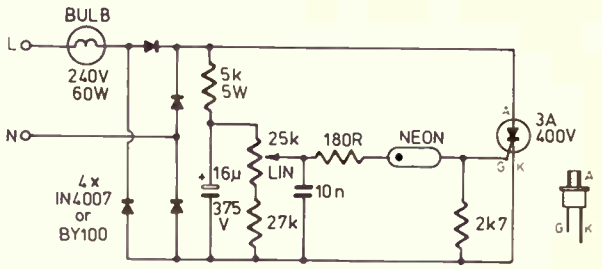
In the circuit in Fig. 2 the ripple is considerably reduced at low levels and at high currents the supply voltage is only minimally affected.

Maximmum low ripple current (1m) = Vz/R where Ptot R must be more than Vz^2/R = 1m Vz. 1M ° maximum total current so P_{tot} = 1M-1m Vz. A typical set of values for 1m = ½Amp is Vz = 3V, R = 1½ ohms.



FM modulated TTL crystal oscillator

This TTL crystal oscillator is useful for checking FM receivers or to drive multipliers-amplifiers for an FM transmitter. It will accept crystals between 1 and 18 MHz. Output level is quite high and rich in harmonics. Audio can be provided at a low level from an audio oscillator or a microphone amplifier.



Low frequency strobe

The circuit will flash the bulb at a rate between 0 and 10 Hz. Points to note are:

(i) Because all components are connected directly to the mains, do not touch whilst the unit is on.

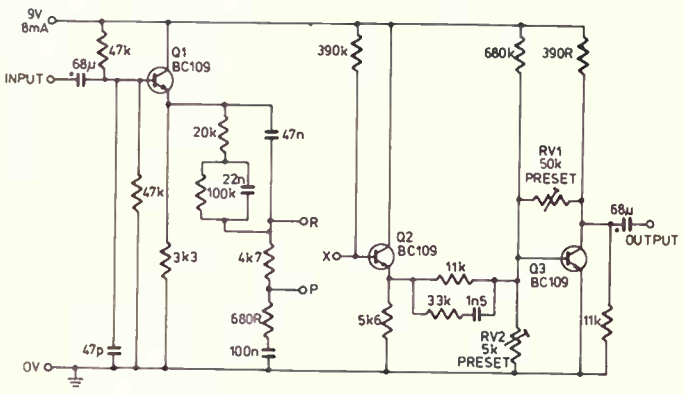
(ii) Use a television type 25 k pot with insulated spindle.

(iii) Mount in an insulated box with ventilation holes.

(iv) The 5 k resistor gets hot, hence the wattage rating.

(v) The 27 k may be altered to obtain a full range of control by the pot.

There is a risk of inducing convulsive seizures in people suffering from epilepsy if this unit is operated in their presence. Such people should avoid areas where strobe lights are used. A rate of nine flashes per second is considered the most dangerous and most people will find this unpleasant.



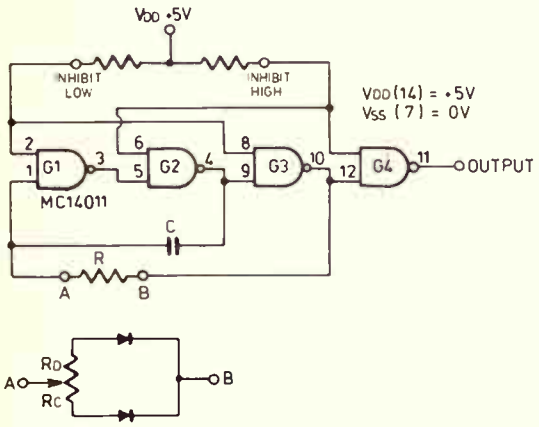
Tape hiss reduction circuit

The circuit is used to either boost or cut frequencies. When making a recording, point X is wired to point R so that treble signals are boosted by 10 dB, and then during playback, point X is wired to point P so that the signal from the tape, including the hiss, has the treble cut by an equivalent amount. The circuit values are such that the overall frequency response, from record through playback, is flat over the range 20 Hz-20 kHz. Thus the output signal after playback is identical with the input signal before recording, but the hiss is cut by 10 dB.

RV1 sets the gain of the circuit to be unity at low frequencies (<500 Hz); RV2 is adjusted so that the collector voltage of Q3 is half the positive rail voltage. When this is set, the circuit will function without distortion with an input voltage of up to 1.5 V rms.

If monitoring during recording is not required, the same circuit may be used for record and playback, with X switched between P and R as necessary. If monitoring during record is required, two circuits are needed, one with X wired to R and the other with X wired to P.

For stereo, two circuits are required.



5000 second astable

An astable multivibrator with RC network values as high as 200 MΩ and 25μF may be constructed using CMOS logic gates. A simple modification makes it possible to vary the mark-space ratio between wide limits. Mark-space ratios higher than 5000: 1 can be achieved.

Such high values of RC frequency determining components are made possible by the almost infinite input impedance of the basic CMOS gate. This high impedance places negligible loading on the RC network, a factor that normally limits the lowest frequency attainable.

As the time constant of 200 MΩ and 25μF is 5000 seconds, it can be seen that the circuit can be used to provide long time delays or an ultra low frequency pulse generator.

The gates in the astable multivibrator, shown in Fig. 1a are used as simple inverters with the second inputs being employed to provide an inhibit function. Normally these inputs, pins 2, 6, 8 and 13, are connected to the positive supply line through two resistors and are at logical 1.

Three gates form the astable G_1, G_2 and G_3, and the fourth gate, G_4, performs the function of output buffer.

Gate G_1 monitors the potential at the junction of the timing capacitor (C) and resistor (R). When this potential is below the threshold of G_1, gate 2 connects one end of C to ground and G_3 connects one end of R to V_{DD}.

The capacitor charges through R until the potential at the input of G_1 exceeds the gate's threshold. When this occurs, the output of gate 1 falls to 0, G_2 rises to 1 and G_3 falls to 0. The gates have now connected the resistor to ground and the capacitor to V_{DD}. The capacitor discharges through the resistor until G_1 again switches off. The circuit therefore oscillates at a frequency determined by C and R with a mark-space ratio close to unity.

If the circuit shown in Fig. 1b is connected between A and B in place of R, the two diodes isolate the capacitor charge and discharge paths. Variable resistors in the two paths, or the potentiometer shown, allow the mark-space ratio to be varied over a very wide range.

Grounding the inhibit inputs stops the astable from oscillating and puts the output at either 1 or 0 depending upon which inhibit input is used.

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

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

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

'Idea of the month' contest

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

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

RULES

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

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

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

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

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

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TEXAS INSTRUMENTS
TECHNOLOGY AWARD UPDATE

During 1987 Texas Instruments sponsored various final year electrical engineering projects in the fields of Digital Signal Processing, Local Area Networks, and Parallel Processing. Throughout 1988, we will be highlighting the work of some of these projects and we believe that you will be both impressed and encouraged by the high standard of work that these students have carried out.

Project: A Digital Baseband Echo Cancellation Test Set
Student: C. E. Chew
Supervisor: Dr K. K. Pang

Overview

Throughout the Australian telecommunications network, both two wire and four wire lines are widely used as tranmission channels for voice and digital data. Because of the cost of laying cable to customer premises, many short haul lines are only two wires, however, for long haul tranmissions, four wire systems are used. A hybrid, which is essentially a bridge network, is used to couple the two wire and four wire channels. In order to operate properly, the bridge must be perfectly balanced with two wire channel, however, due to the multitude of types of two wire circuits, it is not possible to ensure that the hybrid is balanced with all two wire circuits. Any imbalance causes coupling between the tranmission and reception signal paths, resulting in a leakage of transmitter power into the receiver circuit. This forms an echo which is classified as near end or far end, depending upon which hybrid causes the leakage. In this project a TMS32020 Digital Signal Processor was used to review and simulate some schemes for adaptively identifying the parameters of a leakage path through a hybrid and then cancelling the echo signal.

IN order to develop the test set a TMS32020 card which plugs into an IMB PC was used. The echol cancelling software was developed on the PC and loaded into the processor for execution. An interface between the processor and the external world was then constructed in order to complete the test set.

Various algorithms for echo cancellation were examined, however, the 'Least Mean Square' LMS algorithm was considered to provide the greatest throughout for a given amount of computing power. The canceller has tranversal (tapped delay line) filter structure, and a stochastic cost function. The convergence time is typically in the order of several thousand interations.

The test set generates an AMI line coded signal from an external Pseudo Random Binary Sequence (PRBS) generator. A resistive 120 ohm hybrid connects the test set to an external tranmission line. A receiver circuit with a bandpass filter detects signals from the hybrid and feeds them to a 12 bit ADC circuit. A TMS32020 DSP samples both the received and transmitted signal with the output observable after passing the signal through a DAC.

A working system has been constructed and tested.

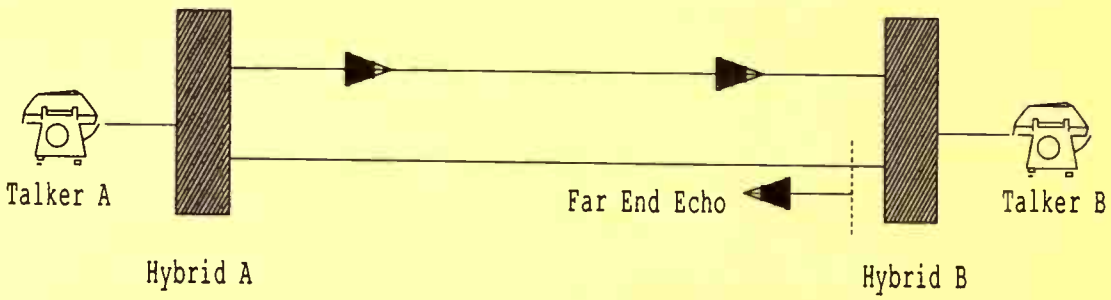

Diagram of Telephone Network Scenario

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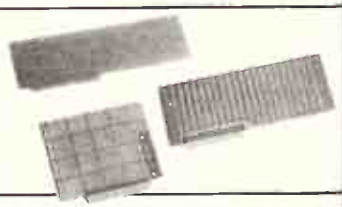

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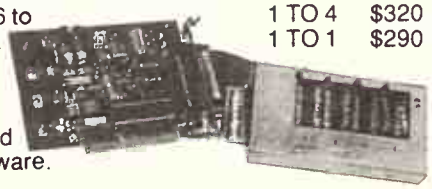

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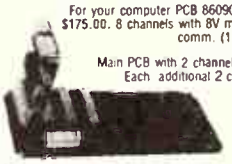

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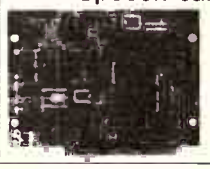

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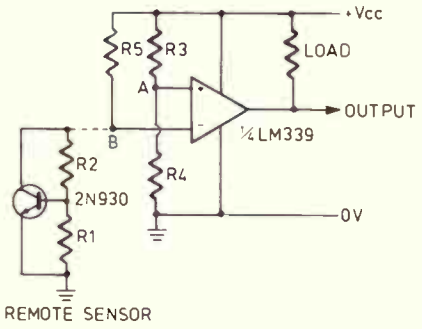


Remote temperature sensor

The circuit shows a temperature sensing device which can be used to indicate at a remote point when the temperature passes through a certain value or to give an alarm when this occurs.

The sensing unit itself contains a 2N930 transistor. The base-emitter voltage of this device appears across R1 and (as the base current is far less than the collector current) the voltage at the upper end of R2 will be the emitter-base volume multiplied by (R2+R1)/R1. The base-emitter voltage changes with a temperature coefficient of −2.2 mV/°C and this change is multiplied by the same factor before being applied to the LM339 circuit.

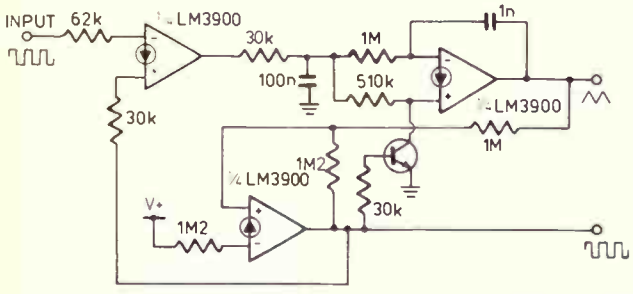
The potential at point A is set by the resistors R3 and R4. As the temperature of the sensor transistor rises, the voltage at point B falls. At the time this voltage falls below that at point A, the output of the LM339 voltage comparator will go 'high'. If, however, the input connections to the LM339 are reversed, the output will go 'low' when the temperature of the sensor falls below the preset point.

The LM339 contains four separate voltage comparators in one package; only one of these comparators is used in the circuit shown. The other three comparators could be used with another three temperature sensing transistors so that an indication is given when the temperature passes through three other preset values.

The value of R5 should be chosen so that the current passing through the remote sensor unit is about 10μA. If the temperature range over which operation is required is narrow, the ratio R2/R1 may be large so that the system is very sensitive to small temperature variations. A potentiometer may be substituted for R3 and R4 so that the temperature at which the comparator switches is variable. The voltage at point B is highly linear over a very wide temperature range (about −65°C to +150°C) and therefore the potentiometer which replaces R3 and R4 can be given a linear calibration.

A feedback resistor may be connected from the output to the non-inverting input to provide a small amount of hysteresis (so that the temperature at which the output changes when the temperature is rising is different from that when it is falling); one then has the basis of a thermostat.

The output current has a maximum value of about 15 mA.



Economical phase locked loop

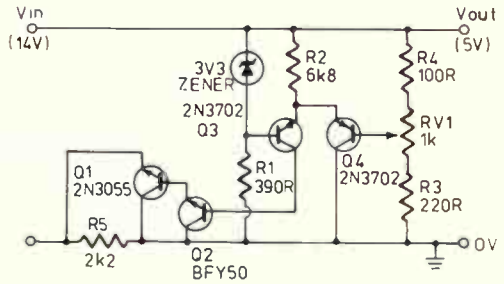
Integrated circuits which have been specially designed as complete phase locked loops are available, but many of them tend to be rather expensive devices. The circuit shows how the economical LM3900N integrated circuit can be used to build a phase locked loop which has a centre frequency of about 3kHz.

The LM3900N contains four current differencing amplifiers in a single 14 pin dual-in-line package. Only three of these amplifiers are used in the circuit shown, so the fourth amplifier is available for other purposes. The special circuit symbol shown is used for the amplifiers in the device, since they are not a conventional type of operational amplifier.

If desired, the locking range of this phase locked loop may be increased by employing the fourth amplifier in the LM3900N in the input circuit to increase the signal amplitude.

Voltage regulator and electronic fuse

This circuit offers several useful features compared to more basic designs. Among them are the facts that current cut-off is achieved, it is self-resetting once that overload is removed and it is an efficient voltage regulator. Choose V_Z to be about 2/3 V_{out} and R_1 to supply enough current for stabilization of the Zener voltage. Choose R_2, which determines the cut-off current, I_{max} such that $I_{max}\ R_2 = (V_Z - 0.5) \times (\beta Q1 + Q2)$ and the values of R_3, RV_1. Choose R_4 so that the base of Q4 is at the same voltage as the base of Q3 and a large current (100 times) passes down the resistor chain compared to the base current of Q4 which is $(V_Z - 0.5)/R_2\beta Q4$. Altering RV1 gives fine control over V_{out} R5 (200 ohms to 2k2) allows switch-on under no load conditions. Component values are given for a 5 V supply with a 2A cut-out. For low current applications, Q1 can be a BFY50 with Q2 omitted.



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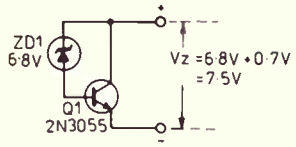


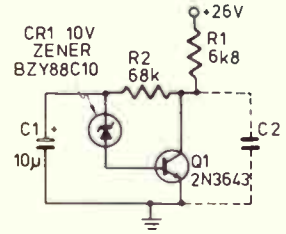
Increasing power rating of zener diodes

There are occasions when a higher power Zener diode is required and one is not readily available. Here is a circuit which with the aid of a power transistor can increase the power rating of any Zener diode.

By simply shunting the base-collector junction of the transistor by a low power Zener and if the gain of the transistor at the operating current exceeds 30, then across the collector-emitter terminals the device will behave as a Zener diode.

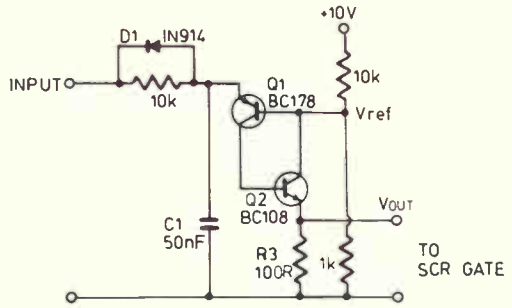
If the original diode is a 250 mW device then the power dissipation of the system will be 30 x 250 mW = 7.5 watts. It should be noted that the Zener voltage thus obtained will be 0.7 V higher than the diode rating.

Thus if originally a 6.8 V diode was used then the new voltage will be 6.8 V + 0.7 V = 7.5 V. Thus for a power of 7.5W, the maximum permissible current willb e 7.5 W/7.5 V = 1A.



Noise generator

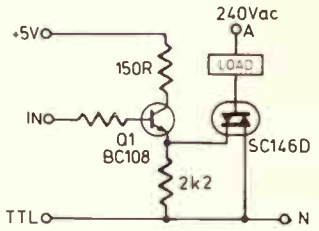
In this circuit the Zener diode, as well as providing a source of noise, stabilizes the amplifier transistor collector operating point. The gain of the transistor is about 75 and the noise output of the circuit is about 15 volts. Capacitor C2 may be added to filter out high frequency noise — in which case the output drops. For example with C2 = 0.1µF, the output falls to 0.5 volt.



Noise rejecting scr trigger

When switching inductive loads, unreliable triggering is sometimes encountered due to feedback of switching transients.

The circuit shown overcomes this problem by using an integrator together with a voltage comparator to eliminate transients. Data pulses should be of 8 volt amplitude and 0.5 millisecond duration. Discrimination against noise pulses will depend on their energy content. For example a 70 volt 10 microsecond wide pulse will not cause triggering, but a 100 microsecond pulse must not exceed 20 volts amplitude.



TTL-mains interface

Here is a useful circuit for driven mains operated devices direct from TTL logic circuits. Although it works well, it has the inconvenience that the neutral line is connected to circuit ground.

For inputs other than TTL levels a 10k series resitor may need to be connected between Q1 base and ground to reduce leakage.

Approximately 1mA at 1.4 volts is required to switch Q1 on. If driving from a low impedance, some means of current limiting will also be required.

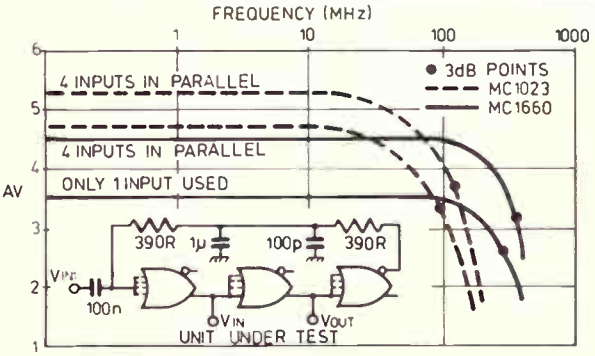


Figure 1

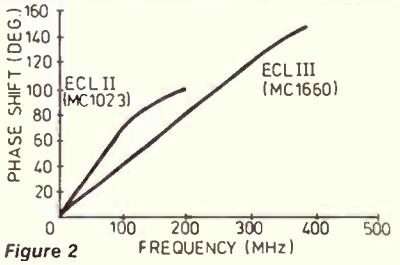


Figure 2

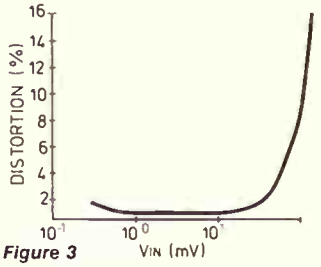


Figure 3

Wideband amplifiers

It is not commonly known that some digital ICs can be used in the linear mode to obtain performance equal, or superior, to some more conventional components.

A typical example is the use of a MECL logic gate as a wideband amplifier. Such an amplifier based on the Motorola MC 1023 of the MECL 2 family provides a gain of 5.2 over a frequency range from zero to 125 MHz (at the 3 dB points). A still wider bandwidth of zero to 350 MHz may be obtained by using the MC 1660 from the MECL 3 family.

