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Electronics Australia

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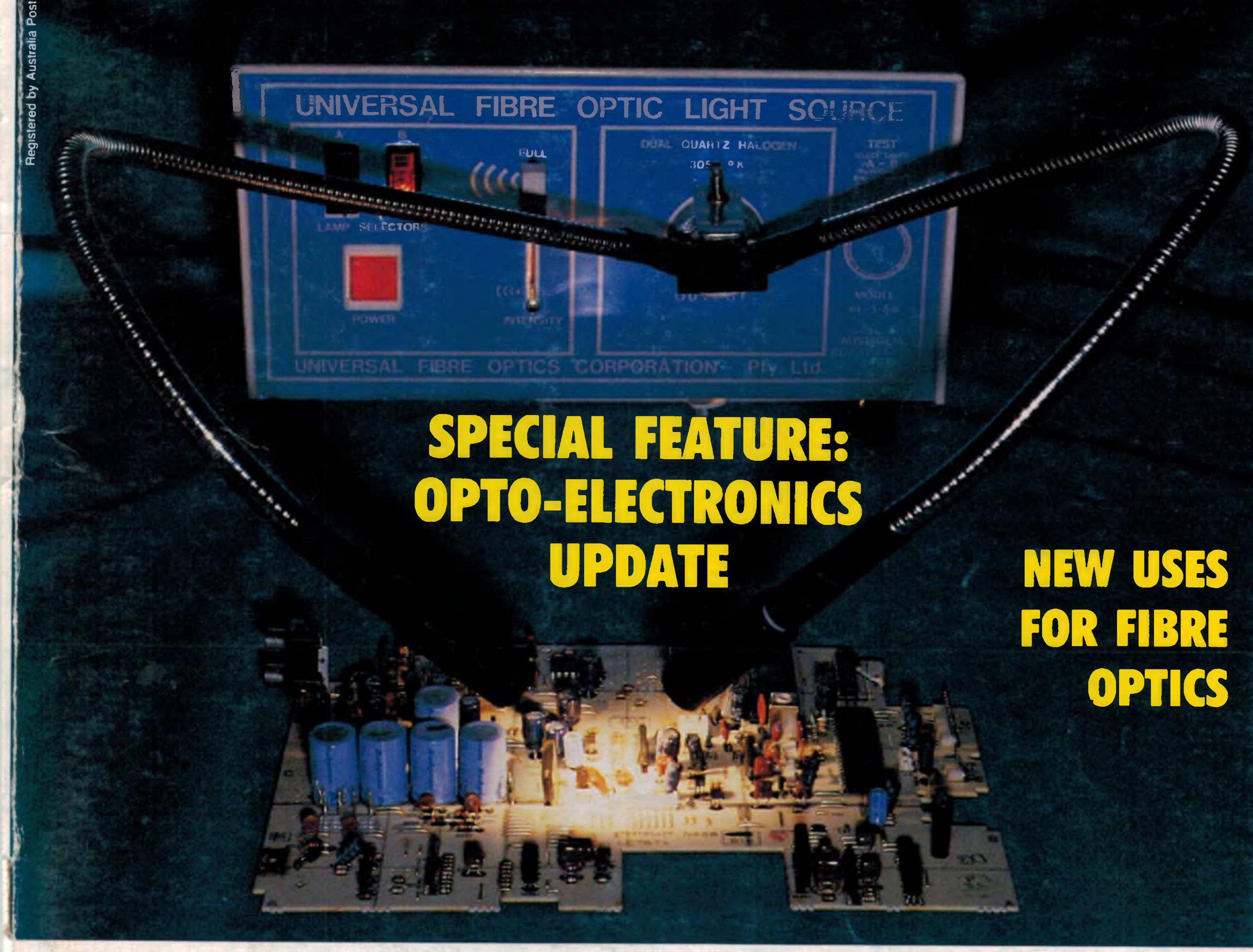

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NEW USES FOR FIBRE OPTICS

GUIDE TO ELECTRONICS CAREERS
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MIDI INTERFACE FOR APPLE 2
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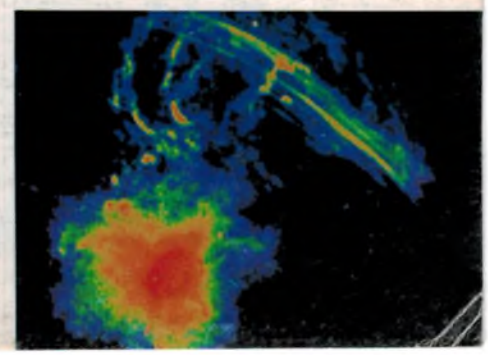

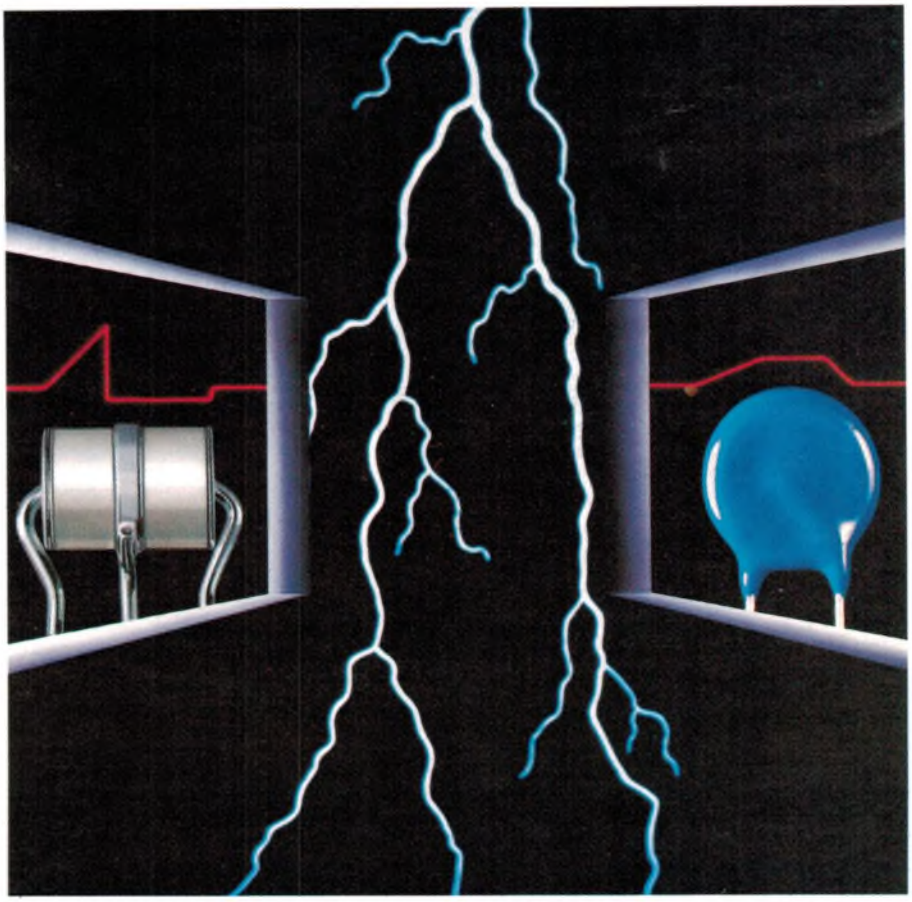

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EA NOV '88

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Australian Personal Computer
LOW COST IBM COMPATIBLE SURVEY – OCTOBER 1987

...and the experts agree with his choice.