The method used to bias MECL gates for linear operation is shown in the inset of Fig. 1. The NOR output is connected back to the input. This can be done over one, or over several, gates. The external 'self-biasing' network feeds back only the dc component of the output signal. Therefore the dc input current is furnished by the output of the same gate. Assuming that the voltage drop across the biasing resistors is small, the input and output voltages are identical. This is only possible in the centre of the gates' transition region. The main advantage of this very simple biasing method is that the circuit automatically compensates for all offset and bias voltage variations. In addition, the method is very economical, especially when a cascade arrangement of gates is needed.

The response depends on how many inputs are connected in parallel, there is a disadvantage however in connecting several inputs together to increase gains. The offset voltage between input and output increases with the number of inputs that are paralleled. It therefore depends on the individual application, if a slightly higher offset voltage can be tolerated then a higher gain can be achieved.

Fig. 2 shows the phase shift curves for the two gates and Fig. 3 is a plot of distortion against input voltage.

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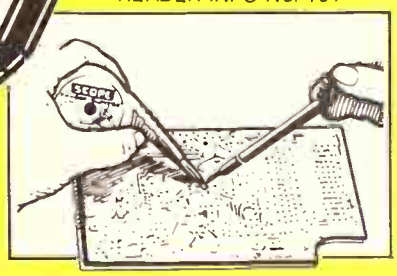

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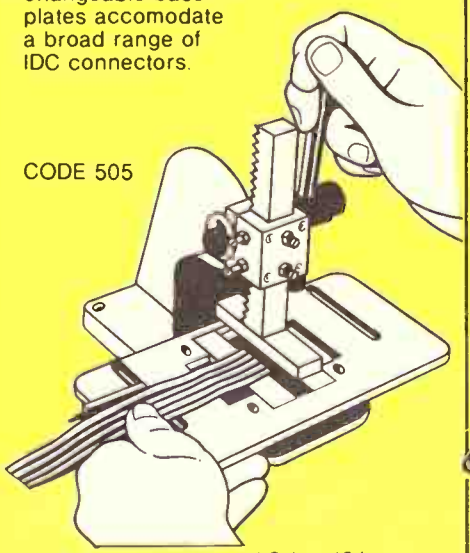

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READER INFO No. 106

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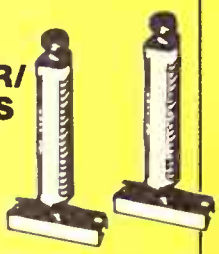
CODES SIT8, SIT1416, SIT 1820, SIT 2428, SIT 3640, SIT 22
READER INFO No. 105



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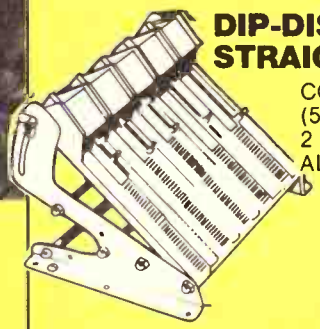

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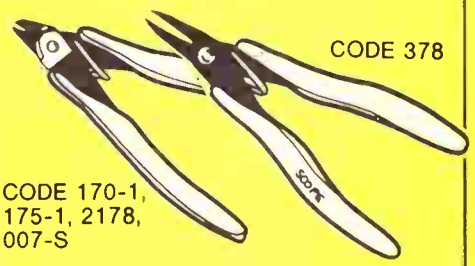

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```
100 REM ****************************
110 REM NAME   LORES DRAWING WITH
120 REM        PRINTER DUMP
130 REM BY     JOHN AVIS
140 REM DATE   26/7/87
150 REM ****************************
160 DF=CHR$(18)+"  "+CHR$(146)+" M$="■" LF=" "
170 X=0:Y=1 D=11 M=12 L=15 S=0
180 POKE650,128
200 REM ************
210 REM SET SCREEN
220 POKE53280,0:POKE53281,0:PRINT"□"
230 FORA=1DO4100TO222:POKEA,160
240 POKEA+54272,C:NEXTA
270 GOTO600
300 REM **************
310 REM MAIN PROGRAM
320 I=15:A$="":GETA$
330 I=PEEK(56320)AND15:F=PEEK(56320)AND16
340 POKE1024+X+40*Y,171
345 IFA$="■"THENPRINT"■■■MODE CLEAR     " GOTO320
347 IFA$="■"THENGOTO1000
350 IFA$="■"THENC=D:GOTO600
360 IFA$="■"THENC=M:GOTO600
370 IFA$="■"THENC=L:GOTO600
380 IFA$="■"ORF=0THENGOSUB540
390 IFA$="■"ORJ=14THENGOSUB440:Y=Y-1:GOTO470
400 IFA$="■"ORJ=13THENGOSUB440:Y=Y+1:GOTO470
410 IFA$="■"ORJ=11THENGOSUB440:X=X-1:GOTO470
420 IFA$="■"ORJ=7THENGOSUB440:X=X+1:GOTO470
430 GOTO320
440 REM **************
450 REM CLEAR CURSOR
460 POKE1024+X+40*Y,160:RETURN
470 REM ************
480 REM MOVE CURSOR
490 IFY=1THENY=24
500 IFY=25THENY=2
510 IFX=0THENX=39
520 IFX=40THENX=0
530 GOTO320
540 REM ****
550 REM DRAW
560 POKE55296+X+40*Y,C:RETURN
570 REM ************
580 REM PRINT SHADE
590 IFC=DTHENPRINT"■■■MODE CREATE                    SHADE DARK   "
600 IFC=MTHENPRINT"■■■MODE CREATE                    SHADE MEDIUM "
610 IFC=LTHENPRINT"■■■MODE CRUSE                     SHADE LIGHT  "
620 GOTO320
1000 REM **************
1010 REM PRINTER DUMP
1020 PRINT"■■■MODE PRINT    " OPEN1,4,5:F$=CHR$(8):D$=CHR$(15)+
1030 FORA=1TO24:PRINT#1,D$;  FORB=0TO79
1040 C=PEEK(55296+B+40*A):AND15
1050 IFC=1THENPRINT#1,CHR$(18);D$;CHR$(146);
1060 IFC=2THENPRINT#1,M$;
1070 IFC=5THENPRINT#1,L$;
1080 IFC=8THENPRINT#1,F$;
1090 NEXTB:PRINT#1:CLOSE1:GOSUB600:GOTO320
```

PENDY.

Low res drawing (with printer dump)

This is a low resolution drawing program with a printer dump. Drawings can be done in three shades of black by using a joystick in port two or the cursor keys and F7 or the firebutton to plot a point.

At the top of the screen there is a status line which indicates the current mode and shade. To clear your drawing press F2, and to print it out use F4. The program was designed for an MPS-803 printer but others may be used with a bit of adaption. To select a shade of black, use one of the following keys:

F1 — Dark,
F3 — Medium,
or, F5 — Light, which is also used to erase.

J. Avis
Frenchs Forest
NSW

```
@0100 REM BUDGET v 2.00 : b  Don Barnie  1987
@0110 REM initialisation for entries
@0120 DIM C#(50) , C1(50), C2(50), C3(50), C4(50), C5(50), C6(50),C7(50), S1(50),
 B1(50), D1(50), W1(50), N@(10)
@0130 STR$(3000):Rem:A=0:DIM Z$(50):Z$=" "+@$+@$+Z$:Z$=Z$+
@0140 Y$="Car Registration ..............":Z$="Car Maintenance ..............":
Y2$="Car Insurance ..............":Z$=Z$+"Car Taxes ..............":
@0150 Y4$="Life Assurance (Dom) ..............":Z$=Z$+"Petrol ..............":
Y6$="Electricity ..............":Z$=Z$+"Telephone ..............":
@0160 Z0$="Savings Balance ..............":Z1$="TOTAL BALANCE ..............":
Z2$="Bank Transfer Westpac ..............":Z3$="Bank Transfer M.P.B.S. ..............":
@0170 Z4$="Rent ..............":
@0180 X0$=" Car Registration ":X1$=" Car Maintenance ":X2$=" Car Insurance ":X3$
=" Car Taxes "
@0190 Y4$=" Life Assurance (Dom) ":Z$=" Petrol ":Z6$=" Electricity ":Z7$=" Tele
phone "
@0200 W7$=" Savings "
@0210 REM ***** Main Menu *****
@0220 IF R=50 THEN GOSUB 2300
@0230 REM ----- Recalculate Total -----
@0240 B1(R)=C0(R)+C1(R)+C2(R)+C3(R)+C4(R)+C5(R)+C6(R)+C7(R)+S1(R)
@0250 CLS:CURS14:INVERSE:PRINT" BUDGET MAIN MENU     Date "Z6$:" ":NORMAL
@0260 PRINT\,,"1","Load Data"\,,"2","Save Data"
@0270 PRINT\,,"3","Deposit"\,,"4","Withdraw"
@0280 PRINT,, "5","Change deductions"\,,"6","Transfer"
@0290 PRINT\,,"7","Display Totals on Screen"
@0300 PRINT,, "8","Print Statement"
@0310 PRINT,, "9","Set Date (dd/mm/yy)"
@0320 PRINT,, "ESC","Exit Program"
@0330 K7$=""
@0340 K7$=KEY:IF K7$="" THEN 340
@0350 IF K7$=CHR(27) THEN 400
@0360 T=INT(VAL(K7$)):IF T < 1 OR T>9 THEN 330
@0370 ON T GOSUB 450, 570, 680, 960, 1140, 1330, 1560, 1610, 1730
@0380 GOTO 220
@0390 REM ***** exit program *****
@0400 IF A > 0 THEN CLS:SYSTEM
@0410 INPUT"You have altered data.  Do you want to save changes";K7$
@0420 IF K7$(1,1)="N" OR K7$(1,1)="n" THEN CLS:SYSTEM ELSE GOSUB 570
@0430 GOTO 220
@0440 REM ***** Load Data *****
@0450 CLS:CURS475:INVERSE:PRINT" Loading ":NORMAL
@0460 CLOSE 6:OPEN "I",6,"BUDGET.ACT"
@0470 INPUT#6 ON:OUT#0:OUT#0 OFF
@0480 INPUT I
@0490 FOR R=0 TO I
@0500 INPUT #6,C0(R),C1(R),C2(R),C3(R),C4(R),C5(R),C6(R),C7(R),S1(R),B1(R),D
1(R),W1(R)
@0510 NEXT R
@0520 INPUT N@(0),N@(1),N@(2),N@(3),N@(4),N@(5),N@(6),N@(7),N@(8),N@(9),N@(10)
@0530 IN#0:OUT#0:CLOSE 6
@0540 M@=N@(0):M1=N@(1):M2=N@(2):M3=N@(3):M4=N@(4):M5=N@(5):M6=N@(6):M7=N@(7):P0
=N@(8):P1=N@(9):P2=N@(10)
@0550 Z6$=Z5$(R):PLAY 9:RETURN
@0560 REM ***** Save Routine *****
@0570 A=0:CLS:CURS475:INVERSE:PRINT" Saving ":NORMAL
@0580 OPEN "O",6,"BUDGET.ACT"
@0590 OUT#6
@0600 PRINT R
@0610 FOR I=0 TO R
@0620 PRINT Z5$(I)",",C0(I)",",C1(I)",",C2(I)",",C3(I)",",C4(I)",",C5(I)",
",C6(I)",",C7(I)",",S1(I)",",B1(I)",",D1(I)",",W1(I)
@0630 NEXT I
@0640 PRINT N@(0)",",N@(1)",",N@(2)",",N@(3)",",N@(4)",",N@(5)",",N@(6)",",
N@(7)",",N@(8)",",N@(9)",",N@(10)
@0650 OUT#0:CLOSE 6
@0660 PLAY 9:RETURN
@0670 REM ***** Deposit Routine *****
@0680 CLS
@0690 CURS24:INVERSE:PRINT" Deposit to Account ":NORMAL
@0700 GOSUB 2260:PRINT,,"Paid to be distributed .....Type F"
@0710 GOSUB 1860:PRINT,,,:INVERSE:PRINT" Select number to Deposit ":NORMAL
@0720 K7$=""
@0730 K7$=KEY:IF K7$="" THEN 730
@0740 IF K7$=CHR(27) THEN RETURN
@0750 IF K7$<CHR(48) THEN 720
@0760 A=1:R=R+1:GOSUB 2210
@0770 IF K7$="F" OR K7$="f" THEN 780 ELSE 870
@0780 CURS811:INVERSE:PRINT" Enter @ ":NORMAL
@0790 CURS897:PRINT(A60 32)
@0800 CURS913:INVERSE:PRINT" Enter Net PAY ":NORMAL:INPUT#1
@0810 IF T1=0 : A=0:R=R-1:RETURN
@0820 IF T1 M@+M1+M2+M3+M4+M5+M6+M7+F0+P1+P2:P=R-1:A=0:CURS897:INVERSE:PRINT" Am
ount is to small to distribute"   Returning to Main Menu ":PLAY 0,30:RETURN
@0830 D1(R)=T1
@0840 C1(P)=S1(R)+T1-M0-M1-M2-M3-M4-M5-M6-M7-P0-P1-P2
@0850 C0(P)=C0(R)+M0:C1(P)=C1(R)+M1:C2(P)=C2(R)+M2:C3(R)=C3(P)+M3:C4(R)=C4(R)+M4
:C5(P)=C5(P)+M5:C6(P)=C6(P)+M6:C7(P)=C7(P)+M7
@0860 "RETURN
@0870 IF K7$=CHR$(  THEN 72
@0880 A=INT(VAL(K7$)):IF   =0 THEN 720
@0890 CURS897:PRINT(A60 32)
@0900 CURS811:INVERSE:PRINT" Enter @ ":NORMAL
@0910 CURS PO:PRINT,"Enter Amount for ":GOSUP 1870:INPUT#1
@0920 IF T1=0 : A=0:R=R-1:RETURN
@0930 D1(R)=T1
@0940 GOSUB 2100:RETURN
@0950 REM ***** Withdraw Routine *****
@0960 CLS
@0970 CURS20:INVERSE:PRINT"
@0980 GOSUB 2260:GOSUB 1860
@0990 PRINT\,,,:INVERSE:PRINT" Select number to Withdraw ":NORMAL
@1000 K7$=""
@1010 K7$=KEY:IF K7$="" THEN 1010
@1020 IF K7$=CHR(27) THEN RETURN
@1030 IF K7$<CHR(48) OR K7$>CHR(57) THEN 1000
@1040 A=1:R=R+1:GOSUB 2210
@1050 Z=INT(VAL(K7$)):IF Z=0 THEN 1000
@1060 CURS747:INVERSE:PRINT" Enter @ ":NORMAL
@1070 CURS834:PRINT(A60 32)
@1080 X=Z
@1090 CURS832:PRINT,"Enter Amount from ":GOSUB 1870:INPUT#1
@1100 IF T1=0 : A=0:R=R-1:RETURN
@1110 W1(R)=T1
@1120 GOSUB 1990:RETURN
@1130 REM ***** Alter Deduction Amounts *****
@1140 CLS:CURS2:INVERSE:PRINT" AMOUNTS ":NORMAL:CURS20:INVERSE:PRINT" Alter Dedu
ction Amounts ":NORMAL
@1150 D@=M0+M1+M2+M3+M4+M5+M6+M7+P0+P1+P2
@1160 PRINT\{F10.2 M0},Y0$+"Type 0"\{F10.2 M1},Y1$+"Type 1"\{F10.2 M2},Y2$+"Type
 2"\{F10.2 M3},Y3$+"Type 3"\{F10.2 M4},Y4$+"Type 4"\{F10.2 M5},Y5$+"Type 5"
@1170 PRINT {F10.2 M6},Y6$+"Type 6"\{F10.2 M7},Y7$+"Type 7"\{F10.2 P0},Z2$+"Type
 8"\{F10.2 P1},Z3$+"Type 9"\{F10.2 P2},Z4$+"Type R"
@1180 GOSUB 1860
@1190 PRINT{F10.2 D@},"Total Deductions"
@1200 K7$=""
@1210 K7$=KEY:IF K7$="" THEN 1210
@1220 IF K7$=CHR(27) THEN RETURN
@1230 IF K7$="R" OR K7$="r" THEN 1240 ELSE 1260
@1240 PRINT"Enter new amount of deduction for Rent"1
@1250 Y=10:GOTO 1290
@1260 IF K7$<CHR(48) OR K7$>CHR(57) THEN 1200
@1270 X=INT(VAL(K7$)):IF   =0 THEN 1200
@1280 PRINT"Enter new amount of deduction for ":GOSUB 1870:INPUT N@(X):GOTO 13
00
@1290 INPUT N@(X):
@1300 M0=N@(0):M1=N@(1):M2=N@(2):M3=N@(3):M4=N@(4):M5=N@(5):M6=N@(6):M7=N@(7):P0
=N@(8):P1=N@(9):P2=N@(10)
@1310 A=1:GOTO 1140
@1320 REM ***** Transfer Routine *****
@1330 GOSUB 2250:GOSUB 1860
@1340 PRINT\,,,:INVERSE:PRINT" Enter number to TRANSFER from. ":NORMAL
```

```
01350 K?$=""
01360 K?$=KEY:IF K?$="" THEN 1360
01370 IF K?$<CHR$(27) THEN RETURN
01380 IF K?$<CHR$(48) OR K?$>CHR$(57) THEN 1350
01390 X=INT(VAL(K?$)):IF X<0 THEN 1350
01400 A=1:R=R+1:GOSUB 2210:GOSUB 2250
01410 PRINT\\,,:INVERSE:PRINT" Enter number to TRANSFER to. ":NORMAL
01420 K?$=""
01430 K?$=KEY:IF K?$="" THEN 1430
01440 IF K?$<CHR$(48) OR K?$>CHR$(57) THEN 1420
01450 Y=INT(VAL(K?$)):IF Y>8 THEN 1420
01460 CLS:CURS20:INVERSE:PRINT" Transfer within Account ":NORMAL
01470 PRINT\\,,"Transfer from ";
01480 GOSUB 1870:Z=X:Y=Y
01490 PRINT\\,,"Transfer  to  ";
01500 GOSUB 1870
01510 PRINT\\\\,,"Enter AMOUNT to transfer ";
01520 INPUT T1
01530 IF T1=0 : R=R-1:RETURN
01540 GOSUB 1990:GOSUB 2100:RETURN
01550 REM ***** Screen Display *****
01560 CLS:CURS12:INVERSE:PRINT" PRESENT BALANCE OF ACCOUNTS ":NORMAL:PRINT
01570 PRINT,Y0$+(F10.2 C0(R))\,,Y1$+(F10.2 C1(R))\,Y2$+(F10.2 C2(R))\,Y3$+(F10.2
C3(R))\,Y4$+(F10.2 C4(R))\,Y5$+(F10.2 C5(R))\,Y6$+(F10.2 C6(R))\,Y7$+(F10.2 C7(R
))
01580 PRINT,,Z0$+(F10.2 S1(R))\,(A20 32)(A10 45) ,Z1$+(F10.2 B1(R)) ,(A20 32)(A10
 61)
01590 GOSUB 1330:RETURN
01600 REM ***** Print Statement *****
01610 CLS:REM * Add more here if required
01620 OUTL#1
01630 CLS:PRINT"Printing.....";
01640 LPRINT"BUDGET ACCOUNTS  v 2.10 : Statement"
01650 LPRINT CHR$(15)
01660 LPRINT CHR$(27)"U";CHR$(1)
01670 LPRINT"  Date      Deposit  Withdrawl  Car Rego  Car Hire  Car Ins  Car Ty
es  Don Assur  Petrol     Power     Phone     Savings   Balance"
01680 FOR I=1 TO R
01690 LPRINT Z5$(I);(F10.2 D1(I));(F10.2 W1(I));(F10.2 C0(I));(F10.2 C1(I));(F10.2 C
2(I));(F10.2 C3(I));(F10.2 C4(I));(F10.2 C5(I));(F10.2 C6(I));(F10.2 C7(I));(F10.2 S1(
I));(F10.2 B1(I))
01700 NEXT I
01710 LPRINT CHR$(18);CHR$(27);"U";CHR$(0):RETURN
01720 REM **** Date Routine ****
01730 CLS:CURS465:PRINT"Enter Date of ";D$;" Trans.":CURS 1 0
01740 PRINT" ":Z6$="":FOR I = 1 TO  FOR J=1 TO 2
01750 Z7$=KEY:IF Z7$<"0" OR Z7$>"9" THEN
01760 PRINT Z7$;:Z6$=Z6$+Z7$:NEXT J
01770 IF I=3 THEN Z6$=Z6$+"/":PRINT"/";
01780 NEXT I
01790 D=INT(VAL(Z6$)):M=INT(VAL(
0800 IF D>31 AND D<32 AND M=  UNE H 13:RETURN
0810 CURS960:PRINT"INVALID DATE":PLAY0,0,1:GOTO
01820 REM ***** An  Key Option *****
01830 PRINT"Press any key to return to menu.";
01840 K?$=""
01850 K?$=KEY:IF K?$="" THEN 1850 ELSE RETURN
01860 PRINT,,"RETURN to main menu ..........\ESC.":RETURN
01870 INVERSE:IF X=0 THEN PRINT X0$;
01880 REM ***** INVERSE Items *****
01890 IF V=1 THEN PRINT X1$;
01900 IF V=2 THEN PRINT X2$;
01910 IF V=3 THEN PRINT X3$;
01920 IF V=4 THEN PRINT X4$;
01930 IF V=5 THEN PRINT X5$;
01940 IF V=6 THEN PRINT X6$;
01950 IF V=7 THEN PRINT X7$;
01960 IF V=8 THEN PRINT W7$;
01970 NORMAL:RETURN
01980 REM ***** Subtract Routine *****
01990 IF Z=0 : C0(R)=C0(R)-T1
02000 IF Z=1 : C1(R)=C1(R)-T1
02010 IF Z=2 : C2(R)=C2(R)-T1
02020 IF Z=3 : C3(R)=C3(R)-T1
02030 IF Z=4 : C4(R)=C4(R)-T1
02040 IF Z=5 : C5(R)=C5(R)-T1
02050 IF Z=6 : C6(R)=C6(R)-T1
02060 IF Z=7 : C7(R)=C7(R)-T1
02070 IF Z=8 : S1(R)=S1(R)-T1
02080 RETURN
02090 REM ***** Add Routine *****
02100 IF V=0 : C0(R)=C0(R)+T1
02110 IF V=1 : C1(R)=C1(R)+T1
02120 IF V=2 : C2(R)=C2(R)+T1
02130 IF V=3 : C3(R)=C3(R)+T1
02140 IF V=4 : C4(R)=C4(R)+T1
02150 IF V=5 : C5(R)=C5(R)+T1
02160 IF V=6 : C6(R)=C6(R)+T1
02170 IF V=7 : C7(R)=C7(R)+T1
02180 IF V=8 : S1(R)=S1(R)+T1
02190 RETURN
02200 REM ***** Copy previous RECORD to new one ready for update *****
02210 Z5$(R)=Z6$:C0(R)=C0(R-1):C1(R)=C1(R-1):C2(R)=C2(R-1):C3(R)=C3(R-1):C4(R)=C
4(R-1) ,
02220 C5(R)=C5(R-1):C6(R)=C6(R-1):C7(R)=C7(R-1):S1(R)=S1(R-1)
02230 RETURN
02240 REM ***** Screen Options *****
02250 CLS:CURS20:INVERSE:PRINT" Transfer within Account ":NORMAL
02260 PRINT\\F10.2 C0(R)),Y0$+"Type 0"\(F10.2 C1(R)),Y1$+"Type 1"\(F10.2 C2(R)),
Y2$+"Type 2"\(F10.2 C3(R)),Y3$+"Type 3"\(F10.2 C4(R)),Y4$+"Type 4"\(F10.2 C5(R))
,Y5$+"Type 5"
02270 PRINT (F10.2 C6(R)),Y6$+"Type 6"\(F10.2 C7(R)),Y7$+"Type 7"\(F10.2 S1(R)),
Z0$+"Type 8"
02280 RETURN
02290 REM ***** Erase old data and start new with last record of old *****
02300 CLS:CURS25:INVERSE:PRINT" WARNING ":NORMAL
02310 PRINT\"You now have 50 records in this file.  You have two Options:"
02320 PRINT\\,"1.","Print a STATEMENT, and erase old file with"
02330 PRINT,,"the last record of old file as first of new file."
02340 PRINT"2.","Same as No. 1 but, no Statement printed."
02350 PRINT\\\\,,"Select Option (1 or 2 ";
02360 K?$=""
02370 K?$=KEY:IF K?$="" THEN 2370
02380 X=INT(VAL(K?$)):IF X<1 OR X>2 THEN 2360
02390 IF X=1 THEN GOSUB 1610
02400 F=1:Z5$(F)=Z5$(R):C0(F)=C0(R):C1(F)=C1(R):C2(F)=C2(R):C3(F)=C3(R):C4(F)=C4
(R):C5(F)=C5(R)
02410 C6(F)=C6(R):C7(F)=C7(R):S1(F)=S1(R):W1(F)=W1(R):D1(F)=D1(R)
02420 R=1:Z5$(R)=Z5$(F):C0(R)=C0(F):C1(R)=C1(F):C2(R)=C2(F):C3(R)=C3(F):C4(R)=C4
(F):C5(R)=C5(F)
02430 C6(R)=C6(F):C7(R)=C7(F):S1(R)=S1(F):W1(R)=W1(F):D1(R)=D1(F)
02440 Z6$=Z5$(R):RETURN
```

Budget savings account

This program is a complete rewrite of the "Budget savings account" program in April 1987 of ETI. This program has been written for a disk Microbee, and prints a statement of your last 50 transactions automatically, every 50 transactions (line 2290). The Transfer function has been upgraded (line 1320), you are now asked to enter ITEM FROM and then ITEM TO, followed by the amount being transferred. Escapes from accidental key selections are provided, and a program exit trap, after data has altered.

The program creates a file called "BUDGET.ACT". When running the program for the first time, select option 5, change deduction amounts to the total amounts of each item you have saved for each budget item. Enter the grand total of your account, by selecting option 3 and then option "P" to distribute the total amounts into each budget item. Once this has been done select option 5 and change the deduction amounts to your weekly or fortnightly, etc, deduction amounts.

D. R. Barney
Edmonton
Qld


```
10000 REM 'DATA DE-BUGGER' By S. Carter 29/3/1987
10010 REM This program requires that data lines are numbered
10020 REM in steps of ten to operate properly.
10030 INPUT"With delay (Y or N)";Z1$
10040 IFZ1$="Y"THENLETZ=1
10050 INPUT"How many lines of data...";Y
10060 IFY<1THEN10050
10070 INPUT"What line does it start at...";X
10080 RESTOREX:CLS
10090 FORW=0TOY-1:FORV=1TO16:CURSB
10100 READA:PRINTA;
10110 ONERRORGOTO10180
10120 B=B+B:IFB>=1024THENLETB=0:H=Z:GOTO10170
10130 K1$=KEY:IFK1$<>""THENLETH=1:GOTO10170
10140 IFZ>0:PLAY0,9
10150 NEXTV:NEXTW
10160 PRINT\"All data is correct.":END
10170 K1$=KEY:IFK1$=""THEN10170ELSEIFH=1:GOTO10140ELSEIFH=2:CLS:GOTO10140
10180 PRINT\"There is a data error in line "X+W*10" at position "V
```

Data De-Bugger

How many times have you typed in a program with endless lines of data that are incredibly hard to de-bug? I created this program with that problem in mind. It shows you the data as the computer 'sees' it, showing you where the errors are.

It requires that lines of data are numbered in steps of 10, and prefers sixteen numbers per line. It will give you the option of a delay to give you time to refer to the book and any key being pressed will halt execution until another key is pressed. It will also stop when the screen is full until a key is pressed.

S. Carter
Heathmont
Vic

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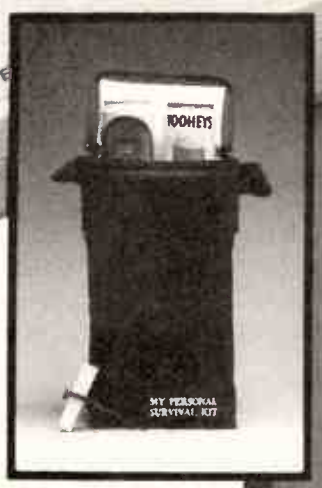

But HURRY — The draw closes 31st March, 1988!

CONDITIONS OF ENTRY

1. The competition is open only to Australian Residents authorising a new/renewal subscription to Electronics Today International before last mail March 31, 1988. Entries received after closing date will not be included. Employees of the Federal Publishing Company, and Supply and Trading Pty Ltd and their families are not eligible to enter. To be valid for drawing, subscription must be signed against a nominated valid credit card, or, if paid by cheque, cleared for payment.
2. South Australian residents need not purchase a subscription to enter, but may enter only once by submitting their name, address, and a hand-draw facsimile of the subscription coupon to The Federal Publishing Company, PO Box 227, Waterloo, NSW 2017.
3. Prizes are not transferable or exchangeable and may not be converted to cash.
4. The judges decision is final and no correspondence will be entered into.
5. Description of the competition and instructions on how to enter form a part of the competition conditions.
6. The competition commences on January 1, 1988 and closes with last mail on March 31, 1988. The draw will take place in Sydney on April 4, 1988 and the winner will be notified by telephone and letter. The winner will also be announced in The Australian on April 6, 1988, and a later issue of Electronics Today International.
7. The prize is a Microbee 128K Premium Computer with Keyboard and twin 3.5 inch floppy discs, RGB colour monitor with tilt stand, Epsom LX800 Printer with cable and auto dial modem. Software includes the Wordstar Professional Pack valuing $2,274.
8. The promoter is The Federal Publishing Company, 180 Bourke Road, Alexandria, NSW 2015. Permit No. TC 87/3251 issued under the Lotteries and Art Unions Act 1901. ACT Permit No. TP 87/950 issued under the Lotteries Ordinance, 1964; Raffles and Bingo Permits Board Permit No. 87/2077 issued on 10/11/87.

```
100 REM ***********************
110 REM NAME: MATHS PRACTICE
120 REM BY  : JOHN AVIS
130 REM DATE: 15/8/1987
140 REM **********************
150 POKE650,128:POKE53280,0:POKE53281,0
160 CC=0:IC=0:PRINT""
170 PRINT"                               "
180 PRINT"                               "
190 PRINT"                               "
200 PRINT"                               "
210 PRINT"                               "
220 PRINT"                               "
230 PRINT"                               "
240 PRINT"                               "
250 PRINT"                               "
260 PRINT"                               "
270 PRINT" YOU MUST STOP THE BOMB FROM BLOWING UP"
280 PRINT" BY  ANSWERING  SOME  MATHS  QUESTIONS."
290 PRINT" IF YOU GET A QUESTION WRONG A BIT MORE"
300 PRINT" OF  THE FUSE WILL  BURN AND IF YOU GET"
310 PRINT" TEN QUESTIONS  WRONG IT WILL  EXPLODE."
320 PRINT" IF  YOU  GET  TEN  QUESTIONS  RIGHT  THE"
330 PRINT" FUSE WILL GO OUT."
340 PRINT"           PRESS  RETURN  TO PLAY"
350 GETA$:IFA$<>CHR$(13)THEN350
360 PRINT""::FORA=1TO10
370 PRINT"                        I":NEXTA
380 PRINT"                       "
390 PRINT"                       "
400 PRINT"                       "
410 PRINT"                       "
420 PRINT"                       "
430 PRINT"                       "
440 PRINT"                       "
450 PRINT"                       "
460 PRINT"                       "
480 PRINT"                       "
490 PRINT"                       "
500 PRINT"                       "
510 PRINT"                       "
520 PRINT"                       ";
525 IFX=10THENGOTO790
530 N1=INT((13-1)*RND(1))+1
540 N2=INT((13-1)*RND(1))+1
550 S=INT((5-1)*RND(1))+1
560 IFS=1THENS$="+":A=N1+N2
570 IFS=2THENS$="-":GOTO610
580 IFS=3THENS$="*":A=N1*N2
590 IFS=4THENS$="  ":GOTO650
600 GOTO690
610 IFN1>N2THENA=N1-N2:GOTO600
620 N1=INT((13-1)*RND(1))+1
630 N2=INT((13-1)*RND(1))+1
640 GOTO610
650 IFINT(N1/N2)=N1/N2THENA=N1/N2:GOTO600
660 N1=INT((13-1)*RND(1))+1
670 N2=INT((13-1)*RND(1))+1
680 GOTO650
690 PRINT"
691 PRINT"
692 PRINT"
695 PRINT""N1
700 PRINT"";S$
710 PRINT""N2"=";
720 INPUTN
730 IFN=ATHENX=X+1:PRINT"CORRECT  ":GOTO525
735 PRINT"INCORRECT"
740 POKE1043+40*Y,32
750 Y=Y+1
760 IFY=10THEN860
770 POKE1043+40*Y,86
780 GOTO525
790 PRINT""
800 PRINT"              WELL DONE!"
810 PRINT" YOU STOPPED THE BOMB FROM EXPLODING..."
820 PRINT" YOU MADE"Y"MISTAKES."
830 PRINT"      PRESS  RETURN  TO PLAY AGAIN"
840 GETA$:IFA$<>CHR$(13)THEN840
850 RUN
860 FORA=0TO200:POKE53270,A:NEXTA
870 PRINT""
880 PRINT"              BAD LUCK.."
890 PRINT" IF YOU PRACTICE A BIT MORE YOU WILL BE"
900 PRINT" ABLE TO STOP THE BOMB FROM EXPLODING."
910 PRINT"      PRESS  RETURN  TO PLAY AGAIN"
920 GETA$:IFA$<>CHR$(13)THEN920
930 RUN

READY.
```

Maths Practice

Maths Practice is educational for children who know and want to practice their times tables. You must answer the maths question that appears in the top right of the screen. If you get a question wrong the fuse on a bomb will burn a bit away and if you get 10 wrong, the bomb will explode and the screen will shudder. If you get 10 right, the fuse will go out.

J. Avis
Frenchs Forest
NSW