Australian Personal Computer have now proved what our customers have known for years

Processor.

NEC. The Uni-x contains a NEC V20, manufactured by Sony.

... V20 running at 4.77MHz will outrun an 8088 running at the same clock speed.

... machines examined provided a standard PC clock rate of 4.77MHz as a minimum, although the Uni-x delivered higher than standard performance even on this clock rate by virtue of the V20. The Atlantis and ... machines ...

Performance.

... The Uni-x is fastest overall, providing a 50 per cent boost over the Technology Interface due to the V20.

Display.

... delivered with a nice INTRA tilt/swivel amber screen. ...

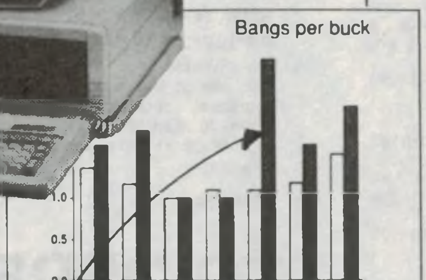
Cost Effectiveness.

As you might expect, the do-it-yourself Uni-x comes up trumps with its low cost and relatively high performance ...

Specifics.

The Uni-x features a delightfully small motherboard. It has employed a VLSI component to replace the Intel 8253 timer, 8255 PPI, 8237 DMA controller and several other components. This reduced the component count and a simplified motherboard serves to reduce costs.

. . . see for yourself in the full Report in the October '87 issue, or ring us for a copy.



Bangs per buck — just one way of comparing the relative merits of these seven ultra cheap clones. The lighter shading denotes price (in thousands of dollars) and the darker shading a performance index. See Table 3 for more details. (Machines in order from left to right are ... Bird Irving MicroDOS, Commodore, Uni-x, Afronics and Techn...

No, he's not a genius, but he's brilliant at spotting great value. Like many of us, he's realized that a personal computer is invaluable, yet the price tag for a professional unit has always been a little beyond his reach. Until now.

Quite simply the UNI-X CompuPak kit contains all the major componentry of a top quality Industry standard computer, in an unassembled form. You save the dollars and increase your knowledge, by putting it together yourself.

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Electronics Australia

Volume 50, No.11

November 1988

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Careers in electronics

There are many different areas of electronics in which you can find a satisfying career, and quite a few different ways of getting started. Our feature article starting on page 18 explains where you can go, and how to get there.

Projects to build

Our construction projects this month include a very flexible audio preamp module, a 16-channel remote control transmitter for security applications and an easy to build MIDI interface for Apple IIGS computers.

Opto-electronics feature

This month's special feature on opto-electronics includes a story on the fibre-optic network developed for the new Australia Telescope, to link its moveable dishes up with the central computer.

ON THE COVER

Our main picture might look a little like an undersea robot, but it's really a fibre-optic light source from Universal Fibre Optics, in Melbourne. The smaller picture is a radio-astronomy image like those that will shortly be produced by the Australia Telescope.

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Entertainment Electronics

Projects and Technical

News and Comment

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Letters to the Editor

Vintage radios

It was with great interest that I read your articles on Vintage Radio, and I am sure they will be welcomed by your readers not only as a nostalgic look at the past, but to give younger readers an insight into how radio functioned before the age of transistors.

However, I do not entirely agree with the author when he suggests that early type valves should not be replaced with later types. The main purpose of restoring a set is to put it in working order so it can be fully appreciated by those who see it, and how many of the general public nowadays are familiar with valves, let alone tell the difference between a Mullard PM4 and a Radiotron 1H6G. At least it is possible to obtain the latter, and to use the triode section as a replacement for the PM4. A special socket has to be made to mount it on the wooden baseboard behind the bakelite front panel, but that's another story.

Some time back I decided to build a set as much as possible like one I made in the late 1920's. It turned out quite well using the triode section of a 1B5 as a detector with a 1F4 capacity coupled output. The coil was made with a "tickler" at one end, similar to the Radiokes tuning coil shown in your July issue. The single gang tuning capacitor was a normal 2-gang, with one section removed and mounted on a bakelite front panel.

It gives good loudspeaker reception of the local stations, and is running continuously in my workshop. A photo is enclosed.

I am at present restoring an early 1924 3 valve battery set in a blackwood cabinet, and using an advance tuning capacitor, Puratone 3:1 audio transformer and square buss wire for the wiring.

I hope the vintage section of your magazine creates enough interest to warrant its continuation.

Jim Oliver VK7JO,
South Launceston, Tas.

Comment: Thanks for your views, Jim. I think there will always be two approaches to restoration. To those in the "purist" camp, everything in the set must be of the correct period.

Superhet inventor

I refer to the interesting article "Vintage Radio" by Peter Lankshear in the September 88 issue of EA and his reference to Edwin Armstrong and the superheterodyne receiver.

All publications of US origin have always accorded Edwin Armstrong the honour of first inventing the superheterodyne receiver but, at the time of granting him the patent, the US authorities were either unaware of or chose to ignore the prior invention of the system by Lucien Levy of Paris. Armstrong's patent was filed with the US Patents Office on 8th February 1919. Patent No. 1,342,885 was issued on 8th June 1920. The French Patent No. was 493,660.

The Levy patent was later assigned to the Western Electric Company of London on 25th June 1924, and subsequently on 2nd June 1926 to Standard Telephones and Cables (Australasia) Limited (STC) in Sydney. Thus all licence fees for superheterodyne receivers built in Australia were payable to STC as explained in *Wireless Weekly* during September 1931. There does not seem to be any evidence of the Armstrong patent being assigned to any Australian organisation.

Further reference to these matters is made in Chapter 13 of my book "Aus-

DROP US A LINE!

Are you concerned about something to do with electronics, and believe that others ought to know about it? If so, feel free to put pen to paper, or fingers to keyboard, and send us a Letter to the Editor. If it's clearly expressed and on a topic of interest, chances are we'll publish it — but we do reserve the right to edit those that are overlong, or potentially libellous.

editor

tralian Radio – The Technical Story" published in 1984 by Kangaroo Press. It is also interesting to note that much of the information contained in the above-referenced article can be found in Chapter 1 of the same book.

Winston T. Muscio,
Leumeah, NSW

Comment: Thanks for the information, Winston. It's strange that the US patent authorities either didn't know about Levy's patent, or chose to ignore it.

Oral History – bouquet

Congratulations for featuring Jim Lawler's excellent and timely series "Recording Australia's Oral History". Readers attracted to the idea of oral history may be interested to learn of other avenues of support.