```
00005EDIT 520
00100 REM program written for ***microbee***
00110 POKE 140,1:POKE 141,1:POKE 220,20
00120 CLS
00130 CURS 210:PRINT"What would you like the volume of:"
00140 CURS 530:PRINT"5=a cone "
00150 CURS 274:PRINT"1=a cube"
00160 CURS 338:PRINT"2=a rectangular prism "
00170 CURS 402:PRINT"3=a sphere "
00180 CURS 466:PRINT"4=a square based pyramid "
00190 CURS 594:PRINT"6=a cylinder "
00195 CURS 722:PRINT"Please place commas between numbers"
00200 CURS 658:PRINT"ALL MEASUREMENTS ARE IN CENTIMETRES!"
00210 A1$=KEY$
00220 IF A1$="" THEN 210
00230 U=INT(VAL(A1$))
00240 IF U>6 OR U<1 THEN 210
00250 ON U GOTO 260,300,340,380,420,460
00260 CLS
00270 CURS 210:INPUT"please state height";A7
00280 CURS 274:PRINT"volume of cube= ";A7*A7*A7
00290 GOTO 490
00300 CLS
00310 CURS 193:INPUT"please state width,height, and length";A1,B1,C1
00320 CURS 274:PRINT"volume of rect. prism= ";A1*B1*C1
00330 GOTO 490
00340 CLS
00350 CURS 210:INPUT"please state radius";R6
00360 CURS 274:PRINT"volume of sphere= ";(4/3)*3.1416*(R6*R6*R6)
00370 GOTO 490
00380 CLS
00390 CURS 192:INPUT"please state perp. height, and side length";H1,Z2
00400 CURS 274:PRINT"sq. base pyramid volume= ";(1/3)*(Z2*Z2*H1)
00410 GOTO 490
00420 CLS
00430 CURS 200:INPUT"please state radius, and perp. height";T2,O4
00440 CURS 274:PRINT"volume of cone= ";(1/3)*3.1416*T2*T2*O4
00450 GOTO 490
00460 CLS
00470 CURS 210:INPUT"please state radius and height";L2,K2
00480 CURS 274:PRINT"volume of a cylinder= ";3.1416*L2*L2*K2
00490 PRINT:PRINT
00500 PRINT"                ANY KEY FOR MENU"
00510 K1$=KEY$:IF K1$="" THEN 510
00520 CLEAR:GOTO100
```

Volume Calculator

The following program listing is just a short routine I wrote one night to assist me in checking my homework. Some of your readers may find it useful. The program is fairly self explanatory but essentially it assists you to find volumes of several different shaped objects.

S. Ashdown
Year 8
Ipswich, Qld

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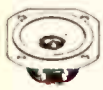
1½" TWEETER

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

Cat C10200 ..... **$5.95**



2½" TWEETER

SPECIFICATIONS:
Sensitivity: 94dB
Freq. Response: 1 1 - 17 kHz
Impedance: 8 ohms
Power RMS: 10 watts
Magnet Weight: 2 oz

Cat C10202 ..... **$6.95**

4" MIDRANGE WITH SEALED BACK

SPECIFICATIONS:
Sensitivity: 96dB
Freq. Response: 650 - 15 kHz
Impedance: 8 ohms
Power RMS: 15 watts
Magnet Weight: 3 6 oz

Cat C10204 ..... **$11.95**

6½" WOOFER

Cloth edge roll surround.
SPECIFICATIONS:
Sensitivity: 96dB
Freq. Response: 55 - 7 kHz
Impedance: 8 ohms
Power RMS: 15 watts
Magnet Weight: 5 4 oz

Cat C10208 ..... **$17.95**

8" WOOFER RIBBED CONE

Cloth edge roll surround.
SPECIFICATIONS:
Sensitivity: 94dB
Freq. Response: 55 - 8 kHz
Impedance: 8 ohms
Power RMS: 20 watts
Magnet Weight: 5 4 oz

Cat C10210 ..... **$20.95**

12" WOOFER RIBBED CONE

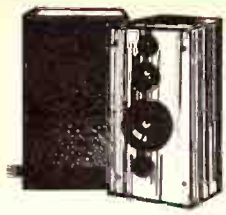
Cloth edge roll surround.
SPECIFICATIONS:
Sensitivity: 92dB
Freq. Response: 32 - 4 kHz
Impedance: 8 ohms
Power RMS: 30 watts
Magnet Weight: 13 3oz

Cat C10214 ..... **$49.95**

DUAL ATTENUATOR

- LED indicator
- Mid/High range for 3 way systems
- Impedance 8-10 ohms
- Power handling 18 watts RMS

Cat A16013 ..... **$17.95**



VIFA/AEM 3 WAY SPEAKER KIT!

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

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

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

D19 DOME TWEETER SPEAKER SPECIFICATIONS
Nominal Impedance: 8 ohms
Frequency Range: 2 5 - 20kHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts (fo 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6 2ohms
Moving Mass: 0 2 grams
Weight: 0.28kg

D75 DOME MIDRANGE SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 350 - 5,000Hz
Free Air Resonance: 300Hz
Sensitivity (1W at 1m): 91dB
Nominal Power: 80 Watts (fo 500Hz, 12dB/oct)
Voice Coil Diameter: 75mm
Voice Coil Resistance: 7 2ohms
Moving Mass (incl. air): 3 6 grams
Weight: 0.65kg

P25 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 25 - 3,000Hz
Free Air Resonance: 25Hz
Operating Power: 5 watts
Sensitivity (1W at 1m): 89dB
Nominal Power: 60 Watts
Music Power: 100 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5 7ohms
Moving Mass (incl. air): 44 grams
Thiele/Small Parameters:
Qm 3 15
Qe 0 46
Qt 0 40
Vas 180 1
Weight: 1 95kg

Complete Kit Cat K16030 **$1,199**
Speaker Kit Cat K16031 **$949**
Cabinet Kit Cat K16032 **$349**

OMNI-DIRECTIONAL WIRELESS MICROPHONE

Tuneable: 92 - 104MHz
Freq. Response: 50 - 15kHz
Range: Over 300 feet in open field
Modulation: FM
Power Source: 9V Battery
Type: Electret Condenser
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

Cat A10450 **$19.95**

CRYSTAL LOCKED WIRELESS MICROPHONE AND RECIEVER

MICROPHONE SPECIFICATIONS:
Transmitting Frequency: 37 1MHz
Transmitting System: crystal oscillation
Microphone: Electret condenser
Power Supply: 9V battery
Range: 300 feet in open field
Dimensions: 185 x 27 x 38mm
Weight: 160 grams

RECIEVER SPECIFICATIONS:
Recieving Freq: 37 1MHz
Output Level: 30mV (maximum)
Recieving System: Super heterodyne crystal oscillation
Power Supply: 9V Battery or 9V DC power adapter
Volume control
Tuning LED
Dimensions: 115 x 32 x 44mm
Weight: 220 grams

Cat A10452 ..... R.R.P. $113
Our price, $99

SENNHEISER HD 410 SL

The HD 410 SL embodies all the advantages of the new "Slim-line" concept: brilliant sound characteristics with an optimum of sound volume combined with high wearer comfort.
SPECIFICATIONS:
Frequency Range: 20 - 18,000Hz
Impedance: 600ohm
Distortion Factor: Less than 1%, pressure on ear, approx 2.5 N
Weight: Approx 82g
Length of lead: 3 metres

Cat. A10518 ..... **$74.95**

AUDIO

SPEAKER CONTROLLER (TAA801)

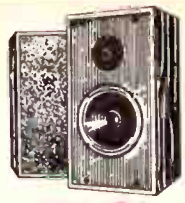
- Enables up to 5 pairs of stereo speakers to be switched on or off in any combination
- Rated at 50 watts continuous per channel
- Stereo headphone socket available for private listening
- Constant minimum load circuit protects amplifier regardless of how many speakers are connected
- Dual circuit breaker protection

Cat. A16054 ..... **$59.95**

SPEAKER CONTROLLER (TAA803)

- Enables 2 amplifiers (or TV & Amp) to be switched to 4 pairs of speakers in any combination
- Rated at 50 watts continuous per channel
- Headphone output can be utilized without interfering with the speaker
- Constant minimum load circuit protects amplifier regardless of how many speakers are connected
- Each channel is protected separately by circuit breakers

Cat. A16058 ..... **$59.95**



SUPERB VIFA/EA 60+60 SPEAKER KIT!

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

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

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

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

D19 TWEETER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 2 5 - 20KHz
Free Air Resonance: 1,700Hz
Sensitivity 1W at 1m: 89dB
Nominal Power: 80 Watts (fo 5,000Hz, 12dB/oct)
Voice Coil Diameter: 19mm
Voice Coil Resistance: 6 2 ohms
Moving Mass: 0 2 grams
Weight: 0 28kg

Cat C10301 ..... **$38**

C20 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 35 - 6,000Hz
Resonance Frequency: 39Hz
Sensitivity 1W at 1m: 90dB
Nominal Power: 50 Watts (12dB/oct)
Voice Coil Diameter: 25mm
Voice Coil Resistance: 5 5 ohms
Moving Mass: 15 grams

Cat C10322 ..... **$89**

Cat K86092 (speakers only) **$379**

Cat K86091 (complete kit) **$449**

SUPER HORN

- Wide dispersion tweeter, handles up to 100W
- Sensitivity 105dB@0 5m
- Frequency Response 3kHz-30kHz
- Impedance 8 OHMS
- Size 145x54mm

Cat C12103 **Normally $12.95**
SPECIAL, ONLY $9.95

SUPER HORN TWEETER

- Requires no crossover and handles up to 100W!
- Sensitivity 100dB@0 5m
- Frequency Response 3kHz-30kHz
- Impedance 8 OHMS
- Size 96mm diameter

Cat C12102 **Normally $12.95**
SPECIAL, ONLY $9.95

PIEZO DIRECT RADIATING TWEETER

Requires no crossover, handles up to 100 watts
Sensitivity: 98dB
Maximum Imput: 24 volts
Freq. Response: 3 2 - 30kHz
Dimensions: 95mm diameter

Cat C12104 **$11.95**

VIFA/AEM 2 WAY SPEAKER KIT!

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

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

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

D25T SPEAKER SPECIFICATIONS
Nominal Impedance: 6 ohms
Frequency Range: 2 -24kHz
Free Air Resonance: 1500Hz
Operating Power: 3 2 watts
Sensitivity (1W at 1m): 90dB
Nominal Power: 90 Watts
Voice Coil Diameter: 25mm
Air Gap Height: 2mm
Voice Coil Resistance: 4 7ohms
Moving Mass: 0 3 grams
Weight: 0.53kg

P21 WOOFER SPECIFICATIONS:
Nominal Impedance: 8 ohms
Frequency Range: 26 - 4,000Hz
Free Air Resonance: 33Hz
Operating Power: 2.5 watts
Sensitivity (1W at 1m): 92dB
Nominal Power: 60 Watts
Voice Coil Diameter: 40mm
Voice Coil Resistance: 5 8ohms
Moving Mass: 20 grams
Thiele/Small Parameters: Qm 2 4
Qe 0 41
Qt 0 35
Vas 80 1

Weight: 1.65kg

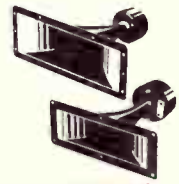
Complete Kit Cat K16020 **$799**
Speaker Kit Cat K16021 **$649**
Cabinet Kit Cat K16022 **$209**

COMPACT DISC CLEANER

Even compact discs need to be kept clean otherwise the listening pleasure will be spoiled by drop outs or skips

- Cabinet incorporates working base to place disc
- Soft suede cleaning pad (with pad cleaning brush)
- Spray which will gently loosen contaminents and not damage discs
- With disc cloth for handling discs
- Replacement cleaning pad and spray available separately

A10025 ..... **$19.95**



MIDRANGE HORNS

Use these quality, all metal, Piezo tweeters for great top end sound in your band speakers, disco sound system, etc. Rated at 30 watts RMS, in a system they will handle over 100 watts RMS

Two sizes to choose from:
Size: 4"x 10½"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 1 5kHz - 14 kHz
Dimensions: 102 x 267 x 177mm

Cat C92082 **Normally $49.95**
This month only $39.95

Size: 3"x 7"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 2kHz - 15 kHz
Dimensions: 76 x 177 x 145mm

Cat C92084 **Normally $29.95**
This month only $24.95

Dealers, OEM's, etc., phone (03) 543 2166 for wholesale prices

PHILIPS SPEAKERS

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

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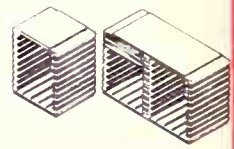
AD070620M8	(C12045)	$69.95
AD12250W8	(C12050)	$129.00



COMPACT DISC STORAGE UNITS

- Holds 10/20 compact discs in their cases
- Interlocking modular design allows vertical and horizontal interlocking
- Discs slide into place horizontally making titles easy to read
- Wall mount or free standing

A10031 (10 discs) **$12.95**
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-Paul Garrison

Most computer programmers begin by learning BASIC But as BASIC is slow and cumbersome many people are taking advantage of the affordable and more efficient Turbo Pascal software In this book Paul Garrison draws from your knowledge of BASIC programming fundamentals to show you how to Turbo Pascal works BASIC programs are compared side by side with their Pascal equivalents so that you can see clearly the similarities and differences of the two languages The comparisons demonstrate why Pascal is easier to write, read test and debug

Within this book you will find

- Clear and simple explanations of the specifics of the structured programming with Turbo Pascal
- A library of useful programs for personal and business uses There are, for example database programs, a financial projection program a currency conversion program a mortgage amortization program and many more
- Seven appendixes that include the ASCII character codes a Turbo Pascal dictionary, a glossary of computer terms and abbreviations and other helpful aids

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-Mitchell Waite, David Fox

If you are learning programming or have dabbled in the popular language BASIC and wish to learn the capabilities of Pascal, this book is definitely written for you Written and illustrated with a touch of humour, the informative text describes Pascal program structure Pascal vanables, Pascal procedures and many other features There are chapters on decision making statements, numeric functions, string functions, arrays and sets, and much more The eight appendices present facts about the advantages and disadvantages of Pascal, components of a Pascal system interfacing assembly language routines, and other useful information

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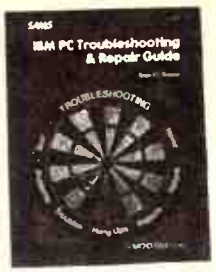

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The IBM PC Trouble Shooting & Repair Guide will make even the computer novice feel comfortable with the complex world of electronic trouble shooting This fully illustrated book is recommended for anyone who uses an IBM PC

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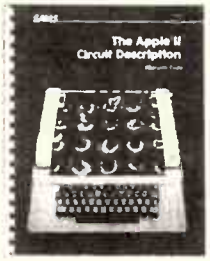

APPLE II CIRCUIT DESCRIPTION

-Winston D. Gayler

- Covers all Apple II motherboard and keyboard versions
- Helps you learn about microcomputer hardware in general and Apple II hardware in detail
- Provides you with accurate schematics and verified waveforms to rely on for servicing and repair
- Explains the advanced concepts of daisy chains, interrupts, direct memory access, and the ready line
- Gives you many valuable hints for successful interfacing
- Contains tutorials on video signals, memory IC s and the 6502 microprocessor, as well as full explanations of advanced concepts
- Each chapter contains an overview for the beginner and a detailed section for the more adventurous
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-Donald E. Herrington

Interpreting schematics is essential for understanding electronic circuits A schematic is a symbol diagram showing the components of a circuit and their interconnections To the electronics technician, the schematic is an invaluable guide to the operation of a circuit It's also crucial in indicating the test points for a technician s service equipment

This book is your key to unlocking the mysteries of schematics Beginning with a general discussion of electronic diagrams, including block diagrams and flowcharts, which are not true schematics but also important in understanding electronics, the book systematically covers the various components that comprise a circuit resistors, capacitors, coils and transformers, electron tubes, semiconductors, printed circuits, integrated circuits, and more

You'll find this handy reference book

- Explains logic symbols and their use in digital circuits
- Interprets sample schematics
- Analyzes the operation of a radio reciever
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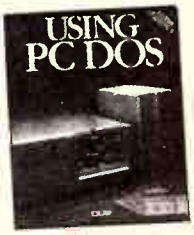

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- Use RAM disks
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-David Watt

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Z80 MICROCOMPUTER HANDBOOK

-William Barden, Jr.

Organizationally the book is arranged in three sections

Section 1 discusses Z-80 hardware It covers architecture, interface signals, timing, addressing modes, instructions, the effect of arithmetic operations, operations on CPU flags, the powerful interrupt sequences of the Z-80 and interfacing examples of I/O on memory devices

Section 2 presents the software A look at representative assembler program, machine language, common programming operations of moving data, arithmetic operations, list and table procedures, subroutine use, I/O functions relative to instruction set groups Many examples of each operation are provided as well as some commonly used subroutines written in Z-80 assembly language

Section 3 discusses microcomputers built around the Z-80 It features the Zilog products including the microprocessr board products in the Z-80 family and development systems, and four other Z-80 microprocessors manufacturers' hardware and software are described

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At these crazy low prices, NOW is the time to buy!

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

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Q10518	MU45 0-1A	12.50
Q10520	MU45 0-1A	12.50
Q10525	MU45 0-20V	12.50
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- 25 Detachable plug on leads
- 2 mini jumpers
- Ideal for experimenting or temporary connections

Cat X15665 Normally $49.95
Only $44.95

HEATSINK COMPOUND

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

Cat H11800 (10g) $2.95
Cat H1181J (150g) $17.50

ARLEC "DISCO LITE" CONTROLLER

Give your parties a professional touch with the arlec "Disco Lite" Simply plug your light(s) into the "Disco Lite" and you've instant party life!

3 DIFFERENT MODES!

Music Mode: Place the "Disco Lite" in range of the speakers and it flashes the lights to the beat of the music!

Strobe Mode: Simply adjust to desired speed! Great for mime or theatre! The christmas season or advertising!

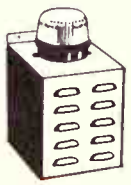
Dim Mode: Allows you to dim the lights to create moods, effects etc

Cat M22003 **$49.50**

BELL WIRE

Red and white twisted Conductors 2 x 1 strand 0 17mm Sheath O D 2 x 1 35mm Cat W

1-9 rolls $19.00/m
10 + rolls $17.50/m



EXTERNAL SIREN & FLASHING LIGHT

Housed in a waterproof, metal case, with tamper switch.

SPECIFICATIONS:

Siren:
DC 12V 450 mA
Impedance 8 ohm
S P L (dB/W) 110
Dimensions 135 x 150mm

Flashing Light:
DC 12V
100 flashes per minute
Dimensions 82 x 100mm

$89.50

HOOK UP WIRE

Cat. No.	Description
W11251	13/ 12 TNO BLK
W11252	13/ 12 TLD BROWN
W11253	13/ 12 TLD ORANGE
W11254	13/ 12 TLD YELLOW
W11255	13/ 12 TLD GREEN
W11256	13/ 12 TLD BLUE
W11257	13/ 12 TLD WHITE

PRICES PER 100 METRE ROLL

1-9	10 +
$5.95	$5.00

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

PRICES PER 100 METRE ROLL

1-9	10 +
$12.00	$10.00

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

PRICES PER 100 METRE ROLL

1-9	10 +
$14.00	$12.00

W11280	32/ 2 BROWN
W11282	32/ 2 BLUE

PRICES PER 100 METRE RDLL

1-9	10 +
$20.00	$18.00

VERBATIM DISK SPECIALS!

All prices 10 disk boxes!

Description	1-9	10 +
3½" 1S/2D	$44.95	$42.95
3½" 2S/2D	$46.95	$43.95
5¼" 1S/2D	$22.00	$21.00
5¼" 2D/2D	$26.00	$24.00
5¼" 2S/4D	$75.00	$70.00
5¼" 2S/HD	$42.95	$41.00

"NO BRAND" DISKS!!

Now you can buy absolute top quality disks that are also the cheapest in Australia! They even come with a 5 year guarantee! So why pay 2-3 times the price for the same quality?

Packs of 10, D/S D/D without boxes or brand name, just their white paper jacket, and index labels (5¼" disks includes write protects)

5¼" "NO BRAND" DISKS

10 - DISKS	100 - DISKS	1,000 - DISKS
$10.00	$9.00	$8.50.00

(ALL PRICES PER 10 DISKS)

3½" "NO BRAND" DISKS!

10 - DISKS	100 - DISKS	1,000 - DISKS
$29	$28	$27.50

(ALL PRICES PER 10 DISKS)

5¼" DISK STORAGE

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

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

Cat C16025 **only $14.95**

½" HIGH INTENSITY RED LED DISPLAYS

(Available in Common Cathode and Common Anode)

Dimensions:
Overall 12 7mm across, 19mm high
Display 12 7mm(H) x 7 3mm(W)
Segment Width 1 2mm
Brightness 3400 ucd I_F = 10mA

COMMON CATHODE:

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

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

SCOPE 60W SOLDERING SYSTEM

SAVE $30!

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

Cat T12900 Normally $229
SPECIAL, $199

PUSH BUTTON DIALLERS

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

Cat A12030 Normally $19.95
SPECIAL, ONLY $14.95
(Note: Not Telecom approved)

RELAY AND BASE

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

Cat S14074 $8.95

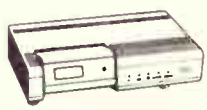
POCKET SIZE BATTERY TESTER

- Tests all 9V to 1 5V batteries including button cells
- Arms extend to various battery sizes
- Easy to read meter
- Requires no power source

M23521 **$11.95**

ECONOMY TRANSFORMERS

	1-9	10 +
2155 240V 6-15V 1A Cat M12155	$9.95	$8.95
2156 240V 6-15V 2A Cat M12156	$14.95	$13.95
2840 240V 9V CT Cat M12840	$5.95	$4.95
2851 240V 12-6V CT 150mA Cat M12851	$5.95	$5.50
2860 240V 15V CT 250mA Cat M12860	$5.95	$4.95
6672 240V 15-30V 1A tapped Cat M16672	$14.95	$13.95



P.I.R. SENTRY

FEATURES:
- 7 LED indicators
- Passive Infra-red detection radium
- Built-in piezo siren
- Rechargeable 12V battery
- Built-in automatic battery charging system
- External siren connections
- Exit/Entry system
- Terminals for external detection devices
- Separate digital panel and main unit
- 3 Function switch: delay off/instant
- 3 Adjustable timers
- 24 Hour loop included
- Built-in tamper switch
- Adjustable detection angle
- LED monitor for walk test
- R F Protection design

$175

CODE KEY PAD

- Telephone type digital keypad
- Four digit, changeable code
- Over 5000 possible combinations
- Power consumption 5mA standby, 50mA alarm
- Two sector LED and 1 arm LED
- Wrong number lockout
- 12V DC operation
- Relay output
- Panic button
- Normally open tamper switch
- Dimensions 145 x 100 x 37mm
- ACP3 compatible

Cat A13014 R.R.P. $79.95
SPECIAL, ONLY $69.95

ULTRASONIC TRANSDUCERS

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

Full specifications below for design purposes

Maximum Input Voltage: 20V rms
Centre Frequency (kHz): 40 + - 1 0
Sound Pressure Level 10V RMS: 110dB min
Sensitivity (dB/v/ubar) min.: 65 min
Bandwidth (kHz):
Transmit 4 0 (at 100dB)
Receiver 5 0 (at - 73dB)
Impedance:
Transmit 500
Receiver 5000

Cat L1[illegible] (Transmitter) $4.75
Cat L19991 (Receiver) $4.75

PASSIVE INFRA-RED DETECTOR

(WP-800)

FEATURES:
- Walk test LED indicator
- Wall/corner/ceiling mount
- Micro switch tamper proof protection
- 24 detection beams in 3 different ranges
- N C silent S P S T dry relay contact output
- Alarm auto reset approximately 3 seconds after triggered
- Superior RFI immunity protection
- Extremely low power consumption
- Adjustable mounting bracket
- Easy installation, easy adjustment
- Dual element, low noise, high signal to noise ratio pyroelectric
- Detection degree indicator
- D C 8-16V power operating

S15079 **$89.95**

SPRING RETURN TOGGLE SWITCHES

		WAS	NOW
S P D T	Cat S11012	$2 25	$1.95
D P O T	Cat S11022	$2 50	$2.25

Rod Irving Electronics

48 A'Beckett St, MELBOURNE
Phone (03) 663 6151

425 High St, NORTHCOTE
Phone (03) 489 8866

Mail Order and Correspondence
P.O. Box 620, CLAYTON 3168

Telex: AA 151938
Fax: (03) 543 2648

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

LOCAL ORDERS & INQUIRIES
(03) 543 7877

POSTAGE RATES:

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

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

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

Errors and omissions excepted

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MasterCard VISA

READER INFO No. 113

WIMA

MINIATURE FILM CAPACITORS

- Polyester-Polycarbonate-Polypropylene
- World leaders in miniaturisation
- Outstanding electrical characteristics
- Approved mains suppressors
- Fully supported stock lines

RECTRON
RECTIFIER SPECIALISTS

RECTIFIERS

- Extensive Range Bridge Rectifiers
- Silicon Rectifier Diodes
- Fast Recovery Rectifiers
- Schottky Barrier Rectifiers
- Fully supported stock lines

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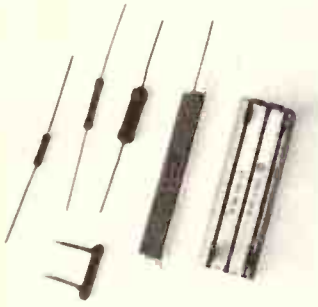


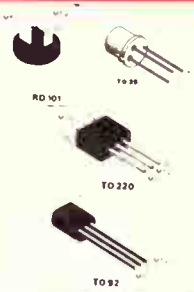
VITROHM

RESISTORS

- Wirewound incl. Precision and Lo Ohm
- Metal and Carbon Film
- Networks and Hybrids
- taped Zero Ohm and Jumper Wires

READER INFO No. 114

Tag



TRIACS AND SCR

- Packages include T092, T039, T0202, T0220, RD101
- Advanced technology
- ITrms to 40 amp V DRM to 800 volt
- Fully supported stock lines

READER INFO No. 119

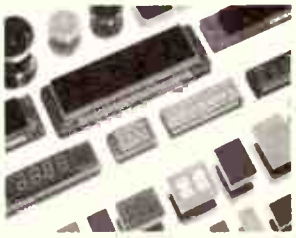
ASTRALUX
dynamics limited

REED RELAYS – IC SOCKETS

- Dual in Line Relays
- Mercury Wetted Relays
- Machine Pin/Standard Sockets
- Approved Jack Plugs and Sockets

READER INFO No. 115

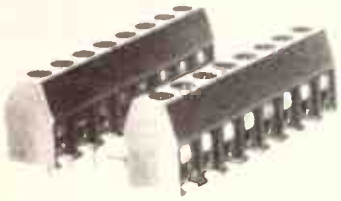
LITON
SPECIALIST



LED LAMPS AND DISPLAYS

- Round, Rectangular Lamps
- Single, Dual Displays
- Clock, Multidigit Displays

READER INFO No. 120



WECO

TERMINAL BLOCKS

- Printed Circuit Board Mounting
- Plug and Socket Connectors
- Screwless Terminal Strips
- Tab Type Connectors
- Socket Terminal Strips

READER INFO No. 116

DELTA

EMI FILTERS

- Over 200 Standard Types
- Rated Top quality supplier by IBM, DEC, WANG, RCA, ITT, etc.
- Superior design features
- Competitively priced

READER INFO No. 121

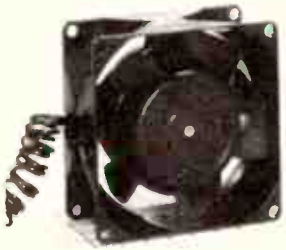
HARTING

CONNECTORS

- European Leader DIN41612
- Extensive Range Heavy Duty Types
- Miniature D Series
- Mass Termination – Flat Cable

READER INFO No. 117

PAPST



FANS AND BLOWERS

- AC Fans 115, 240 VAC
- DC Fans, electronically commutated
- Proven reliability and long life
- Very low noise types
- Also extensive range of motors

READER INFO No. 122

Adilam Electronics Pty Ltd
Incorporated in VICTORIA

Melb — **Suite 7, 145 Parker St, Templestowe 3106**
PO Box 52, Bulleen 3105
Tel (03) 846 2511
Tlx 151369

Syd — Suit 1, Ramsgate Plaza
191 Ramsgate Rd, San Souci 2219
Ph (02) 529-2277. Fax (02) 529-5893

Adel —	K.D. Fisher	(08) 277 3288
Bris —	F. Hoe & Sons	(07) 277 4311
Canb —	Electronic Components	(062) 80 4654
Perth —	Atkins Carlyle	(09) 321 0101
	Prospec	(09) 362 5011