The Oral History Association of Australia is 10 years old in 1988 and has branches in every mainland state. The Association conducts meetings, runs workshops and produces several useful publications including an *Oral History Handbook* for beginners.

Readers wishing to preserve original (and unedited) recording and to make their work available to a wide range or researches can contact their state library (or the Northern Territory Archives or National Library of Australia) – all of which recognise the tremendous value of serious oral history recordings.

As Chairperson of the Oral History Association and Oral History Officer at the State Library of South Australia, I can put interested readers in touch with the appropriate agencies.

Beth Robertson
Mortlock Library of South Australiana
State Library of S.A.,
North Terrace, Adelaide. 5000
Telephone (08) 223 8924

Thanks

Thank you very much for the superbly written editorial on our experience, in the May issue. Many people have communicated to us that either similar occurrences have occurred to them in this local area, and some from very diverse industries all over Australia, after reading the editorial.

(Continued on page 142)

Editorial Viewpoint

A tribute to Aussie technology...

Along with quite a few other editors and journalists, I was lucky enough to be invited to the official opening of the Australia Telescope Compact Array, by the Prime Minister. The CSIRO flew us up to Narrabri in northern NSW, and then took us by air-conditioned coach to the telescope site at Culgoora.

Frankly I was most impressed by the whole project, and I'm sure I wasn't the only one. It's hard to convey the sheer size of the telescope in words, or even pictures (like the one on our September cover, and those illustrating the story inside that issue). You almost have to see it for yourself and clamber up inside one of those big dish antennas, for the full impact of the project to sink in.

There's no doubt that it's a tremendous achievement, and one that brings Australia back to its traditional leading position in radio astronomy. Dr Bob Frater and his teams of dedicated CSIRO scientists thoroughly deserve the congratulations they've received – especially when you realise that the total cost of the telescope is less than 1/20th that of the new Parliament House in Canberra!

It was also very cheering to learn that just on 80% of the total cost of the project was Australian content. From the major structural metalwork, right down to the correlator chips used in the computers, most of it was designed, developed and made here. And many aspects of the project involve significant breakthroughs in technology, with important applications in other areas such as satellite communications, high speed data comms and digital signal processing. So despite the 'pure science' nature of radio astronomy itself, there will obviously be quite a few spin-offs for local industry.

I found it particularly interesting to talk to the various CSIRO scientists involved in each aspect of the project, learning of the technical hurdles it presented – and how they were overcome. For example one interesting area was the development of an optical fibre network to link the antennas and receivers to the computer, as explained in the story later in this month's issue. I hope we can cover other interesting aspects of the project in later issues, all going well.

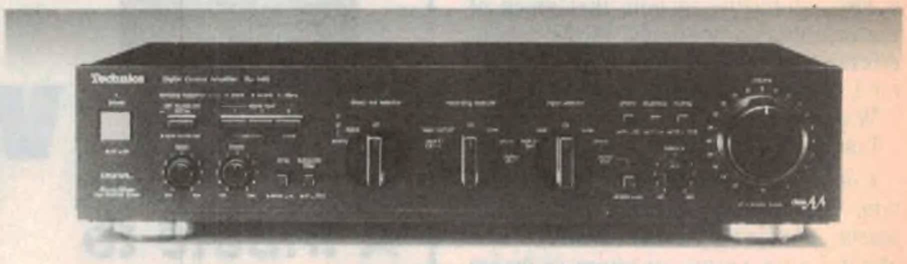
All of the scientists I talked to were very helpful, and happy to explain their specialised work in simple terms to an electronic 'GP' like myself. In fact it was nice to find that quite a few even admitted to reading *EA* regularly, to keep up with the latest developments in other areas!

The Australia Telescope really is a tribute to Australian achievement in science and technology, and a great investment in the future. If you get a chance to see it for yourself, I thoroughly recommend that you do so.

Jim Rowe

What's New In
Entertainment Electronics

Panasonic re-launches Technics hifi range



The new SU-A60 digital control amplifier, with built-in four-DAC 18-bit conversion and optical inputs for CD and DAT.

The matching SE-A50 'digital audio' power amplifier, which uses Class AA to provide 210W per channel into 4 ohms with very low THD.

The SL-P990 CD player, which features both a four-DAC 18-bit high resolution conversion system and optical fibre output.

After standardising earlier this year on its 'Panasonic' brand for most of its consumer electronics and electrical products, National Panasonic has re-launched its 'Technics' range of true hifi equipment with a wide range of upgraded products. The products cover both 'midi' and 'full-size' (430mm wide rack) systems, and also separate components.

Technics' product manager Gary Love emphasises that the company clearly differentiates between its compact Panasonic 'music centre' systems, offering good value for money, and its Technics 'midi' systems which are designed and manufactured to true hifi standards. In keeping with the emphasis on true hifi, all power ratings for Technics amplifiers are given in effective or RMS watts, not 'peak music power' or PMPO.

Both the full-size and midi systems are based on modular components, making things easier for both dealers and customers. In the full-size systems, for example, there are basically four amplifiers with power ratings from 30W/channel to 100W/channel, plus an integrated receiver with 35W/channel. Complementing these there are three tuners, a dual cassette deck, a semi-automatic turntable, two CD players, a graphic equaliser, two different 3-way speaker systems and four rack styles. Various combinations of these components are available in the various systems, with basic system prices ranging from $1745 to $2445.

Similarly for the midi systems there are two amplifiers with power ratings of 60W/channel and 80W/channel, two amplifier/tape decks with outputs of 40W/channel and 50W/channel and an integrated receiver/tape deck offering 40W/channel. These are complemented by two dual cassette decks, a tuner, two turntables, two CD players, a graphic equaliser and five speaker systems. Midi system basic prices range from $1199 to $2999, with CD players and graphic equalisers as optional extras.

For those who wish to assemble custom systems of very high quality, Technics offers a very wide range of separate components. This covers 10 CD players, seven cassette decks, seven turntables, five tuners, a receiver, a graphic equaliser, six integrated amplifiers, a digital integrated amplifier (with built-in DACs for digital inputs), a separate digital preamp/control unit and power amp combination (135W/channel), and seven different speaker systems including the new SB-AFP10 flat-panel type based on Technics' coaxial flat drivers.

Two of the component CD players feature four DACs (two per channel), 18-bit 4-times oversampling filtering and optical/coaxial digital output for operation with a DAC-equipped amplifier. The SU-V90D digital integrated amplifier and SU-A60/SE-A50 control unit/power amplifier combination also feature four DACs and 18-bit 4-times oversampling. These amplifiers and three other models also feature Technics' 'Class AA' output circuitry, with separate voltage and current amplifiers for very low distortion.

Further information on the new range is available from authorised Technics dealers.

New Sanyo midi hifi system

Latest addition to the Sanyo range of Midi Hi Fi stereo systems is the SYS-W27, which comprises a 20 watts RMS per channel amplifier, compact disc player, turntable, FM stereo/AM synthesiser tuner, double cassette deck and matching two way four-speaker system – plus an 8-function infrared remote control.