```
00100 REM TITANIC BY SIMON CARTER 21/3/1987
00110 P=63488+65*16
00120 RESTORE1030:FORA=PTOP+16*18-1
00130 READB:POKEA,B
00140 NEXTA
00150 CLEAR:CLS:PCG:CURS192
00160 PRINT"BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB";
00170 PRINT"BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB";
00180 PRINT"BBBBBBBBBBBBAAAAAABAABAAAAAABAAAAAABAABBAABAABAAAAAABBBBBBBBBBBB";
00190 PRINT"BBBBBBBBBBBBBAABBBAABBBAABBBAABBAABBAABAAABAABAABAABBBBBBBBBBBBBB";
00200 PRINT"BBBBBBBBBBBBBAABBBAABBBAABBBAABBAAAAAABAABAAABAABAABBBBBBBBBBBBBB";
00210 PRINT"BBBBBBBBBBBBBAABBBAABBBAABBBAABBAABBAABAABBAABAABAABBBBBBBBBBBBBB";
00220 PRINT"BBBBBBBBBBBBBAABBBAABBBAABBBAABBAABBAABAABBAABAABAAAAAABBBBBBBBBB";
00230 PRINT"BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB";
00240 PRINT"BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB";
00250 FORI=1TO500:K1$=KEY$:IFK1$<>""THENNEXTI: 270ELSENEXTI
00260 GOTO150
00270 NORMAL:CURS960:PRINT(A64 32):PRINT(A64 32)
00280 PRINT"                    I  N  S  T  R  U  C  T  I  O  N  S"
00290 PRINT\"Your hull is badly damaged and you've no weapons to speak of."\"As
you limp home through treacherous iceberg strewn waters,"\"you become aware that
 two enemy ships are";
00300 PRINT" tailing you."\"Strangely they can detect you but not the icebergs,
so your best chance is to lure them into hitting one.";
00310 PRINT" You ( "::PCG:PRINT"HIJKL";:NORMAL:PRINT" ) can move North, South, E
ast or West one space using I, J, K and M."
00320 PRINT"Your enemies ( "::PCG:PRINT"HIJML";:NORMAL:PRINT" ) move towards you
 by the most direct route";
00330 PRINT" and can move diagonally. The icebergs ( ";:PCG:PRINT"CDEFG";:NORMAL
:PRINT" ) cannot move."\"                              GOOD LUCK"\
00340 PRINTTAB(10);"One or two enemies (1 or 2)?"\
00350 CLEAR:B=0:DIMB(12,12)
00360 A1$=KEY$:IFA1$=""THEN360
00370 IFA1$="1":M=1:F=2:GOTO400
00380 IFA1$="2":M=1:F=1:GOTO400
00390 GOTO360
00400 N=INT(RND*8)+4
00410 FORI=1TON:LETB(INT(RND*12+1),INT(RND*12+1))=1:NEXTI
00420 IFF=1:LETR=INT(RND*12+1):LETW=INT(RND*12+1)
00430 IFF=1:IFB(R,W)<>0THEN420ELSEIFF=1THENLETB(R,W)=4
00440 LETH=INT(RND*12+1):LETI=INT(RND*12+1)
00450 IFB(H,I)<>0THEN440ELSELETB(H,I)=3
00460 LETJ=INT(RND*12+1):LETK=INT(RND*12+1)
00470 IFB(J,K)<>0THEN460ELSELETB(J,K)=2
00480 CLS:PCG
00490 FORY=1TO12
00500 FORX=1TO12
00510 IFB(X,Y)=0:PRINT"NNNNN";:GOTO550
00520 IFB(X,Y)=1:PRINT"CDEFG";
00530 IFB(X,Y)=2:PRINT"HIJKL";
00540 IFB(X,Y)=3ORB(X,Y)=4:PRINT"HIJML";
00550 NEXTX:PRINT:NEXTY
00560 CURS768:NORMAL:PRINT"DIRECTION (I,J,K,M) ";:PCG
00570 D1$=KEY:IFD1$=""THEN570
00580 IFD1$="I"ORD1$="J"ORD1$="K"ORD1$="M"THEN590ELSE570
00590 CURSJ*5-4,K:PRINT"NNNNN":LETB(J,K)=0
00600 IFD1$="M"ANDK=12THEN1210ELSEIFD1$="M"ANDK<12:LETK=K+1
00610 IFD1$="I"ANDK=1THEN1210ELSEIFD1$="I"ANDK>1:LETK=K-1
00620 IFD1$="K"ANDJ=12THEN1210ELSEIFD1$="K"ANDJ<12:LETJ=J+1
00630 IFD1$="J"ANDJ=1THEN1210ELSEIFD1$="J"ANDJ>1:LETJ=J-1
00640 IFB(J,K)=3ORB(J,K)=4:GOTO850
00650 IFB(J,K)=1:LETO=J*5-4:LETP=K:GOTO880
00660 CURSJ*5-4,K:PRINT"HIJKL":LETB(J,K)=2
00670 PLAY0,2
00680 IFM<>1THEN760
00690 CURSH*5-4,I:PRINT"NNNNN":LETB(H,I)=0
00700 LETP=J-H:IFP<0THENLETH=H-1ELSEIFP=0THENLETH=HELSEIFP>0THENLETH=H+1
00710 LETQ=K-I:IFQ<0THENLETI=I-1ELSEIFQ=0THENLETI=IELSEIFQ>0THENLETI=I+1
00720 IFB(H,I)=2:GOTO850
00730 IFB(H,I)=1:M=0:LETO=H*5-4:LETP=I:GOTO880
00740 IFB(H,I)=4:LETB(H,I)=0:S=1:LETO=H*5-4:LETP=I:GOTO880
00750 CURSH*5-4,I:PRINT"HIJML":LETB(H,I)=3
00760 IFF<>1THEN570
00770 CURSR*5-4,W:PRINT"NNNNN":LETB(R,W)=0
00780 LETP=J-R:IFP<0THENLETR=R-1ELSEIFP=0THENLETR=RELSEIFP>0THENLETR=R+1
00790 LETQ=K-W:IFQ<0THENLETW=W-1ELSEIFQ=0THENLETW=WELSEIFQ>0THENLETW=W+1
00800 IFB(R,W)=2:GOTO850
00810 IFB(R,W)=1:LETF=0:LETO=R*5-4:LETP=W:GOTO880
00820 IFB(R,W)=3:LETB(R,W)=0:S=1:LETO=R*5-4:LETP=W:GOTO880
00830 CURSR*5-4,W:PRINT"HIJML":LETB(R,W)=4
00840 GOTO570
00850 NORMAL:CURS768:PRINT"You've been caught";
00860 IFM=0ORF=0THENPRINT" but at least you took one down with you."ELSEPRINT"."
00870 GOTO980
00880 GOSUB1220:PRINT"NNONN":GOSUB1220:PRINT"NNP":GOSUB1220
00890 PRINT"NNQ":GOSUB1220:PRINT"NNR":GOSUB1220:PRINT"NNNNN"
00900 NORMAL:CURS768
00910 IFB(J,K)=1:PRINT"You've hit an iceberg";:GOTO860
00920 IFS=1:PRINT"You're safe-they hit each other.";GOTO970
00930 IFM=0ANDF=1:PCG:CURSO,P:PRINT"CDEFG";:GOTO770
00940 IFF=0ANDM=1:PCG:CURSO,P:PRINT"CDEFG";:GOTO570
00950 IFM=0ANDF=2:PRINT"You're safe-he's hit an iceberg."
00960 IFM=0ANDF=0:PRINT"You are safe-they both hit icebergs."
00970 PLAY8,2;13,2;8,2;13,2;15,2;17,2;18,1;17,1;15,2;17,1;18,1;20,2;13,2;17,1;15
,1;13,1;12,1;13,4
00980 PRINT" Another go? (Y or N)";
00990 K1$=KEY:IFK1$=""THEN990
01000 IFK1$="Y"THEN270
01010 IFK1$="N"THENEND
01020 GOTO990
01030 DATA247,247,247,247,247,247,247,247,247,247,247,247,247,0,247,247
01040 DATA8,8,8,8,8,8,8,8,8,8,8,8,8,255,8,8
01050 DATA0,0,0,0,0,0,1,3,4,8,18,44,88,159,158,127
01060 DATA8,20,51,97,97,194,134,138,208,60,67,64,128,6,63,192
01070 DATA8,28,106,210,21,35,7,229,137,9,128,197,118,62,255,0
01080 DATA0,0,0,0,0,0,0,0,128,128,128,80,238,127,192,0
01090 DATA0,0,0,0,0,0,0,0,0,0,0,0,0,92,0,0
01100 DATA0,0,0,0,0,0,3,4,8,16,255,128,128,128,127,0
01110 DATA0,0,0,2,1,63,226,2,2,3,255,0,0,0,255,0
01120 DATA0,0,0,0,0,240,88,76,71,248,0,0,0,0,255,0
01130 DATA0,0,0,0,0,0,0,0,255,72,72,48,48,49,255,0
01140 DATA0,0,0,0,0,0,0,60,200,8,16,32,32,192,0,0
01150 DATA0,0,0,0,0,0,0,0,255,56,32,48,32,56,255,0
01160 DATA0,0,0,0,0,0,0,0,0,0,0,0,0,0,195,60
01170 DATA0,128,224,160,140,66,66,67,65,65,65,65,65,65,65,65
01180 DATA0,0,0,0,0,128,224,160,140,66,66,67,65,65,65,65
01190 DATA0,0,0,0,0,0,0,0,0,128,224,160,140,66,66,67
01200 DATA0,0,0,0,0,0,0,0,0,0,0,0,0,128,224,160
01210 CURSJ*5-4,K:PRINT"HIJKL":GOTO570
01220 PLAY0,2:CURSO,P:RETURN
```

```
100 REM *********************
110 REM NAME: BLACK JACK
120 REM BY  : JOHN AVIS
130 REM DATE: 23 AUGUST, 1987
140 REM *********************
150 POKE650,128:PRINTCHR$(8)
160 POKE53280,1:POKE53281,1
170 DIMS$(52),C(52),D(4)
180 PRINT""
200 PRINTTAB(12);"C O M M O D O R E"
210 PRINTTAB(11);"                 "
220 PRINTTAB(11);"                 "
230 PRINTTAB(11);"                 "
240 PRINTTAB(11);"                 "
250 PRINTTAB(11);"                 "
260 PRINTTAB(11);"                 "
270 PRINTTAB(11);"                 "
280 PRINTTAB(11);"                 "
290 PRINTTAB(11);"                 "
300 PRINTTAB(11);"                 "
310 PRINTTAB(11);"                 "
320 PRINTTAB(12);"B L A C K J A C K"
325 PRINTTAB(13);"JOHN AVIS, 1987"
330 FORA=1TO1500:NEXTA
340 FORA=1TO25:PRINT:NEXTA
350 FORJ=0TO3:FORI=1TO13
360 C(I+J*13)=I:S$(I+J*13)=""
370 IFJ=1THENS$(I+J*13)=""
380 IFJ=2THENS$(I+J*13)=""
390 IFJ=3THENS$(I+J*13)=""
400 NEXTI,J
405 FORY=1TO2
410 PRINT"B L A C K J A C K"
420 PRINT"_________________"
425 PRINT"PLAYER"Y""
430 PRINT"                                "
440 PRINT"|     ||     ||     ||     ||     |"
450 PRINT"|     ||     ||     ||     ||     |"
460 PRINT"|     ||     ||     ||     ||     |"
470 PRINT"|     ||     ||     ||     ||     |"
480 PRINT"|     ||     ||     ||     ||     |"
490 PRINT"                                "
495 IFY=2THENPRINT"SCORE TO BEAT;"PL(1)
500 S=-1:T=0
510 S=S+1
520 GOSUB1000
530 IFS=0THENW=1
540 IFS=1THENW=8
550 IFS=2THENW=15
560 IFS=3THENW=22
570 IFS=4THENW=29
580 PRINT"";TAB(W);N$
590 PRINT"";TAB(W+2);S$(P)
600 PRINT"";TAB(W+3);N$
610 T=T+D(S)
620 PRINT"";TAB(W);T
621 IFS=1ANDT=21THENPRINT"BLACKJACK...";GOTO680
625 IFT>21THENPRINT"BUST...";GOTO680
627 IFS=4ANDT<22THENPRINT"5 CARDS AND UNDER 21..";GOTO680
630 PRINT"";
640 PRINT"F1-SIT, F3-MORE"
650 GETA$:IFA$=""THEN650
660 IFA$=""THEN510
670 IFA$<>""THEN650
675 PRINT"SITTING..."
680 PL(Y)=T
690 IFT>21THENPL(Y)=0
700 FORA=1TO1000:NEXTA,Y
710 IFPL(1)=0ANDPL(2)=0THENPRINT"NO RESULT...";GOTO730
715 IFPL(1)>PL(2)ORPL(1)=PL(2)THENPRINT"PLAYER 1 WINS..."
720 IFPL(2)>PL(1)THENPRINT"PLAYER 2 WINS..."
730 PRINT"PRESS <RETURN> TO PLAY AGAIN..."
740 GETA$:IFA$=""THEN740
745 IFA$<>CHR$(13)THEN740
750 GOTO405
1000 P=INT(RND(1)*52+1)
1010 IFC(P)=0THEN1000
1020 N$=STR$(C(P)):D(S)=C(P)
1030 IFC(P)=1THENN$=" A":D(S)=11
1040 IFC(P)=11THENN$=" J":D(S)=10
1050 IFC(P)=12THENN$=" Q":D(S)=10
1060 IFC(P)=13THENN$=" K":D(S)=10
1070 IFC(P)=10THENN$="10":D(S)=10
1080 RETURN