The double cassette features synchronised dubbing at standard speed as well as high dubbing for easy duplication of tapes, and continuous play from one tape to the next for longer listening enjoyment. To assist in reducing tape noise Dolby 'B' is also included.

The tuner features facility to preset 6 FM and 6 AM stations, while the turntable is a belt-driven semi-automatic. The CD player has soft touch controls and a 3-beam laser pick-up. Search (forward and reverse). Skip (forward and reverse), memory, and repeat are just some of its features.

Functions that can be operated via infrared remote control include those of the compact disc, including Play/Pause, Skip Up/Skip down for fast selection of music tracks, and Stop, as well as Volume, Tuner Band selection and Preset scanning.

The SYS-W27 including compact disc player sells at a RRP of $1008-00.

NAD introduces 'super receiver'

NAD claims its new NAD 7600 is the world's most powerful, sensitive, and most flexible stereo receiver.

Stereo receivers often are compromised, either in sound quality or in operating flexibility, when compared to separate components. But not the NAD 7600: it actually consists of NAD's three finest Monitor Series stereo separates, combined on a single chassis and operated by infrared remote control.

The power amplifier section of the 7600 receiver is sold separately as the NAD 2600. Conservatively rated at 150 watts per channel RMS, its Power Envelope circuitry delivers 400 to 800 watts per channel of dynamic power, depending on speaker impedance. These high power levels are available, not just for the 20-millisecond period of the IHF dynamic headroom test, but for hundreds of milliseconds – the full duration of the tone bursts in musical sound.

The phono preamp section of the 7600 receiver is the same as that in NAD's top-of-the-line Model 1300 preamp. Its eight-transistor, FET-input MM stage is said to be exceptionally immune to RFI and has a total dynamic range of 112dB. Its MC input is a class A pre-preamp measuring 10 to 15dB quieter than many separate pre-preamp units.

The tuner section of the 7600 reeiver has the outstanding sensitivity and quieting of NAD's top-line Model 4300 tuner. Manual tuning is accomplished not by pushbuttons but by a good old-fashioned tuning knob that operates an optical shaft encoder to generate pulses for the digital tuning circuit.

Further information from NAD Australia, 28 King Street, Rockdale 2216 or phone (02) 597-1111

NAD's new 7600 combines the features of many existing products.

New TDK tapes

TDK (Australia) has introduced a new range of 'digitally ready' cassette tapes. The main concept behind this new lineup of eight tape grades covering three bias positions is compatibility with digital sources.

The new audio lineup consists of four type I/normal position tapes: new D, new AD, Ar, and AR-X. Each with slightly varying specifications and cassette mechanisms.

The type II/high position tapes are the new SF, new SA, and the new SA-X. The type IV/metal position range comprises the new MA-X, and the MA-XG which has the improved formulation as that of the new MA-X but retains the RS-II (Reference Standard II) mechanism. The new range comprises various playing times.

TDK has published two booklets, *TDK Guide to Better Recording* and *TDK Audio/Video Cassettes*, which include complete new specifications and are available free at any record store or by writing to TDK (Australia), Unit 14/39 Herbert Street, St. Leonards nsw 2065.

The new lineup of TDK 'digitally ready' audio tape cassettes.

Integrated amp from Mordaunt Short

The new Mordaunt Short MSA5000 integrated amplifier has been designed to set the standard for a new school of amplifier design, offering a sound quality and technical performance appropriate to the most sophisticated audio systems, yet combining this with the highest standards of aesthetic quality and operational flexibility.

All control features of the MSA5000 have been designed to complement the overall concept, and at each stage of the design development their implications on sound quality have been monitored meticulously. For example the tone controls incorporated are of a type that offer only the limited of adjustment appropriate to correction of mild tonal imbalances; any more extreme control range being liable to compromise sound quality.

The MSA5000 achieves an extremely high level of installation flexibility by incorporating input facilities for up to seven programme sources, two switchable loudspeaker outputs, a further directly connected loudspeaker, a headphone facility, and a tape output independent of the amplified input.

Further information can be obtained from Concept Audio, 17-98 Old Pittwater Road, Brookvale 2100 or phone (02) 938-3700 .

It takes everything but your pulse.

Pioneer VSX-3000

And your heart will beat a little faster when you experience the flexibility and performance of the Pioneer VSX-3000.

With inputs for VCR1, VCR2, Video Disc Player or VCR3 (Playback only) Tape Deck, Turntable and CD Player it gives any audio/visual system a new lease of life.

Other features include:

- Simulated Surround Sound
- Comprehensive VCR (dubbing) facility
- Sleep Timer
- VCR Noise Filter to reduce tape hiss on Video Playback
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The Pioneer VSX-3000. It's the perfect heart for a comprehensive audio/visual system.

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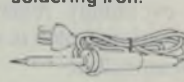

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- Replacement tips **$6.50**

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Perna mail order: professionalism is knowing your business inside-out.

Electronic navigation coming for motorists

A prototype of the Philips 'Carin' car information and navigation system. (Courtesy Philips)

Motorists should find it more difficult to get lost in the 1990s, thanks to electronic navigation systems currently under development. Several car manufacturers and electronics companies have already demonstrated prototypes.

by IAN GRAHAM

The most basic of the new car navigation systems rely on the accuracy of an electronic compass and sensors on the car's wheels, to calculate how far the car has travelled and in which direction. The car's position is displayed on a television monitor screen on the dashboard. For safety's sake, the screen is disabled while the car is moving and information is presented to the driver via a computer-generated voice.

This type of self-contained system suffers from the problem of accumulated error. It can't be 100% accurate in every respect. Tiny errors inevitably creep into the system's calculation of the car's position. These errors pile up and if nothing is done to correct them, they eventually reach the point where the positional plot is so inaccurate as to be meaningless.

The electronic compass works by detecting the direction of the Earth's magnetic field. But the field is changed by any large chunks of iron nearby. The iron in man-hole covers, reinforced concrete and bridges, for example, will upset the electronic compass and lead to false positioning. Even passing cars cause problems – a serious disadvantage to a car-borne system!

Fortunately, the on-board computer that calculates the car's position can be programmed to ignore rapid and short-lived fluctuations in the received magnetic field due to nearby iron-rich objects.

Satellite navigation

The American Navstar *Global Positioning System* (GPS) offers a way of improving accuracy. Eighteen satellites orbit the Earth, at a height of 20,000 kilometres. At any given time, four satellites should be within 'sight' of a receiver on the ground. Information transmitted by the satellites will enable the receiver to calculate its position in longitude, latitude and height to within 10 metres and time to within the microsecond accuracy of an atomic clock.

But that's not the whole story, of course. It's all very well knowing how far a car has travelled and in which direction, or, with the help of satellites, the precise latitude and longitude of the car within a few metres; but that doesn't give the driver any information whatsoever about which road the car is driving along and where it leads. To be of practical use to the driver, the position has to be related to a street map overlaid with 'ye olde worlde' pre-computer street names.