READY.
```

Titanic

Titanic is a sea adventure game, where you pit your wits against the computer's ship/s. As the computer cannot 'see' the icebergs, you must try to lure the ships into icebergs. You can have either one or two enemies, and full instructions are included.

S. Carter
Heathmont
Vic

Blackjack

This program is a two player version of the popular card game, Blackjack. To play just press the first function key to 'sit' and the second function key to receive more cards. If your card total is over 21 you 'bust', and if you have five cards and less than 21 then you win.

J. Avis
Frenchs Forest
NSW

ETI PROJECTS

198 months of projects

June 1971-December 1987

SIMPLE PROJECTS

No.	Name	Date	Suppliers
043	Heads or tails	Oct 76	AEC, RIE
044	Doorbell	Oct 76	AEC, RIE
061	Simple amp	Oct 76	RIE

On page 64 the negative lead from the 9 volt battery to the Veroboard (Fig. 2) should be connected to the copper track above that shown, i.e. to the track marked 'common'.

062	Simple AM tuner	Mar 77	
064	Intercom	Nov 76	RIE
066	Temp alarm	Dec 76	RIE
068	LED dice	Oct 76	AEC, RIE
070	Tie breaker	Jan 77	
071	Tape noise limiter	Jun 78	RIE
072	Two octave organ	Jun 78	RIE
081	Tacho	Mar 77	AEC
084	Revised Car Alarm	Oct 87	
801	LINC	May 75	
802	Windicator	Feb 75	
803	Cannonballs and missionaries	Dec 75	

In Fig. 2 on page 101 the line joining the contact M3d to the buzzer common line should be deleted. Switch M3d should be normally open. On page 102 Fig. 5 a connection should be made between the bottom-left contact of M3 and the bottom-right contact of M1.
For those who built this project and think that it cannot be solved — and for those still struggling with the problem on bits of paper — here's a solution.
M means any missionary. C means either of the non-rowing cannibals. C2 means the cannibal who can row.

1. C and C2 go over
2. C2 comes back
3. C and C2 go over
4. C2 comes back
5. M and M go over
6. M and C come back
7. M and C2 go over
8. M and C come back
9. M and M go over
10. C2 comes back
11. C and C2 go over
12. C2 comes back
13. C and C2 go over

804	TV game	Nov 76	
805	Drunken sailor	Oct 77	
806	Skeet	Jan 78	
807	Tub o'war	Aug 84	
810	TV game	Jun 78	
811	Tank game	Oct 78	
812	wheel of fortune	Dec 78	
813	Race track	Jan 79	
814	Electronic dice	Aug 79	AEC

Capacitor C2 is shown with the wrong polarity on both the circuit and the overlay. Also, C1 and C2 are incorrectly listed in the parts list. C1 is a 10µF tantalum.

824	Slot car controller	Dec 81	

The power transistor, Q1 is an MJ2955, not a 2N2955. On the overlay, page 29, R3 is shown as 830R, but is really 820R, as in the circuit and parts list.

905	Organ	Jan 83	
918	Polyphone light beam transceiver	Sep 82	
201	Current limiter	Apr 71	
202	Stereo balance meter	May 71	
203	10 c moisture meter	Jun 71	
204	Elapsed time indicator	Aug 71	
205	Doorbell	Sep 71	

No.	Name	Date	Suppliers
206	Audio visual metronome	Oct 71	
207	Emergency lighting unit	Oct 71	
208	Loudhailer	Nov 71	
209	Meter mount	Oct 72	
210	Decision-maker	Jan 73	
211	Audio frequency meter	May 73	
212	Earth resistivity meter	May 73	
213	The revealer	Jun 73	
215	Cyclone detector	Nov 73	
216	TV ghose eliminator	Feb 74	
217	12 V power supply	Feb 74	
218	Mono organ	May 74	
219	Hee-haw siren	May 74	
220	Wailing siren	May 74	
221	Basic power supply	May 74	
222	Transistor tester	May 74	
223	Multi vibrator	May 74	
224	Temp alarm	May 74	
225	Simple amplifier	May 74	
226	Temp meter	May 74	
227	Crystal radio	,May 74	
228	Pocket metronome	Aug 74	
229	Metre beater	Nov 74	
230	The family ferry	Sep 74	
231	Flip-flop flasher	Jan 75	
232	Courtesy light reminder	Oct 74	AEC
233	Combination lock	Oct 74	
234	Intercom	Oct 74	
235	Bicycle speedo	Mar 75	
236	Code practice oscillator	Aug 75	
237	Loudness control	May 75	
238	Headphone adaptor	Dec 75	
239	Breakdown beacon	May 76	
240	High power rescue signal	May 76	AEC
241	electronic dice	Jul 76	
242	Neo nim	Aug 76	
243	Pip beacon	Apr 77	
244	Car alarm	Feb 77	
245	White line follower	Nov 77	
246	Rain alarm	Apr 78	AEC
247	Soil moisture indicator	Nov 80	

There is an error in How It Works on page 52. The circuit on Figure 3, lower right, shows the zener the wrong way round.

248	12 V-22 V converter	Jul 78	AEC
249	Combination lock	Apr 79	AEC

First of all, scrap Table 1 and the associated copy above it. Secondly, have faith in the 'How it Works', for it is correct.
The connections to SW1 and SW2 on the circuit and incorrect. Pin 8 of SW1 goes to C(R8). Pin 1 of SW2 goes to D(D2). Pin 4 of SW2 goes to E (C8, R9 and gate of SCR3). Pin 11 of SW2 goes to F (C6, R6 and gate of SCR2). Note that H on the overlay is point K on the circuit.
Overall, dialling the sequential code on SW1 and SW2 should connect, in sequence, B-D, then A-F, then C-E. Work out your code appropriately.

250	House alarm Incorrectly labled ETI-262	Aug 80	
251	Op-amp power supply The overlay is reversed. See Sept 85 p9.	Aug 85	AEC
252	Passionmeter	Apr 85	
253	Grenade/hot potato game	May 79	
254	Egg timer	Jun 79	
255	Temperature meter	Nov 80	AEC

The meter in the circuit diagram on page 39 was shown the wrong way round. The negative terminal of M1 goes to pin 2 of the LM3911.

KEY TO KIT SUPPLIERS

AEC All Electronic Components
Alt Altronics
App Applix
DSE Dick Smith Electronics
EC Energy Control
ED Electronic Discounters
FE Force Electronics
HIC Hi Com
Jay Jaycar
LE Laser Electronics
RIE Rod Irving Electronics
SYM Symtec

In addition, the following companies advise that they make an effort to keep a selection of parts for all projects:
Eagle Electronics

Circuit Wood
Magshire
Prepac
Circuit boards and some front panels are available from the following:
Jemal
MCS Radio
All Electronic Components
The following services are available direct from ETI:

Artwork for all our projects: $5 for boards up to 10 cms. $10 for larger boards.
Back issues of avaliable: $4
Photocopies of articles: $4 (or $8 if more than one)
Send orders to **Reader Services, ETI magazine, 180 Bourke Road, Alexandria NSW 2015. Sydney, Australia.** Please note that phone orders cannot be accepted.

PROJECT INDEX

No.	Name	Date	Suppliers
256	Humidity metre/controller	May 81	RIE, AEC
257	Universal relay board	May 81	RIE, AEC
258	Mini-drill sped controller	Jul 81	
259	Low-cost timer	Jan 82	
260	CMOS flasher	Dec 79	Jay, ED
261	Fog hom	Dec 79	
262	Intercom	Dec 79	
263	Egg timer	Dec 79	
264	Siren	Mar 80	
265	Mains appliance timer	Jul 83	RIE, AEC
266	Crystal set	Dec 79	
267	Voltage multiplying crystal set	Dec 79	
268	Nicad float charger	Nov 83	RIE, Jay, ED

The curve for 'Typical charging characteristics of NiCad cells' (on page 31) is for one particular type and may not be indicative of most currently on the market. While the shape is generally similar, the maximum terminal voltage reached is generally between 1.4 V and 1.5 V, not 1.7 V as shown.

270	Solar-powered radio	Dec 79	
271	Solar intensity meter	Dec 79	
272	LED amp output indicator	Nov 83	RIE
273	Let caller for tennis	Jan 84	
274	Fast Nicad charger	Feb 84	

Figure 2 shows the battery negative connected to the heatsink. It should be insulated from it. The BYX/200L diode cathode connects to the collector of Q4/Q5 and R1/LED via the heatsink, not the wires shown.

275	Bathroom heater timer	Jun 84	
277	Ready-set-go timer	Oct 84	
278	Door minder	Nov 84	RIE

The overlay and wiring diagram on page 70 contains an error in the caption at the top left corner. The sentence "makes sure the green (neutral) mains lead is the longest" should read as follows: "make sure the green/yellow striped earth wire is the longest."

279	Darkroom exposure meter	Jan 85	AEC
280	Low battery voltage indicator	Mar 85	RIE, Alt, FE, AEC, ED
281	Power supply	Dec 86	
282	Telephone screamer	Sep 86	Jay, ED
283	Lotto selector	Dec 86	
284	VCR Alarm	Nov 86	
285	Oscillators and Ampfliers	Mar 87	
286	Mutt Minder	Mar 87	SYM
287	LED Light Chaser	Oct 87	AEC

Two links left off overlay diagram, see December 87, p20.

288	Ring Tone Customizer	Jun 87	

The pc board artwork is the wrong way around and also the wrong size. Write ETI for a correct version.

289	Watch Alarm In coke tin	Dec 87	

TEST EQUIPMENT

101	Logic power supply	Jun 71	
102	Audio signal gen	Jun 71	
103	Logic probe	Jul 71	
104	Soldering iron control	Aug 71	
105	Dual power supply	Nov 71	
106	CRO calibrator	Feb 72	
107	Voltmeter	Feb 72	
108	Decade resistance box	Sep 72	
109	Digital frequency meter	Sep 72	
110	FET voltmeter	Oct 72	
111	IC power supply	Nov 72	
112	Audio attenuator	Mar 73	
113	Thermocouple meter	Sep 73	
114	Dual beam adaptor	Jul 74	
115	Linear IC tester	Aug 74	
116	Impedance meter	Mar 75	
117	Digital voltmeter	Aug 75	
118	Frequency meter	Sep 75	
119	Switching regulator	Dec 75	
120	Logic probe	Sep 75	AEC
121	Logic pulsar	Sep 75	AEC
122	Logic tester	Oct 75	
123	CMOS tester	Nov 75	
124	Tone burst gen	Nov 75	AEC
125	Oscillator	Jun 75	
126	rf power control	Jan 75	
127	TTL super test	Feb 75	
128	Audio mV meter	Jan 76	
129	rf signal generator	Jan 76	
130	Temp meter	Feb 76	AEC

The photo on page 45 is not that of the temperature meter. The correct photo may be found on page 55.

131	Power supply	Apr 76	AEC

Several references are made throughout the text to R14 and R15. Wherever R14 appears read R12, and wherever R15 appears read R13. In the How It Works section wherever R7 appears read R5.

132	Power supply	Feb 77	AEC
133	Phase meter	Apr 77	AEC
134	RMS voltmeter	Aug 77	
135	Intersil panel meter	Oct 77	AEC
136	Linear scale panel meter	Mar 78	
137	Audio oscillator	May 78	
128	Audio wattmeter	Nov 78	
139	SWR meter	May 78	
140	1 GHz frequency counter	Mar/Apr 78	
141	Logic trigger	Jan 79	
142	Power supply	Feb 79	AEC

The wrong gauge wire was shown for coil L2. The correct gauge is 1.6 mm.

The circuit and wiring diagrams for this project contain a mistake that all builders should be aware of — even at this late stage. Wires from the transformer T1 (PF4244 240V/32V 300 VA) are incorrectly labelled orange and white on the circuit. They should be transposed so that 'orange' should connect to the rectifier rather than 'white' as is shown, and 'white' should connect to the circuit board instead of 'orange'.

143	Curve tracer	Jan 79	
144	True RMS voltmeter	Jun 79	
145	Test board	Jul 82	AEC
146	mains master	Nov 79	
147	Electronic load	Oct 80	RIE
148	Logic probe	Jul 79	AEC

Some readers have reported trouble with this project, apparently caused by the large spread in parameters of some 4049 ICs. Try chips of a different manufacture, is the advice we have received. Also, buffered 4049s or even 4009s may be used, but to get correct operation over the range of supply voltage from 5V to 15V, resistors R2 and R3 should be changed to a value of 1M each.

149	Two tone tester	Jul 80	RIE
150	Frequency meter	Dec 79	AEC
151	Ohm meter	Jan 80	

If you find your speed potentiometer has a considerable 'dead band' at the 'top' (towards full speed) end, this indicates your drill has lower back-emf than that designed for. The cure is to increase R3. If all the speed control is crowded over about 60 of rotation, increase R3 to 330k. If you get 90 or 100 of rotation for zero to full speed, change R3 to 220k or 180k, etc. You may need to increase R4 from 27k to 56k or 68k, also. DISCONNECT THE UNIT FROM THE MAINS BEFORE MAKING ANY MODIFICATIONS.

152	Capacitance meter	Feb 80	

The instrument will not function properly on the 1µ x 10 scale (i.e. 10µ full scale) as the integration time is not long enough. A simple modification cures this. Change SW3 to a DPST type. Change R1 to 1M2. Add a 100 ohm resistor switched across R7 by the extra pole of SW3.

153	Temperature probe	Jan 83	RIE, Jay, ED

Note at the end of the parts list says that a 5V6, 1 W zener can be substituted for the original. This should actually read 5V1, 1 W.

154	Digital logic pulsar	Jul 81	
155	4/8/16 ohm audio dummy load	Jun 81	
156	100 MHz hi impedance probe	Jun 81	
157	Crystal marker	Oct 81	AEC
158	Low ohm meter	Nov 81	RIE
159	10-15 V expanded scale meter	Dec 81	AEC, RIE

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

160	13.8 V/10 A power supply	Jul 82	Alt, FE, ED
161	Digital panel meter	Aug 82	AEC
162	30 V/1 A power supply	Dec 82	AEC, RIE, DSE
163	40 V/5 A power supply	May/Jun 83	AEC, RIE
164	Zener tester	May 83	RIE, Alt, FE, ED
165	Tacho calibrator	Nov 82	
166	Function generator	Jul/Aug/ Sept/Oct 83	AEC

The following errors crept into the parts list: C17 should be deleted, C18 — 22p ceramic, C19 — 470p ceramic, C19 — 470p ceramic, C20 — 4n7 greencap, C21 — 47n greencap, C22 —

PROJECT INDEX

No.	Name	Date	Suppliers
	470n greencap. C23 — 4µ7/16 V RBLL. C24 — 47µ/16 V RBLL. C24 shown on the circuit as 100n was not put on the pc board. It may be soldered on the copper side between pins 1 and 14 of IC4. There are two R40s on the overlay. the one next to R54 is actually R58. Some relays may not match the board and it will be necessary to drill extra holes and wire them in with links.		
168	Continuity tester	Sep 85	
169	Low distortion oscillator	Oct/Nov 85	
	Resistors R38-R49. are labelled incorrectly on the overlay. Also on the overlay. the pc board track from pin 2 IC3 is shown leading to pin 16 IC5. Rather it should lead to pin 15 IC5. To correct this. cut the track from pin 2 IC3 at pin 16 IC5, and attach fly wire between the cut track and pin 15 of IC5.		
170	CRO calibrator	Feb 85	
	In order to make the attenuators conform to the front panel artwork, use the following resistor values: R = 220R, R18 = 330R, R22 = 22R, R23 = 33R, R29 = 220R, R30 = 330R, R34 = 22R, R35 = 33R.		
171	Arbitrary waveform generator	Feb 86	AEC
172	Bit pattern detector	Apr 86	RIE
173	Electro static hazard detector	Jun 86	RIE
174	Timebase standard	Jul 86	RIE
175	20 MHz DFM Q1 and Q2 do not exist	Sept/Oct 85	AEC
177	Analogue Frequency Meter	Jun 87	
178	Analogue Capacitance Meter	Jul87	
179	Analogue Breadboard	Aug 87	AEC
181	RS232 Breakout Box	Nov 87	AEC
182	Digital luxmeter	Mar 85	AEC
183	Op amp tester	Apr 85	AEC, RIE
	The battery polarity was shown reversed in the original circuit diagram. The correct polarity is shown herewith		
184	In-Circuit IC tester	Aug 87	AEC

AUTOMOTIVE

301	Variwiper	May 71	AEC
302	Tacho/dwell	Jul 71	
303	Brake light indicator	Oct 71	
304	Light-operated switch	Nov 71	
305	Car alarm	Jan 72	
307	Headlight reminder	Oct 72 Oct 74	
308	Turn indicator	Feb 73	
309	Battery charger	Aug 73	
310	Ignition timing light	Jun 74	
311	Tacho — timing light	Sep 74	
312	CDI	Dec 74 Jan 75	AEC
313	Car alarm	Nov 74	AEC
314	Auto amp	Feb 75	
315	Solid state flasher	Feb 75	
316	Transistor ignition	May 77	AEC
317	Tacho warning light	Jul 77	AEC
318	Tacho digital	Jul 78	AEC
319	Variwiper Mk2	Sep 78	AEC
320	Battery indicator	Apr 79	AEC
321	Fuel level warning	Jan 80	AEC
322	Over-rev alarm	Mar 80	AEC
323	Headlight delay	May 83	RIE
324	LED tacho	Aug 80	RIE, DSE, Alt, FE, AEC, ED
325	Auto probe	May 80	RIE, AEC
326	Expanded LED voltmeter	Sep 80	RIE, Alt, FE, AEC, ED
327	Hazard flasher	Oct 80	RIE, AEC
328	Oil temp meter	Jan 81	RIE, AEC
329	Expanded scale car ammeter	Feb 81	AEC
330	Car alarm	Jul 81	RIE, DSE, AEC
332	Engine stethoscope	Aug 81	AEC
333	Vehicle reversing alarm	Jan 82	RIE, AEC
334	Auto tester	Jan 83	
335	Programmable wiper controller	Mar 83	RIE, AEC
336	Dwell meter	Aug 83	
337	Auto car antenna driver	Sep 84	AEC
340	Car alarm	Apr 84	Jay, ED, AEC
341	Electronic jumper leads	Aug 85	AEC
342	Pulse-shaped CDI	Feb/Mar 85	Jay, ED
	The circuit diagram should have shown R8 as 220k not 220R.		
343	Optical car alarm switch	Sept/Oct 85	HiC
345	Demister timer	Jun 86	AEC

AUDIO

400	Speaker	Jun 75	
401	FET 4 channel mixer	Sep 71	
402	Simple channel sound	Apr/Aug 71	
403	Guitar sound box	Apr 71	
404	FM conversion unit	Apr 71	
405	Magna ray 8-30	Jul 72 Aug 71	
406	Single transistor radio	Dec 71	
407	Bass booster	Dec 71	
408	Reverb unit	Mar 72	
409	TV sound	Mar 72	
410	Super stereo	May 72	
411	Small speakers	Aug 72	
412	LED peak program meter	Oct 83	RIE, Alt, FE, AEC, ED
	The linking for dot/bar mode is shown incorrectly on the circuit and component overlay. For a dot mode display, link pins 9 and 11 (as per the photograph of the board); for the bar mode, link pin 9 to the positive supply.		
413	100 W guitar amp	Sept 75 Dec 72	
414	Stage mixer	Feb/Apr 73 Mar 75	
415	Quadraflex speakers	Jan 73	
416	25 W amp	Jan/Jul 73	
417	Over LED	Aug 73	
418	Music synth	Oct	
419	Preamp	Sept 73	AEC
420	4 channel amp	Jan/Feb 75 Sept 83	
421	Low-cost stereo speaker system	May/Jun 74	
	On the pc board overlay on page 86 the labels on the two capacitors are reversed — C1 is the 2 µF capacitor, C2 the 8µF capacitor. The values shown are in the correct position. The Parts List and circuit diagram are correct.		
422	50 W stereo	Oct 75	
423	Add-on 4-channel amp	Apr 74	
424	spring reverb	Sep 74	
425	Integrated amp	Jun-Sep, Dec 72	
426	Rumble filter	Oct 74	AEC
427	Graphic equalizer	Oct 74	
428	Amplifier	Dec 74	
429	Colour organ	Nov 74	
430	Line amplifier	Mar 75	
431	FM antenna	Apr 75	
432	Ceramic preamp	Jun 75	
433	Active crossover	Sep 75	
434	Two tape facility	Oct 75	
435	Crossover amplifier	Oct 75	
436	Dynamic noise amplifier	Sep 75	
437	Simple speaker	Nov 75	
438	Audio level meter	Dec 75	AEC
439	3-way speakers	Dec 75	
440	25 W amplifier	Jul 75	
441	Noise generator	Jan 76	AEC
442	Masterplay stereo	Sep 84	AEC
443	Expander compresser	Apr 76	AEC
444	5 W amp	Jun 76	AEC
	On page 44 in the specification table the frequency response should be 4 HZ to 200 kHz within +1 and −3 dB.		