Even in a small country, the system needs a truly enormous memory in which to store all the streets of all the country's towns and cities. And, for route-planning for example, information about locations miles apart have to be accessible from the memory very rapidly indeed. The optical *Compact Disc Read-Only Memory* (CD-ROM) turns out to be the most efficient way of storing and retrieving the information.

Laser disc maps

A standard one-hour CD stores music as a series of digital pulses. The analog (constantly varying) waveform of the music source is converted into these pulses by sampling it 44,100 times every second. Each sample or 'snapshot' of the music is then converted into a 16-bit binary number (1100101011010111, for instance).

This pattern of zeroes and ones is transferred onto the disk permanently by burning it into the disc by laser. As all music is recorded in stereo now, the disc has the capacity for two independent one-hour channels. It can therefore hold:

$$(3600 \times 44{,}100 \times 16 \times 2)$$

bits, or over five thousand million bits of information (3600 seconds in an hour, 44,100 samples per second, 16 bits per sample, two channels). That's equivalent to approximately 150,000 A4-size pages of text.

The immense storage capacity of a CD-ROM is difficult to grasp. If Britain's entire road network down to street name level was converted into CD-ROM format, a single one-hour disc would be only half full. Any part of the disc, and therefore any part of the map stored on it, is accessible to the system computer within a fraction of a second.

Route planning

The *Carin* car information and navigation system designed by Philips shows a plot of the car's position on a small television screen on the dashboard. The screen will only operate when the car is stationary. Carin also helps motorists to plan routes. When the driver enters the start point and destination on the system's keyboard, the on-board computer works out the most efficient route.

As the driver sets off, the computer monitors the car's progress and tells the driver where to turn left or right by means of a speech synthesiser. Research in Britain indicates that if drivers were directed by a navigational computer instead of finding their way by the most familiar routes and landmarks, they would make savings in fuel and time of approximately 20%.

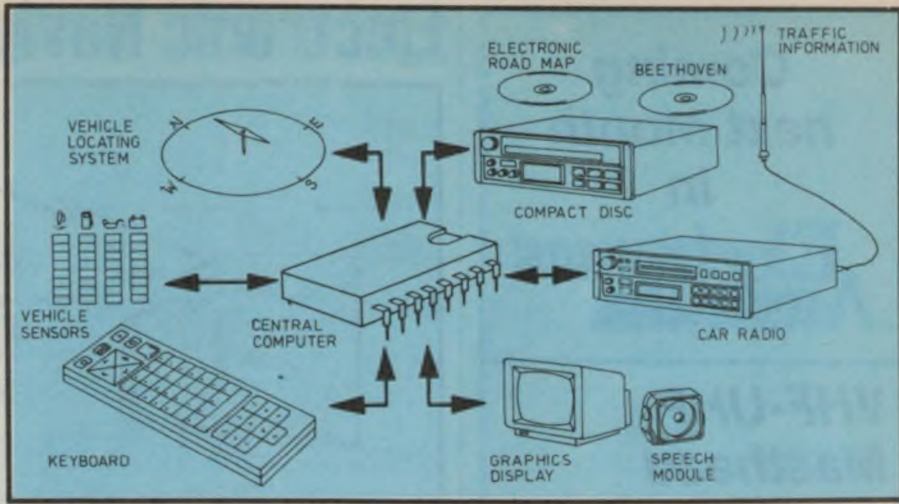


Fig.1: Philips' Carin system brings together information from an electronic compass, CD-ROM disks, radio and vehicle sensors to provide information about vehicle position and the most efficient route for a journey.

Radio update

The advantages of directing a driver along a particular route by computer to save fuel and time are entirely lost if the road is closed because of a traffic accident, or there is a 10-mile traffic bankup on the expressway because of road surface repairs. Test broadcasts of a radio system that could solve these problems are already under way in Europe.

Eleven European countries have so far agreed to adopt the Radio Data System (RDS). In the same way as teletext signals are broadcast with television programmes to supply extra information to the viewer, RDS signals carrying extra information are broadcast with radio programmes via a supersonic subcarrier.

As a result of the proliferation of radio stations, it can be very difficult to find one particular station amongst the many or even to identify the station to which the radio is already tuned. A small liquid crystal screen on an RDS receiver shows the name of the station.

As the radio is tuned through the broadcasting band, the station names on the screen change. The RDS radio also receives a continually updated time-check and so the radio doubles as an accurate digital clock, which need never to be set or corrected.

One aspect of the projected development of RDS is very relevant to car navigation. Local road and traffic reports will be transmitted via RDS. Philips' Carin navigation system will be able to decode traffic information received by RDS and if necessary use it to modify the car's planned route.

If, for example, the road ahead is closed for some reason, Carin will plan an alternative route and advise the driver of the changes by its speech synthesiser.

Later, other sensors on the car will be able to feed information into the system. The system's voice will be able to advise the driver to fill up with fuel or that the engine is overheating, or of the presence of ice on the road. Sensors on the steering wheel will respond if a driver appears to be suffering from drowsiness, and the computerised voice will alert the driver.

Vehicle location

Turning the idea of vehicle positioning on its head, a similar system might be used to show a central base station where a vehicle is, rather than to advise the driver on position and route.

Plessey has developed a vehicle location system with this in mind. Police, ambulance, fire brigade, taxi and courier services generally have to rely on voice communications with their vehicles to monitor the vehicles' locations. Plessey's 'PACE' system shows a street map of the operational area, with continually updated plots showing vehicle locations – without any need for repeated interrogation of the drivers.

Each vehicle is fitted with sensors to monitor its speed and direction travelled from its known start-point, as in the basic car navigation system.

As the system is subject to errors for the reasons explained earlier, it is reset from time to time by radio signals transmitted from short-range (25 metres) radio beacons sited by the roadside. At the base station, the operator can select either an area or specific vehicles. The map and vehicle positions are then shown on a television monitor screen. The system also has a 'free-hand' facility, allowing the operator to add notes

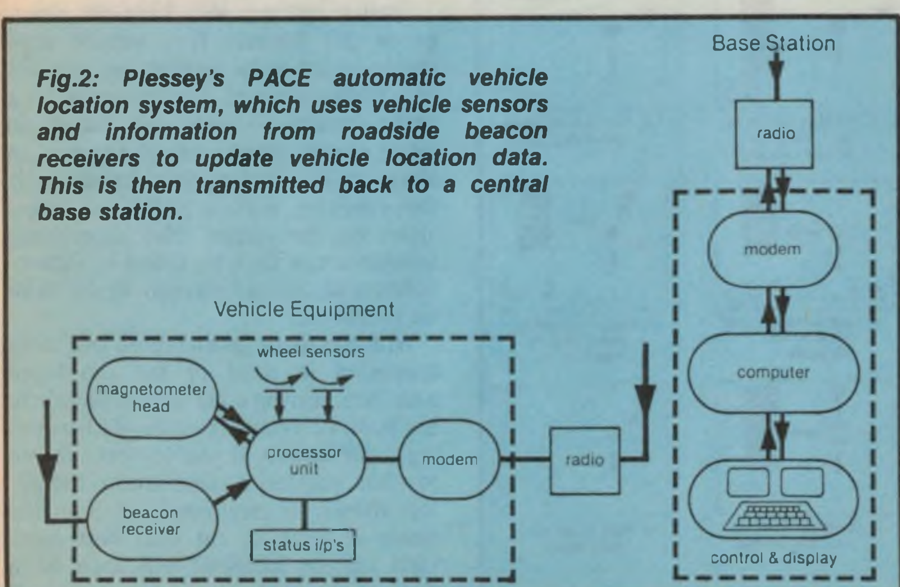


Fig.2: Plessey's PACE automatic vehicle location system, which uses vehicle sensors and information from roadside beacon receivers to update vehicle location data. This is then transmitted back to a central base station.