PROJECT INDEX

No.	Name	Date	Suppliers
445	Stereo preamp	Jul 76	RIE, DSE, Alt, AEC, FE, ED
446	Audio limiter	Aug 76	AEC

The integrated circuit IC1 should not be a Philips type as these versions of the IC have buffered outputs. These devices cannot therefore be connected to give a FET for use in the linear mode as required in the audio limiter.

447	Audio phaser	Sept 76	AEC

The integrated circuit IC9 should *not* be a Philips type. These have buffered outputs and therefore cannot be connected to obtain a FET as required in the Audio Phaser.
On the circuit diagram RV1 is shown connected between +9 volts and the junction of R5 and R6. On the printed circuit board it is connected between +9 volts and the zero-volt line. This variation in connection does not affect operation of the phaser.
The phaser is sensitive to supply-voltage variations especially when using small batteries. Use a large battery, or use a 12 volt battery to feed a 9 volt zener regulator via a 220 ohm resistor.

448	Disco mixer	Nov 76	
449	Balanced mic	Nov 76	RIE, AEC
450	Bucket brigade	Dec 77	AEC
451	50 Hz/100 Hz hum filter	Jul 79	AEC
452	Guitar practice amp	Jan 80	AEC
453	Class B amp	Apr 80	RIE, Alt, FE, AEC, ED
454	Fuzz board	Apr 80	AEC
455	Loudspeaker protection unit	Mar 80	RIE, AEC

On page 41 there is a note on the circuit diagram that says "D1-D4 are 1N914; D5, D6 are 1N4004". This is incorrect: the parts list shows the correct types.

456	140 W amp	May 80	

The power transformer . . ." In the parts list on page 35, D1-D10 and D11-D15 are listed incorrectly. D1-D10 are A14Ps and D11-D15 are 1N4004s as shown on the circuit diagram.

457	Scratch and rumble filter	Sept 80	AEC
458	Peak/average LED level meter	Jun 81	RIE, AEC
459	Third octave graphic equalizer	Nov 82	RIE

In the circuit diagram on page 32, power supply section, diodes D2 and D3 are shown back to front. The pc board overlay is correct. In the parts list, R5 and R6 are shown as 15k, but 10k on the circuit. 10k is the correct value, though not critical.

460	Third octave analyzer	Nov 82	
461	Balanced input preamp	Dec 82	RIE, Alt, FE, AEC, ED
462	Headphone monitor/splitter	Apr 84	
463	Master play 2-way speakers	Oct 84	
464	IC audio amp	Jul 83	RIE, AEC
465	Loudhailer using the 464	Jul 83	
466	300 W amp	Feb 80	RIE, AEC
467	Guitar/mic preamp for 466-4	Jul 80	RIE, AEC Jay, ED

Firstly, on the circuit (page 49) exchange R34 and R35. The 1k resistor should now be connected from pin 9 of IC2b to the common rail (earth, or 0 V). The capacitor across the presence control, a 4n7 marked 'C20', is actually C24. These three components are correctly marked on the overlay.
Next, on the overlay photo (page 50) IC1 and IC2 have been shown with the incorrect orientation. Pin 1 of IC1 is located diagonally opposite to where it it is shown on the overlay. It should be adjacent to R1. Similarly with IC2, pin 1 should be located adjacent to R23. The pc board copper side has them marked correctly.
On the Parts List, R35 and C24 do not appear. Add a 270R resistor and a 4n7 greencap, respectively. Finally, in the second paragraph on page 50, the maximum output is quoted as ". . . 200 volts peak to peak . . ." In reality, it is a more modest 20 volts peak to peak. Kit and component suppliers have already been notified.

469	Drum machine (precision synth)	Apr 82	AEC

Diodes D1 to D6 were omitted from the Parts List on page 43. They are all 1N914s or 1N4148s.

470	60 W amp	May 79	RIE, AEC

The earth rail onto the amplifier must be returned to the 0 volt connection on the power supply. Although it is obvious to most people it was not indicated on the circuit for the 470 module, but was shown on the wiring diagram for the Series 4000 amplifier system in the June issue.

471	Pre-amp	Jun 79	RIE, AEC

The loudness control produces 8 dB boost at 150 Hz and 10 kHz, rather than at 15 kHz and 10 kHz as the article stated (gremlins again . . .). Also in the circuit diagram the function LEDs are shown the wrong way round with respect to the switch, as in the LED power supply with respect to the overlay. The overlay is correct and should be followed, but either connection will work. In the parts list the resistors R118 and R119 have been omitted. They are both 15k, ½ W, 5%.

472	Power supply	Jul 80	AEC
473	Moving coil amp	Oct 80	AEC
474	4000 power amp interface	Feb 80	AEC
475	AM tuner	Aug 80	AEC

RFC1 was omitted from the parts list. This is a Philips type VK200 wideband choke and consists of a six-hole ferrite bead (type number 4312-020-31550) with a length of 22 swg tinned copper wire passed through it five times. In the antenna details the copy beneath the antenna matching coil on page 26 should read: "For use with small loops 6-8 turns" and "For use with large loops 2 turns".

476	Series 3000 amp 'compact'	Nov 80	AEC

An error appears in the How It Works on page 28. Under the sub-heading "Power Amplifier" third paragraph, there is a sentence which reads: "This leaves a total of 0.6V to be dropped across the two 27 ohm resistors R27 and R28". It should read ". . . 100 ohm resistors R27 and R28".
On the overlay (in both Nov. & Dec.) R34 is shown as 270R when it should be 180R. In the parts list, R25, 26, 125 and 126 should be shown as 180R. Only R34 should be shown as "180R, see text". Capacitor C21 (same as C20) was left off the parts list.

477	Series 5000 power module	Jan/Feb/ Mar 81	RIE, Alt, FE, AEC, HiC, Jay, ED

In the circuit diagram capacitors C7 and C8 were shown connected between the gates of Q9 and Q11 respectively, and the feedback line. In fact, they connect between the gate and source of each device, as shown in the Feb. issue.
In the **February** issue, under How It Works, there is a typographical error in the second last sentence, third column. It reads 'Transistors Q4 and Q5 therefore form the main voltage gain section of the amplifier . . .". It should read "Transistors Q6 and Q8 . . .".
The ETI-477 MOSFET amp is not unstable if you build it the way we described. However, some readers have reported difficulties with the amplifier going into high frequency oscillation. There are two reasons for this. If capacitor C9 (200 greencap) has a high self-inductance it will look like a capacitor, the amplifier output will be unloaded at high frequencies and oscillation will result. We found 'Elna' 630 V greencaps have a low inductance and the amp is not unstable using them.
Secondly, if resistors R25 and R27 have more self-inductance than the 'Noble' types we used, then the output stage may be unstable. There are two cures for this one. Either replace R25 and R27 with Noble types or connect a 47n greencap between the sources of Q9 and Q11. This is best done on the copper side of the board, mounting the capacitor between the two pads where the leads of each resistor go to the sources of Q9 and Q11.

478	Series 5000 Stereo preamp	Jul/Sept/ Oct 81	RIE, Alt, FE, AEC, HiC, Jay, ED

Overlay p38, Oct 81, shows R53 as 220R. It should be 220k.
The 400 Hz oscillator set-up procedures is as follows, not as per page 12 in Dec. '81. Take your multimeter, set to read ac volts, and connect it to one of the output sockets. Set the TAPE switch to OSC, and adjust RV4 to obtain 1.2 Vac (RMS) on the meter.

479	Series 5000 power amp adaptor	Mar 82	RIE, Alt, FE, AEC, HiC, Jay, ED
480	50/100 W amp	Dec 76	RIE, DSE, AEC, Jay, ED
481	12 V 100 W amp	Jun 77	AEC
482	50 W stereo amp	Jan/Feb 77	AEC
483	Sound level meter	Feb 78	AEC
484	dBX	Jul 77	
485	New equalizer with gyrator	Jun 77	AEC
486	Frequency shifter	Nov 77	AEC
487	Real-time audio analyzer	Feb 78	AEC
488	650 W 2-NDFL module	Jan 83	
489	Mk2 real-time analyzer	Apr 78	AEC
490	Speech compressor	Dec 78	AEC
491	Graphic equalizer	Mar 79	

A very important resistor was left off the circuit and overlay in this project — A 15.7 k resistor, made from an 18k and 120k in parallel, connects between the output of the gain pot and the input (pin 2) of IC6. The circuit will not work without it.

492	Sound bender	Feb 82	RIE, DSE, AEC
494	Loudspeaker protector	Oct 82	RIE, Alt, AEC, Jay, ED
495	TL speakers	Aug 77	
496	4-way 4000/I speakers	Feb 80	RIE
497	3-way 4000/2 speakers	Jun 80	
498	PA system using the 499	Jun 82	AEC
499	MOSFET amp	Mar 82	AEC, Jay, ED

Some people have had trouble with the output offset voltage adjustment, being unable to reduce it to 10 mV or less. This can be fixed by changing R2 from 100k to 33k. The input high-pass pole only rises to just under 20 Hz, which is OK.

1401	DI box	Sep 85	Jay, ED
1402	Sampler	Apr/May/ Jun 86	RIE, AEC

Resistors mentioned in the Parts List as 5% should be 2% and those marked as 2% should be 5%. The standby power supply VA mentioned at the end of the How It Works should be in house style reading V_{GG} as in the circuit diagram. On the wiring diagram, the trigger switch is labelled incorrectly: terminal lettering F should read J and vice versa.

PROJECT INDEX

No.	Name	Date	Suppliers
1404	4/channel mixer	Jul 85	AEC
1405	Stereo enhancer	Mar 85	RIE, AEC

It is necessary to buffer the metering circuitry from the main signal path. It was originally intended to put the buffers on the meter board but due to layout requirements it was decided that the main board was better. Unfortunately in the melee the buffers were deleted from the meter board but never reinstated on the main board. To fix this, an op-amp will have to be inserted between the main board and the meter board. The circuit and board are shown on p80, Apr '86. The small board mounts on two of the meter board mounting bolts on the right hand side (looking from the front). The positive supply and earth to the buffer can be taken from the meter board supply pins. The negative supply can be taken from the junction of C4 and IC2. The values of the two caps on the reverse side of the meter board should be dropped from 220n to 22n.

Also, the pin numbers from IC5 and the component numbers for R4, R7 and C7, C10 were marked incorrectly on the circuit diagram. The overlay is correct.

1406	Parametric equalizer module	Aug 86	Jay, ED
1407	dbNH noise reduction	Dec 86	
1408	Scan Audio HiFi speakers	Feb 87	
1409	Passive Radiator	Mar 87	
1410	Bass guitar amp	Aug/Sept 84	AEC
1412	Stereo Loudspeaker switcher	Feb 87	

The pc board artwork was incorrectly pinned showing component side rather than copper side. To rectify: reverse the negative of the artwork.

1414	Walkam Amp	Sept 8	

See page 10 May ETI 1987 for correct diagram featured on page 61.

1416	Chorus Unit	Jul 87	
1420	Indoor paging amp system	Jul 84	
1421	Input and tone cont preamp	May 84	RIE
1422	Budget column speakers	Dec 84	
1424	Versatile Guitar Preamp	Nov 87	

MISCELLANEOUS

501	Soil moisture meter	Apr 71	
502	Emergency flash	May 71	
503	Intruder alarm	May/Jun 71	
504	Fastest finger	Jul 71	
505	Hi-powered strobe	Aug 71	
506	Infrared alarm	Sep 71	
507	The farmer's problem	Sep 71	
508	Fluoro light dimmer	Oct 71	
509	50-day timer	Dec 71	
510	Safety crossing	Jan 72	
511	Battery savers	Feb 72	
512	Photographic timer	Mar 72	
513	Tape-slide synchronizer	Apr 72	AEC
514	Sound-operated flash	May 72, May 76	AEC
515	Slave flash	May 72	
516	12 V fluorescent light	Nov 72	
517	Electronic decision-maker	Jan 73	
518	Door monitor	Apr 73	
519	Nicad	Feb 74	
520	Digital stopwatch	Oct 73	
521	Digital clock	Jul 73, Mar 74	
524	Laser	Dec 73	
525	Drill speed controller	Oct 74	AEC
526	Print timer	Aug 74	
527	Pushbutton dimmer	Nov 75	
528	House alarm	Jan 75	AEC
529	Poker machine	May/Jun 75	
530	Temp controller	Oct 74	
531	Coin collector Mk1	Dec 74	
532	Photo timer	Jun 75	AEC
533	3-digit display	Jul 75, Aug 76	
534	Cal stopwatch	Jan 76	
535	Swimming pool alarm	Nov 75	
536	Low-cost digital clock	Jan 75	
537	Low batt warning	Feb 75	
538	Homet power supply	Mar 75	
539	Touch switch	Mar 76	AEC

Add to the parts list:
IC1 integrated circuit 4049 or 449 (CMOS) (do not use Philips ICs or the 4009).

No.	Name	Date	Suppliers

It is recommended that a 2k2 half watt resistor be fitted between gate and cathode of the SCR.

540	Universal timer	May 76	AEC
541	Train controller Mk1	Jun 76	AEC
543	STD timer	Jul 76	AEC
544	Heart rate monitor	Sep 76	AEC

In the parts list on page 77, C1 should be 100 nF and C2 should be a one microfarad 35 volt electrolytic.

Due to the simplicity of this device adjustment of the sensitivity control is fairly critical. To use the instrument adjust the sensitivity control upwards only sufficient to obtain reliable triggering. A too-high setting will result in false triggering and hence a too-high heart-rate indication.

In the How It Works section on page 79 in the third column, seventh line, read IC2/2 *not* IC2/1.

546	Bio rsistance	Mar 77	AEC
547	Bell extender (telephone)	Jun 77	RIE, AEC
548	High power strobe	May 77	AEC
549	Metal detector	May 77	AEC
550	AM digital dial	Aug 78	AEC
551	Chaser	Sep 78	AEC
552	LED pendant	Sep 78	
553	Tape-slide synchronizer	Oct 78	AEC
555	Light activated tacho	Nov 78	AEC
556	Windspeed	Dec 78	
557	Reaction timer	Feb 79	AEC

The Q and Q bar outputs of IC6 are transposed on the circuit diagram. IC4 is a 4018.

558	Masthead flasher	Feb 79	
559	Cable tester	Mar 79	
560	Mains cable seeker	May 80	
561	Metal detector	Mar 80	RIE, AEC

The component overlay on page 33 shows R3 as a 1M resistor where it should be 100k.

562	Geiger counter	Apr 80	AEC
563	Fast Nicad charger	Jul 80	AEC, RIE

Constructors having difficulty obtaining the 1N5625 diodes specified for D6 and D7 in this project, note that Motorola type MR-856 diodes may be substituted.

564	Digital clock (large)	Aug 80	AEC

The pc artwork on page 137 is missing a track between pin 5 of IC2 and pin 11 of IC3. With this missing, the project will work but the clock will gain around four minutes a day as IC2 will divide by a little less than 3000.

565	Laser	Jul 80	LE
566	Pipe and cable locator	Apr 80	AEC
567	Core balance relay	Apr 81	RIE

On page 38 is the pc board for the ETI-567 Core-Balance Relay. Just in case you hadn't noticed, look carefully and you'll see the writing on the poteore and the transformer is laterally reversed. The picture is shown correctly on page 12 of the May '81 issue.

That wasn't the only thing the wrong way round. The two red wires from T2 (L1) are shown incorrectly on the overlay, page 39. Transpose them for correct operation. The How It Works is correct, but the dot on the top wire of L1 on the circuit should go on the lower wire.

A reader has drawn to our attention a problem he experienced when using the core-balance relay with a long lead plugged into its output where a number of fluorescent lights were operating nearby. The core-balance relay would not trip on test with loads over about 25 watts. On investigation, he found severe RF noise, generated by the fluorescent lights, was preventing the unit's trip circuit from functioning. Looking at each end of L3 (secondary of T2, the sense transformer (using an oscilloscope, he found high amplitude noise on each, but of markedly differing amplitudes. The cure is simple — a 4n7 capacitor connected directly across L3. The unit still functions as designed, even with highly inductive loads plugged into the output. Our thanks to Bill Waters for passing that on.

568	Sound and light operated flash	Oct 80	AEC
570	Infrared 'trip' relay	Jan 82	RIE, AEC
572	ph meter	Dec 80	AEC
573	Process timer	Oct 79	
574	Disco strobe	Sep 79	
575	Fluoro light wand	Aug 79	
576	EMG (electromyagram) monitor	Sep/Oct 79	AEC
577	Moving coil power supply	Oct 79	AEC
578	Simple Nicad charger	Jun 80	AEC

R2 should be shown as a 1W resistor.

581	15 V power supply	Jun 77	RIE, AEC, Jay, ED
582	House alarm Mk3	Jul/Aug 77	AEC
583	Gas detector	Aug 77	AEC
585	Ultrasonic beam switch	Sep 77	RIE, AEC
586	Shutter timer	Oct 77	AEC
587	UFO detector	May 78	
588	Dimmer	Nov/Dec 77, Jan 78	

PROJECT INDEX

No.	Name	Date	Suppliers
589	Temp meter	Dec 77	AEC
590	6-digit LCD stopwatch	Oct 78	
591	4-digit up/down counter	Jul 78	AEC
592	3-channel light dimmer	Aug 78	AEC
593	Colour sequencer	Dec 78	AEC
594	Development timer	Apr 79	AEC
595	Aquarium light timer	May 79	
596	White noise generator	Nov 81	
597	Emergency light unit	Dec 80	
598	Sequential touch switch	Feb 81	
599	Infrared remote controller	Apr 81	
1500	Metal detector	Dec 80, Apr 81	AEC

There are a number of designation errors on the circuit on page 42. Firstly, terminals T and V, which go to the volume pot RV5, are shown the wrong way round on both the circuit and wiring diagram. Transpose them and the pot will work in the correct manner. Secondly, the pin numbers to IC2a are shown incorrectly. The gate is actually pin 6 (not pin 3). The drain and substrate are connected (internally) to pin 14 which goes to +10 V. The source is pin 13 (not pin 1). Pins 1 and 2 of IC2 are unused. Pin 3 goes to 0 V. The overlay is correct.
It appears that C20 is shown on the overlay with incorrect polarity, the capacitor's construction and location of the + sign make this a bit confusing. The negative side connects to terminal R. Resistor R33 is shown as 10k on the circuit diagram. It should be 100k. The overlay and parts list are correct.
Search head wiring should be as follows: receive coils, red and black (resistance, about 50 ohms). These go to pins j and k on the pc board, via the DIN plug and socket. the cable shield and white wire are connected to the transmit coil (resistance about 12 ohms). The shield goes to 0 V at pin i and the white wire to pin h. Any extra wires in the head cable are unused.

1501	Negative Ion generator	Apr 81	AEC
1502	Sling psychrometer	Dec 83	
1503	Standby battery charger	Aug 81	
1505	Emergency fluoro light unit	Aug 82	
1506	Bicycle flasher (xenon)	Jul 82	AEC
1507	Lightbulb saver	Nov 85	
1508	model train controller	Dec 82, Dec 83	
1509	Uniersal dc-dc inverter	Sep 82	AEC
1510	model train controller	Jan 83	
1511	Zero crossing temp controller	Feb 83	
1512	Electric fence tester	Feb 83	RIE, AEC
1513	Digital frequency doubler	Jan 86	
1514	Solid state relays	Nov 83	
1515	Drill speed controller	Apr 83	RIE, AEC
1516	Model engine ignition	Jun 83	RIE, AEC

The Parts List on page 74 shows R16 as 18k, but the circuit diagram gives it as 560R. The circuit diagram is correct.

1517	Video distributor board	Sep 83	RIE, AEC

There are two errors in the wiring diagram of the Video Distributor Amp. On page 148, the two yellow wires from the 2851 transformer are shown going to the top and bottom tags of the tagstrip — this is incorrect. They should both be moved one tag toward the centre of the tagstrip.

1518	Video enhancer	Dec 83	RIE, AEC
1520	Wide band amp	Jul 83	AEC

Capacitors C6 and C8 are shown on the overlay on page 74 as 2p2 while the Parts List and circuit shows C6 as 3p3 and C8 as 10p. The latter values are correct.

1521	Digital exposure meter	Mar 84	AEC
1522	Multiple light controller	Mar/Apr 84	
1523	Electronic scales	Jun/Jul 84	AEC
1524	Electronic mousetrap	Aug 84	AEC, RIE
1525	Motion Detector	Jun 87	
1526	Fibre optic link	Apr 85	DSE, AEC,
1527	Burglar alarm module	May/Jun 85	Jay, ED HiC
1528	Door controller	Jul 85	
1530	Noise detector	Feb 86	
1531	Brown out protector	May 86	
1532	Iron temp controller	Sept 86	Alt, FE, AEC, Jay, ED

The circuit diagram is incorrect. The node of D2 and D4 joins the top of R11. There is no connection between R11 and the bezel or R9. The overlay is correct.

1533	300 W power supply	Nov/Dec 86	
1535	Motion detector	Jun 87	

No.	Name	Date	Suppliers
MUSIC			
601	Music sync	Oct 83	
602	Mini organ	Aug 76	AEC
603	Sequencer Mk1	Aug 77	
604	Metronome	Sep 77	AEC
605	Lin-exp converter	Sep 78	
606	Tuning fork	Nov 79	
607	Sound effects unit	Jul/Sep 81 Mar 82	AEC
608	MIDI Patch Change	May 87	
609	MIDI thru box	Mar 86	
610	Drum synth module	Oct 74	
611	MIDI matrix	Sep 86	

All output ports are incorrectly labelled with pins 4 and 5 transposed. All pin 4s are commoned together and pulled up via R21. Pin 5 is connected to the output buffers.

612	Audio Test Set	Aug 87	
613	MIDI Interface for C64	Nov 87	AEC

D99, cols 1 and 2 pin 21 not 20. Col 2 first para IC3 not IC1.

COMPUTERS

630	HEX display	Dec 76	
631	ASCII keyboard	Dec 76, Apr 77	AEC
632	VDU	Jan/Feb/ Mar 77	AEC
633	Video sync	Jan 77	AEC
634	8080 EDU INTERFACE	July 78	
635	Micro power supply	Sep 77	
636	S100 mother board	May 80	
637	Cassette interface	Jan 78	AEC
638	2708 EPROM programmer	Jul 78	AEC
639	Doorbell	Mar 78	
640	VDU Mk2 S100	Apr/May Jun 78	
641	Philips printer interface S100	Sep 78	
642	RAM card 16K	Feb 79	

The inputs to IC38c on the circuit diagram should come from the BLOCK 1 to 4 lines rather than the CS 0 to 3 lines as shown. Two IC43s were accidentally shown. The lower of the two is the real IC43. The IC above and to the left of this is IC44, a 74LS154. In the list of ICs at the top of the diagram, IC45 should be shown as 74LS175.

643	S100 EPROM programmer	Dec 79	
644	Modem	Oct 82,	
644	Follow-up	Nov 83,	
644a	Modification	Feb 84	

Note that R93 should be rated at 1 W or 1.6 W (e.g. Philips PR37 resistor). Capacitor C5 (in reference channel flip-flop, IC5) can be reduced to 680p to provide a better variation range for RV1 ('adjust output symmetry pot') Also note that C18 connects to pin 3 of IC12a on the pc board, not pin 2 as shown in the circuit. R48 goes to 0 V, not −6 V.
In the Parts List, transistors Q4, 6, 8 and 10 were cut off — they are all BC549s. C4 is shown as 1n, but 1n2 on the circuit — it can be either. C19 should be a 2n2 and a C21 a 330p. R48 should be 6k8, not 68k. Resistors R53 to R64 are given as 10k in the Parts List and 47k on the circuit. Either is correct. Note that the programming diodes were not mentioned in the Parts List. A total of 85 are required.
Experience has shown there can be wide variation in the characteristics of the 4528. IC4. At the extreme, it is found that RV1 (ADJUST OUTPUT SYMMETRY pot) does not have enough range. There are two cures for this: Capacitor C5 can be reduced to 680p or you can swap R2 and R16.
If 75 baud operation proves 'touchy' increase the value of C18 to 220n or greater.
There are discrepancies between the circuit diagram and the pc board. C18 goes to pin 3 of IC12a, not pin 2 as shown on the circuit diagram. Secondly, the junction of C31 and R76 goes to the junction of D14 and D4, not to pin 6 of IC20.
Experience indicates an improvement in performance under weak signal conditions can be obtained by making the pc board conform to the circuit here (output of IC20). This requires simply cutting one track and adding a link as shown in the accompanying diagram.

645	Tasman Turtle robot	Apr/May/ June 82	
646	Turtle hand controller	Jul 82	
647	Turtle-talk voice synthesizer	Sep/Oct 82	
648	Micro-grasp robot arm	Apr/May 82	
649	Light pen for Microbee	Aug 83	AEC
650	Stac timer	Nov 78	AEC
651	Binary HEX trainer	Jun 79	AEC
652	System 80 joystick interface	Aug 82	
653	16-channel driver	Nov 82	
654	Apple II card	Mar 83	

PROJECT INDEX

No.	Name	Date	Suppliers
658	RS232 breakout box	Dec 83	
659	Vic20 audio cassette interface	May 84	AEC
660	1802 leamer's microcomptuer	May/Jun/ Oct/Nov 81	

In the circuit diagram on page 37 the data buss lines adjacent to pins 26 to 33 of IC5 are in reverse order; D0 goes to pin 26, D7 to pin 33. This reverses the data out signals from the 6821, but it's all taken care of, so do not worry, my little chickens. Note that, on page 38, the circuit shows the 1864 as IC3 when we all know damn well that it's actually IC4.
On overlay drawings numbers 4 and 5, pages 31 and 32, IC20 is shown as a type 74LS00. It should be 7475. Also, on overlay drawing 5, p.32, the link near IC8 is shown as LINK 2 when it should be LINK 3. On the circuit, pages 36-37, the designations for diodes D5 and D6 are reversed. The upper diode is D6. The note relating to D5, D6 is correct.

661	Chord tutor adaptor for 660	Nov 84	
662	6802 processor board	Apr 84	

Location 61C5 should be 86, not 96. On the circuit diagram for this project, page 74, the pushbuttons are labelled incorrectly. The correct positioning is detailed in ETI June '85, p8. Other minor corrections are: pin 20 of the 24-pin DIL plus is the PA7 connection. PB4 is on pin 9, not 15 as shown. IC1, pin 1, should be pulled down to ground.

664	Hobbybot robot	Nov/Dec 85	
665	Computing routing switch	Oct 85	
666	Printer switch	Feb 85	RIE
667	Printer sharer	Apr 85	

The input connection attached to pin 6 of IC2c should be labelled STROBE-bar. The corresponding Centronics connector pin number should also be 1, not 10, while the Centronics pin number for the BSY output line should be 11 not 1.
If the Chatterbox is to be used with a VZ200 computer, capacitor C1 should be reduced to 100p to allow the circuit to trigger reliably from the narrower stobe pulse. Note also that the BASIC interpreter normally sends a CR-LF combination to the printer when returning to READY after running a program. This causes the Chatterbox to produce a continuous sound, even if your program leaves it silent. The solution is to end your program with a dead loop line (eg 1000 GOTO 1000), and break it using the CTRL + BREAK keys.

668	EPROM bumer for Microbee	Feb 83	RIE, AEC

Two connections to the 4PDT switch have been interchanged. Looking at the wiring diagram on page 70, the two upper and lower right hand wires have been transposed. the upper one says "PIN 7 PERSONALITY SKT" but should go to R14/15 — SW2b, the lower one says "R14/15 — SW2b" and should go to pin 7 of the personality socket.

669	EPROM eraser	Jun 84	
670	ASCII keyboard	May 82	
671	'Bee parallel printer interface	Oct 83	RIE
672	'Bee teletype printer interface	Oct 83	RIE
673	'Bee multiprom board	Nov 83	
674	'Bee joystick controller	Dec 83	RIE
675	'Bee serial-parallel interface	Jan 84	RIE, AEC
676	'Bee RS232 adaptor	Feb 84	RIE, AEC

The pinout for the transistors, shown on page 65, is all screwed up. Use the pinout on page 111.

677	Chatterbox voice synthesizer	Jan 85	RIE
678	'Bee ROM reader	Apr 84	AEC
679	'Bee joystick adaptor	Jun 85	
680	280 cpu board	No 79	
681	Prog character generator	Jun 80	

In Table 1 on page 69, the heading at the top of the left hand column should read "Value of Rp" as the values of RV1 and RV2 are fixed at 5k. On page 70, IC27 has a pin at the bottom marked "18" when it should be 15 — it's only a 16-pin chip, anyway! On page 73, in the parts list, R3 is listed as 1k9, 2%. A 1k8, 5% resistor is OK here. On page 74, under "Dipswitch No. 2:", second paragraph, the lines "We recommend that you put the joystick port at hex 'FF' . . . should say . . . put the joystick port at hex 'EF' . . ." The joystick setup procedure is correct as it places the joysticks at EF.
In addition, a number of typographical errors appeared on the circuit diagram on page 70. Address lines A11, A13 and A14 were shown as going to pins 27, 35 and 36 respectively. This is incorrect. A11 goes to pin 87, A13 to pin 85 and A14 to pin 86.

682	S100 prom board	Mar 81	
683	Computer controller	Dec 84	AEC
684	Intelligent modem	Dec 85, Feb/Mar 86	HiC, Jay, ED
685	2650 100 computer	Dec 81	

In the parts list, the power supply input bypass tantalum capacitors were erroneously specified as 6 V types. They should be 35 V types — these are capacitors C2, C4 and C5. Also capacitors C8 and C9 may be 6 V or 10 V tantalums, but capacitors C6 and C7 should be 15V or 25 V types.

686	PPI EPROM programmer	Oct 82	

In the power supply circuit at the bottom of page 72 the A-E-N on the 240 Vac input should be A-N-E. Q1 is missing from the Parts List. It is a BC547.

687	VZ-200 update Transpose pin 4 and 5 of IC1	Jul 86	
688	Bipolar PROM programmer	Jan 83	RIE, AEC

At date of going to press with this project, Chuck Simmers had only tried the National bipolar PROMs so check the specifications before attempting to program other makes using this project.

No.	Name	Date	Suppliers
689	Bus sharing switch D3 on the overlay should be ZD1	Jan 86	
690	Little big board	Oct/Nov 83	
692	RS-232 to 29 mA current loop	Jan 85	
693	Tape auto search	Jun 85	
694	FORTH computer	May 85	EC
695	VZ-200 terminal	Aug 85	DSE
696	RSC-FORTH card extension	Dec 85	EC
697	FORTH controller board	Mar 86	EC
698	Auto-dialler for modem	Jul 85	
699	300 baud modem	May 85	RIE, AEC
1601	RS232 for Commodore	Jul 86	AEC, HiC, Jay, ED
1602	Commodore function switches	Aug 86	
1603	Commodore tape duplicator	Sep 86	HiC
1604	Twin joystick for 'Bee	Aug 86	
1605	FORTH A-D card	Sep 86	EC
1606	RIE 'Bee extender	Nov 86	
1607	Commodore talker	Feb 87	
1608	RS232 Switcher	Jul 87	
1609	Apple Modem Card	Oct 87	
1616	16-bit computer	Dec 86, Feb-Apr 87	App
1616		Jun 87	App
1617	Applix Disc Drive	Oct-Nov 87	App

RADIO FREQUENCY

701	Masthead amp	Dec 74	
702	Radar alarm	May 75	AEC
703	Antenna matcher	Jun 75	AEC
704	Cross hatch generator	Aug 75	AEC
705	Three simple receivers	Dec 75	
706	Marker generator	Feb 76	

The photo on page 55 is not that of the marker generator as stated. The correct photo can be found on page 45.

707	Converter for 28, 52 and 144 MHz	Feb 76	
708	Active antenna	Mar 76	AEC
709	Attenuator	Mar 76	
710	Power amp	Apr 76	
711	Remote control switch	Jul/Aug/ Sep 76	AEC

MPF 121 transistors are no longer available. The MPF 131 may be used as a substitute as these are the same chip mounted in a slightly different package.

712	CB power supply	Jun 77	AEC
713	Add-on FM tuner	Sep 77	
714	TV-FM antenna	Feb/Mar 78	
715	2 and 6 m power amp	Nov 77	
716	Power amp	Jan 78	
717	Cross hatch marker	May 78	AEC
718	SW receiver	Oct 78	
719	Field strength meter	Nov 78	
720	2 m VFET power amp	Jan 79	
721	Aircraft band converter	Mar 79	AEC
722	Project 721 antenna	May 79	
723	Selective caller	Feb 82	

The last two lines of the intro should read: ". . . then this simple accessory allows you to turn down the volume, notifying you when that 'certain party calls — no tones or funny noises required".

724	Microwave oven leak detector	Jul 79	RIE, DSE, AEC, Jay, ED
725	Polyphase SSB generator	Aug 79	
726	6 and 10 m power amp	Feb 79	

The overlay was perhaps not as clear as it could have been in a few places. The coax cables, A and B, shown near the changeover relay, seem to have their shields connected to the RF output track beneath them. Actually, the lead going up to the comment 'shields earthed' indicates what to do with them. Strap them to the ground to the left of the relay, adjacent to the shim strap.
As the low frequency gain of the DX542CF, used in the ETI-726, is uncharacterised some amps may show HF instability. This problem is easily cured by damping RFC1 with a resistor, around 5 ohms in value, connected in parallel.
If you like to play it safe with regard to TV1, the filter described for use with ETI-715 6m amp, published on p.52 of the January 1978 issue of ETI, will serve very well.

727	Antenna matcher	Jan 81	

PROJECT INDEX

No.	Name	Date	Suppliers
728	UHF TV antenna	Mar 81	

The text states the folded dipole was constructed of aluminium strips 3 mm thick by 12 mm wide, while the diagram on page 43 shows the width to be 25 mm. It is in fact 25 mm wide, but this dimension is not critical and either strip width will work.

729	UHF masthead amp	Apr 81	AEC
730	RTTY receiver converter	Aug 79	AEC

All references to Q1 in the article should refer to Q2, BF338, as there is no way that the circuit will work as shown. If there are difficulties in obtaining the correct waveform at the output of IC7, it may be necessary to change the 56k resistors to 68k, and the 8k2 resistor to 10k. Also note that pin 1 and pin 16 of the CMOS hex inverter should go to + 12 V and pin 8 to 0 V.

731	RTTY modulator board	Sep 79	AEC

If the tone oscillator doesn't oscillate, try placing a 22n capacitor from the emitter of Q4 to common. Note that stability of the oscillator is greatly improved if you use silver mica or styroseal capacitors or C5, C6 and C7.

733	Microbee RTTY	Apr 83	RIE, AEC
734	Phone patch line interface	May 83	
735	UHF TV converter	May 84	AEC
736	Picture plucher	Sep 83	
737	70 cm preamp	May 84	DSE
738	UHF booster amp	Jul 84	
739	AM stereo decoder	Oct 84	
740	FM tuner	Feb/Mar 76	

The LED spacing is 1.25 MHZ *not* 800 kHz. The display driver IC is a UAA 170 *not* a UA 170. The varicap stabiliser is a TAA 550 not a TA550.

No.	Name	Date	Suppliers
741	10-channel synth radio mic	Dec 84/ Jan 85	
742	Broadcast/coms speaker	Feb 85	
743	25 W UHF power amp	Jun 85	
744	UHF/VHF tuner	Apr 86	
745	AM Radio	Mar 87	
746	AM Transceiver	Mar 87	
750	6 m amp	Dec 83	
751	FM bug	Dec 85	Jay, ED

What could go wrong with this one? A typo. The equation for the turns ratio in the How It Works section (p.50) should be:

$$N = k\sqrt{\frac{Ri}{Ro}}$$

755	RTTY transceiver	Nov/Dec 84	RIE, AEC, Jay, ED
756	VZ200 RTTY transceiver	Nov/Dec 84	DSE

There are nine links on the decoder board, not eight. On the circuit diagram, P. 109, C23 should read 470n; Parts List is correct. P. 110 in the table under "Immediate Commands", the second command is SHIFT X. In the text on P. 110, second last paragraph, the last sentence should read: "See that the two polarized capacitors (C21 and C22) are correctly oriented." Note that R7 is actually 2k7, as per Parts List, not 4k7, as per circuit.

757	Cat RTTY/FAX	Nov/Dec 85	DSE
760	Video RF modulator	Oct 81	RIE, AEC
764	AM Transceiver Part 2	May 87	
780	Novice tx	May/Jun 76	AEC

DREGS

Continuing our perusal of other peoples mistakes we publish the following gleaned from a selection of journals from around the world.

THEY managed to contain the outbreak until the arrival of the fire brigade. The van, however, was taken to St Colmcille's Hospital and was discharged after treatment.

'WE make a specialty of gorillas and chimpanzees. They are wonderfully intelligent and can be trained right up to the human standard in all except speech. One of our directors and his wife are both able to be tamed to live in captivity.'

To repair damaged tablecloths, first lay the tablecloth flat, with the hole uppermost.

FOUR youths found guilty of raping a 1-year-old prostitute were each sent to prison for five years at Sheffield Crown Court.

THE victim was taken to an adjoining room where medical aid was given by a woman doctor from Northern Ireland and by a former nurse, who applied the Kiss of Death.

Oven stolen
A microwave oven has been stolen from Waverley Crematorium, Clacton police said yesterday.

McLEOD — On August 18, peacefully in hospital, Joseph Phillip McLeod, loving dad of Joe, father-in-law to Gwen, loving grandad to Jane, Ian and Kelly. Sadly pissed.

Assistant Editor at play

ADVERTISERS' INDEX

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Trigger Couplings	AC, DC, HF Reject, LF Reject
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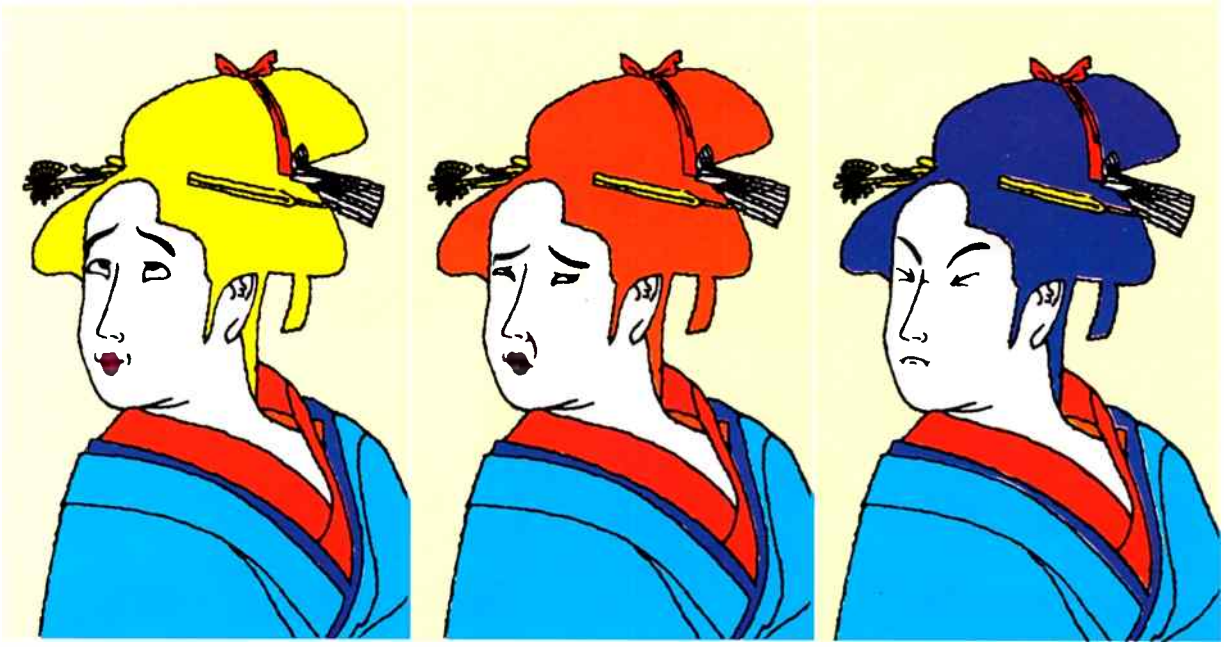
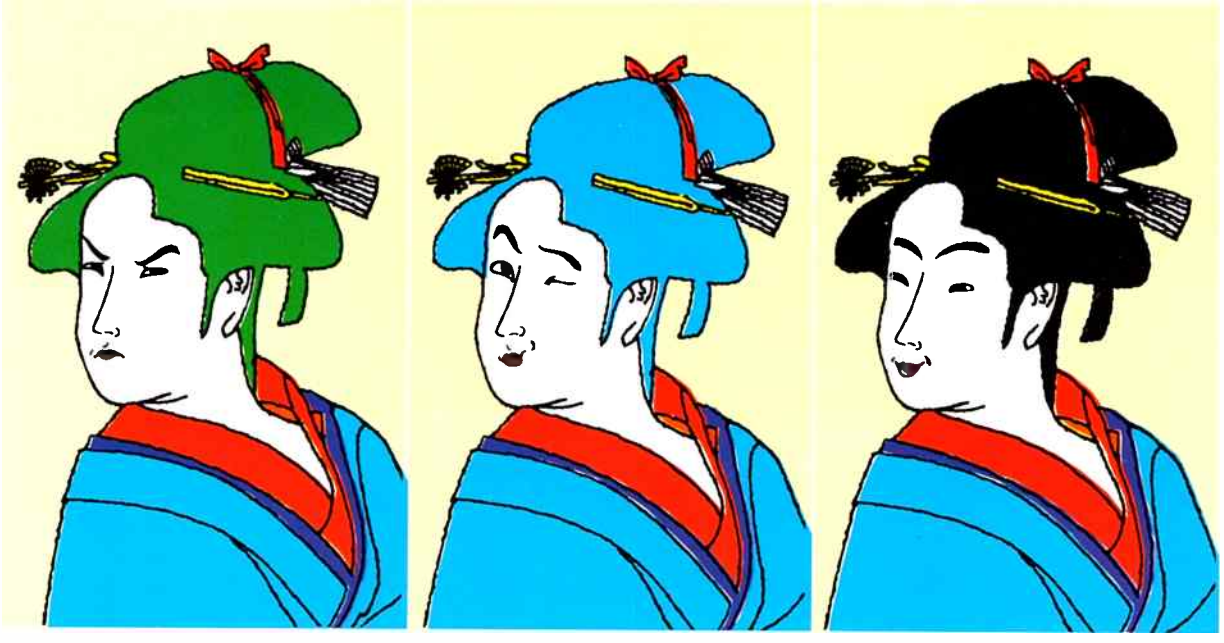


The hard part is choosing the colours.



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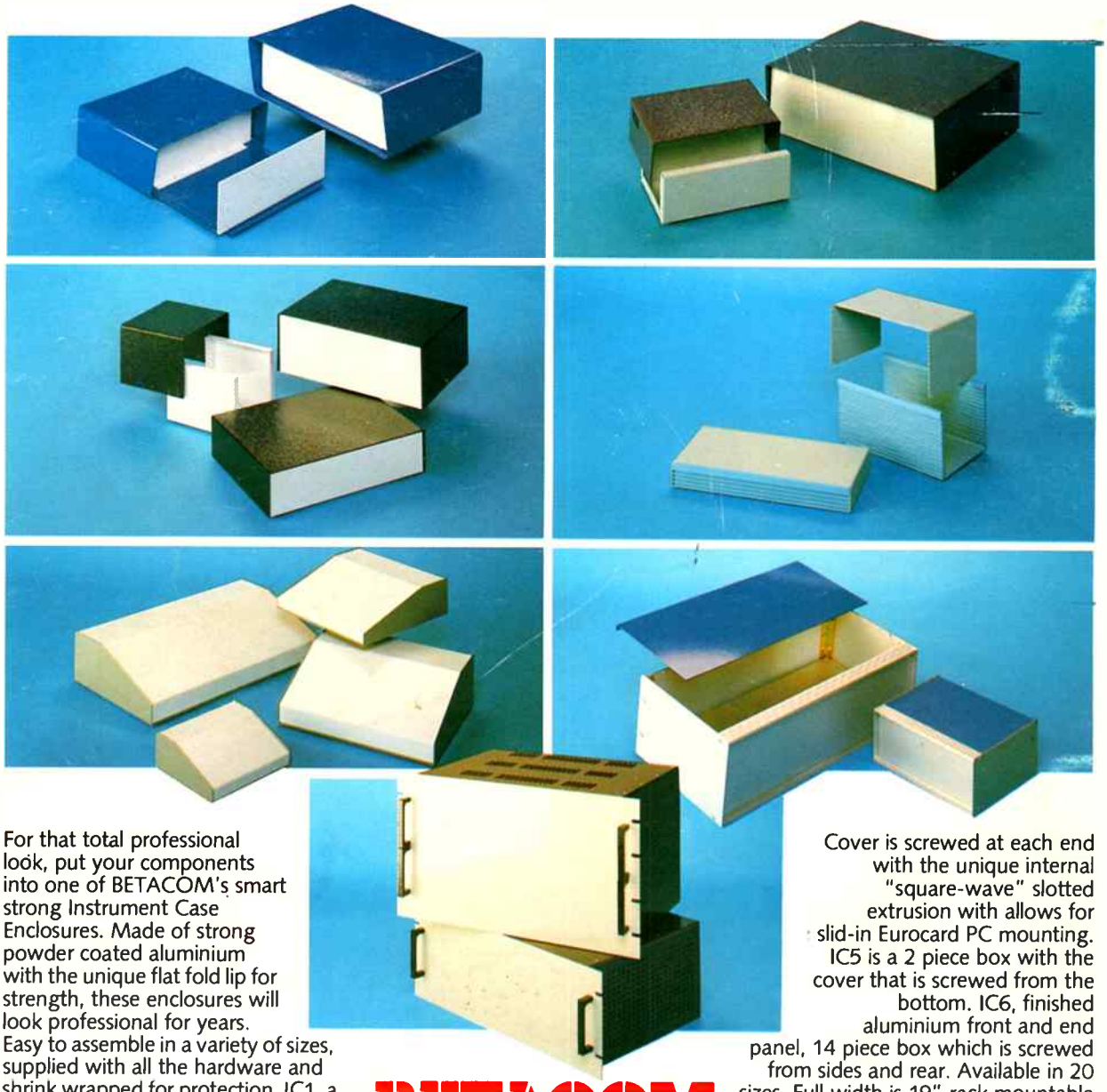

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