Coming next month in Electronics Australia

VHF-UHF Masthead preamp

With more areas changing over to UHF for TV broadcasting, this masthead amp design should get a warm reception. It's not only low in cost and easy to build, but gives a much flatter UHF response than earlier designs.

Audio power amp module

Here's a new general-purpose power amp module that's compact, really easy to build and low in cost. With an output of over 50W into 8 ohms and over 75W into 4 ohms, it's ideal for all sorts of applications.

PC-driven function generator

Yes, we did promise this a couple of months ago, but there were complications. It's now ready to roll. Turn your PC into a fancy programmable waveform generator, at low cost!

Note: Although these articles have been prepared for publication, circumstances may change the final content of the issue.

Electronic Navigation

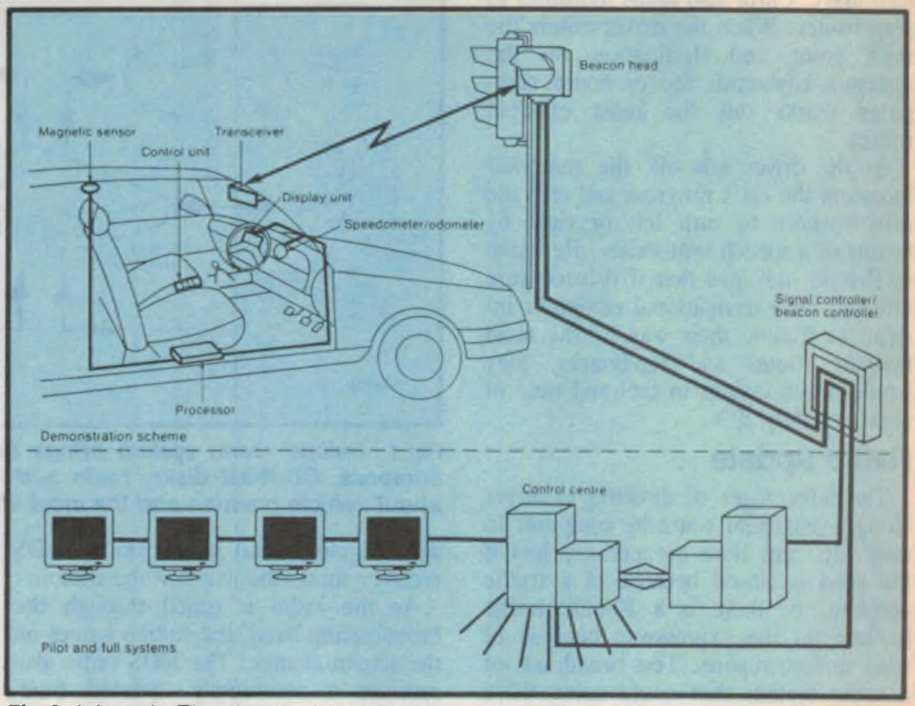


Fig.3 (above): The Autoguide car guidance system, developed by the British Transport & Road Research Laboratory. It uses roadside beacons to relay travel information to a transceiver in the car. If the pilot scheme in London is successful, it will be expanded into a more sophisticated nationwide system.

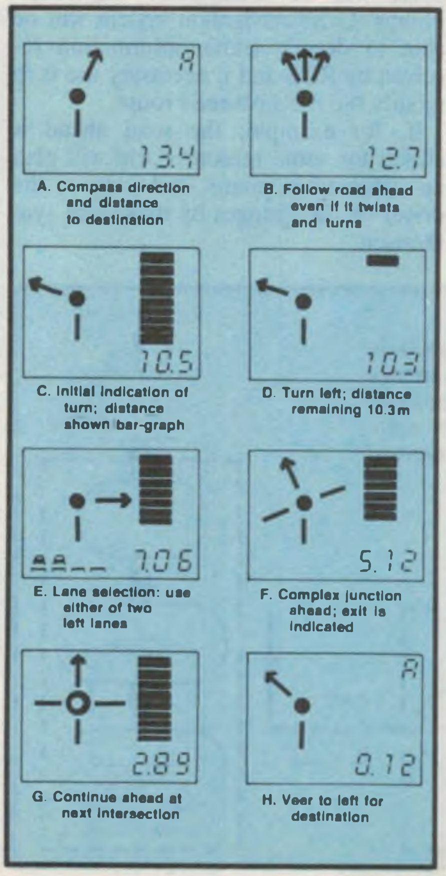


Fig.4 (left): Autoguide's dashboard display shows things like which way the car should turn at the next junction, how far away that is (the bar graph at right) and distance to destination.

to the map regarding traffic conditions, roadworks etc.

Similar systems also have an emergency call feature. If a vehicle crew needs urgent help, perhaps as a result of a traffic accident – or an attack on a wages courier – they can throw an alarm switch, which instantly sounds an alarm at the base station and presents the operator with a distinctive visual alarm on the screen. The appropriate assistance can then be called in without delay, and directed straight to the vehicle in trouble.

With the roads getting more and more congested in most of the developed countries, driving a car almost anywhere has been becoming increasingly frustrating – particularly if you've never driven to that particular destination before. But thanks to electronics, at least the hassle of working out your best route (and current location) will soon be a thing of the past!

SUPER DELUXE BATTERY CHARGER

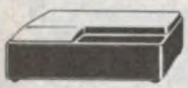
- Charges from 1 to 10 D, C, AA, AAA N, and up to 3 x 9V batteries at the same time
- Dual colour LED in first three compartments to designate 1.5V or 9V
- 240V AC/50Hz
- Approval No. N10637

Cat M23525 .... $59.95

NIGHT SENSOR SWITCH

- Designed to automatically switch on lights at night and off during the day. Ideal for both domestic and security use
- Turns lights off at 120 lux and on at 20 lux
- Waterproof for outdoor use
- Operates on 240V AC 50Hz

A15596 .... $17.95



UHF/VHF CONVERTER

SPECIFICATIONS:
Input (Channel 36): 75 ohm x 1
Output (Channel 1,3,4): 75 ohm x 1
Gain: 12dB
Power Supply: AC adapter 240V AC 50Hz/12V DC, 100mA, DC Plug

Cat. L15051 .... $89.95

CAR ALARM SYSTEM WITH REMOTE CONTROL AND PAGER

- Complete automotive protection system with back-up battery protected siren
- Supplied with remote key switch, pager and glass breakage detector
- 110dB siren with independent inbuilt rechargeable back-up battery
- Automatically arms when ignition is switched off
- Will not start 30 second exit delay until last door is closed

SELECTABLE OPTIONS

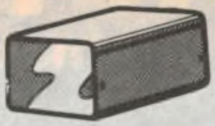
- Transmits signal to pager only, siren only or to both
- Gives audible beep when the system is armed or disarmed
- Valet mode: disarms the system completely for service, etc.
- Extends car power antenna when triggered for long range paging
- Pressing both remote key buttons together activates panic alarm

OUTPUT TERMINALS

- 8 ohm siren/speaker outputs
- Normally open and normally closed output terminals
- 12V DC 300mA output for other alarm devices

COMPONENT BREAK DOWN
Main Unit: Controls and monitors the complete alarm system. All input and output cables are connected to this.
Pager: Portable monitoring receiver "beeps" when the alarm is activated up to 2 miles away. Can also be used as a pager when "paging" button is pressed on the main control unit.
LED Indicator: Shows what stage the alarm system is in, ie: armed/disarmed and exit/entry period. It also has a memory LED that indicates that the system has been triggered and has automatically reset.
Remote Arm/Disarm Key: This transmitter allows you to activate or deactivate the car from outside the vehicle. It also has a panic feature that triggers the alarm when both buttons are depressed together.
Glass Breaking Sensor: This is a piezo sensor that is activated by the frequency of breaking glass which helps to prevent false alarms.
Back-up battery: Rechargeable back-up battery system which stops unauthorised disconnection of the siren. If any of the wires going to the siren are cut it will sound. It also has a keyed manual over ride switch for disarming or servicing.

S15056 .... $399



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

UTILITY BOXES

Plastic boxes with aluminium tops, and available in four sizes. Very popular for projects and very ecconomical!

H10101	150x90x50mm	$ 3.25
H10102	195x113x60mm	$ 4.50
H10103	130x68x41mm	$ 2.75
H10105	83x54x28mm	$ 1.95
H10110	120x65x38mm	$ 2.95
H10112	120x65x38mm (Metal top)	$ 2.95

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POWERFULL MINI DRILL

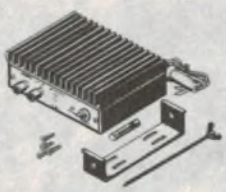
Featuring a powerful 6000 r.p.m. motor, this lightweight (113gm) drill is ideal for many jobs. Perfect for PCB work! Has a 0.8 to 1.2mm chuck and 1mm drill bit. Requires 12V 1 AMP (use with M19010)

Cat. T12302 .... $19.95

FLUORESCENT WORK & EMERGENCY LIGHT

- Suits cars, boating, caravan, camping etc.
- Shatterproof, glare free
- Cigarette lighter plug and alligator clips
- 12V DC, 8 watt, transistorised

Cat. A15052 .... $25.95



STEP DOWN CONVERTER DC-DC

Built around a heavy duty heatsink this unit features the latest transistor switching technology to convert 24V DC to 13.8V DC. Finished in matt black with a unique mounting bracket makes it the best in its class.

SPECIFICATIONS
Input Voltage: 24V DC
Output Voltage: 13.8V DC
Primary Current: 4.2A (24V input 4A output)
Output Current: 4 Amp continuous rated (5.5A max.)
Size: 125(W) x 50(H) x 90(D)mm
Weight: 450 grams

A16155 .... $99.95

10A STEP DOWN CONVERTER DC-DC

Built around a heavy duty heatsink this unit features the latest transistor switching technology to convert 24V DC to 13.8V DC. Finished in matt black.

SPECIFICATIONS:
Input Voltage: 24V DC
Output Voltage: 13.8V DC
Primary Current: 11A (24V input, 10A output)
Output Current: 8 Amp continuous rated (12A max.)
Size: 125(W) x 50(H) x 175(D)mm
Weight: 900 grams

A16160 .... $119.95

"SNAP TOGETHER" PLASTIC CASE

Top and bottom simply snap together (no screws required), removable front and back panels.
Size: 186(W) x 125(D) x 50(H)mm

Cat. H10116 .... $7.95

PRECISION INSTRUMENT SNAP CASE

Features vent system for cooling, top and bottom snap together (no screws required), removable front and back panels.
Size: 135(W) x 93(D) x 47(H)mm

H10114 .... $7.95

STACK COMPARTMENTS

- Precision dovetail system allows units to be interlocked together
- Large handle with index card slot
- One piece moulding ensures trays will not jam or sieze
- Size: 110(W) x 120(D) x 55(H)mm

H10080 Single tray $3.95
H10081 Double tray $4.25

UHF/VHF/FM ANTENNA AMPLIFIER AND 2 WAY SPLITTER.

Covers all Australian frequencies. Suitable for use in houses, caravans, boats etc.

- 1 x 75 ohm input
- 2 x 75 ohm output
- Gain 2 x 6dB
- Maximum output 2 x 96dBuV

Cat. L15041 .... $39.95

CD TO CAR CASSETTE STEREO ADAPTOR

Enables a portable CD player or portable TV to be played through any car speaker system by using the cars cassette player. Reduces the risk of theft. Just plug in when required, and remove when you are finished. Hard wiring not needed.

A10011 .... $29.95

SPEAKER STANDS

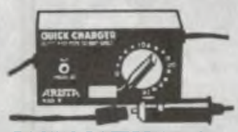
- Black epoxy finished metal floor speaker stands. Base slope is adjustable to allow you to find the correct listening position for your speakers.
- Holds speakers with a minimum dimension of 220 x 190mm
- Maximum speaker weight 30Kg
- Stand height 125mm
- Stand base dimension 370 x 280mm
- Leg studs to stop slipping and vibrating on carpets are easily removed for smooth tile floors, etc.

C10768 .... $99.95

RCA TO RCA ISOLATION TRANSFORMER

- 15A high quality noise suppressor isolation transformer
- Designed to eliminate noise in the audio line
- Does not affect the audio signal
- Simply fits inline between car stereo and the separate power amplifier

M10038 .... $15.95



RACING BATTERY PACK QUICK RECHARGER

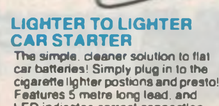
Fast charger for 7.2V NiCad batteries
Input: 12V DC cigarette lighter, fuse protected
Output: standard racing pack lead and terminal to suit S15025 and Tamiya 7.2V batteries
Charge Time: Standard charge is 15 minutes for 7.2V batteries.
0-30 minute timer.

M23528 .... $39.95

7.2V NICAD RACING BATTERY PACK

Suits most Tamiya and other brand remote control cars, toys, and models.
SPECIFICATIONS:
Voltage: 7.2
Charging Current: 130mA
Nominal Capacity: 1300mAH
Charging Time: 15 Hours

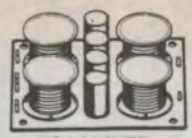
S15025 .... $49.95



LIGHTER TO LIGHTER CAR STARTER

The simple, cleaner solution to flat car batteries! Simply plug in to the cigarette lighter postions and presto! Features 5 metre long lead, and LED indicates correct connection.

Cat. A15062 .... $10.95



CROSSOVER NETWORKS

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

2 WAY 60 WATT CROSSOVER NETWORK

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

Cat A16001 .... $4.95

2 WAY 60 WATT CROSSOVER NETWORK

- 12dB attenuation
- Cross over point 2,300 Hz
- Impedance 8 ohms

Cat A16002 .... $7.95

3 WAY 60 WATT CROSSOVER NETWORK

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

Cat.A16003 .... $9.95

3 WAY 60 WATT CROSSOVER NETWORK

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

Cat. A16005 .... $24.95

3 WAY 150 WATT CROSSOVER NETWORK

- 16dB attenuation
- Cross over point 350 and 3,000 Hz
- Impedance 8 ohms

Cat. A16007 .... $34.95

MINIATURE BUZZER

5-15V White or black

Cat. C15062	1-9	10+
	$2.50	$2.25

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

SUPER HORN

- Wide dispersion tweeter, handles up to 100W
- Sensitivity: 105dB/0.5m
- Frequency Response: 3kHz-30kHz
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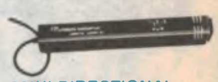

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A special guide to

Careers in Electronics

Confused about careers in electronics? Whether you're just entering the workforce or looking for a career change, here's the lowdown on the options available, based on our new Technical Editor's 14 years of experience as a lecturer in electronics.

Learning robotics. Programming skills are needed, although technical

by PETER PHILLIPS

About 30 years ago, 'electronics' meant radio and 'electrical' covered just about everything else. In fact, entry to electronics other than radio was generally via the electrical field, and engineers of the genre were known as Electrical Engineers. Apart from communications, electronics was mainly confined to the domestic service industry, where a box of valves and a screwdriver often sufficed.

Today, there are a wide range of classifications covering the full gamut of the electronics field, all serviced by appropriate courses available from learning institutions.

This article is aimed at those who are considering electronics as a career, but who need some guidance on what level of training they should consider, and in what area of the field. It is no longer sufficient to simply state 'electronics', as like medicine, the need to specialise is a consequence of the complexity of the field.

Apart from deciding on the area of electronics you wish to enter, the question of level must be considered. Your academic ability will largely determine this, as will your general interest in the subject.

If you are a school leaver, you may not even know whether electronics is for you. I recall wanting to be a car mechanic upon leaving school, and it was good luck that got me into electronics rather than good management. But, like most people with an electronics bent, I had spent much of my youth playing around with electrical things, and I am forever grateful that fate worked out as it did.

But a hobbyist background is not always a characteristic of successful entrants to the field. Over the years, I have seen a wide range of people enjoy academic success in electronics including brick layers, sheet metal workers and many school leavers who initially had no knowledge of the field at all. Certainly, a common characteristic of those who gained the greatest success in the field was a personal interest in electronics.

Academic levels

The hierarchy in electronics is basically engineer, technician and tradesperson. However there is some overlap between these three levels, and it is difficult to accurately define each one. For example, the tag 'Sales Engineer' is often applied to a smart young man with a clean suit, a good line and a trades certificate.

Alternatively, a holder of a degree in Electrical Engineering may be known as an Electronics Technician. Also, the level of training is not neccssarily an indicator of salary. But more on this later.

Deciding on the level you wish to undertake in the field must be based on your academic ability. Entry to a university will always require either the HSC or its equivalent, and diploma level courses in TAFE also usually specify the HSC. Some employers prefer apprentices to have the HSC, although this is not a prerequisite for a trade level course.

Because the phenomena associated with electricity is best explained in mathematical terms, one can relate the level of an electronics course to its mathematical content. Thus, if you can't handle mathematics, then choosing electronics as a career may be a mistake. You might still gain success as a practical person, but will find getting qualifications very difficult.

The highest level of academic training is an engineering degree, available from a University or a CAE. These institutions will generally require an aggregate mark of around 400 in the Higher School Certificate, along with certain subjects, typically mathematics (2 to 3 unit) and science subjects.

The next level is the so-called *technician* level, requiring completion of an Associate Diploma course, available through the TAFE system. This type of course was previously referred to as a Certificate Course, and has a mathematical level of approximately 1st year of a degree.

Finally, you can enter the field as a tradesperson. Before examining each level in detail however, a look at the specific areas of electronics is appropriate.

The electronics field

Trying to identify all the areas of electronics is a bit like trying to classify fish. There are many possible ways to do it. I see the field as breaking down like this: industrial, commercial/domestic, communications, computers, medical, defence, radio/TV operators and automotive.

Within these fields you have the two basic activities of *design* and *maintenance*. Design is usually the prerogative of the engineer, and maintenance/repair

electronics skills often come in handy as well.

is carried out by all levels. Also, cross pollination occurs between the fields, such as data communications with computers, industrial aspects of the same thing in commercial/domestic, and so on.

Finally, the whole field can also be subdivided into *analog* (linear) or *digital* electronics. A brief look at each area may show the similarities/differences between them.

Industrial electronics

Industrial electronics is what it says – electronics in industry, as opposed to commercial/domestic electronics. This type of electronics will vary considerably with the nature of the industry.

Usually, the plant or organisation will have all three levels of trained personnel, and union rules will often specify who does what. Typically, the technician and trades level staff will do work requiring tools, while the engineer will supervise and work with his support staff to commission, modify or repair the plant. Technicians may be involved in software applications and tradespersons in hardware.

Nowadays most major industries rely on Programmable Logic Controllers (PLCs) and computers to run the assembly line or sections of the plant, and a knowledge of software is becoming more necessary.

Other typically industrial electronic applications include motor speed control systems, TV monitoring systems, automated machines and general electronics such as paging systems, conveyor belt control systems and so on. As well, electronic instrumentation is usually found in most industries, although this may be looked after by 'Instrument' staff.

Tradespersons are usually electricians with a post-trade qualification in electronics, and will receive a wage commensurate with their qualifications. Smaller industries may lack the personnel structure of larger enterprises, and it is not uncommon for a skilled trades-level person to be given complete responsibility for anything electronic in the plant.

Entry to the industrial field is usually either as a trainee, in which you undertake a Degree or Associate Diploma, or as an apprentice. Often, the apprenticeship will be as an electrician, requiring post-trade study to gain electronics type qualifications and many industries classify such tradespersons as Electrician, Special Class.

Wages are usually tied to union awards, but when coupled with overtime, penalty rates and bonuses, can be quite healthy. Engineers and technicians may be given staff status, which typically gives kudos but a fixed salary.

Pay for skilled electronics technicians, either trades or diploma level can be quite high, and packages around $35,000 to $50,000 are not uncommon. However, for this kind of money, you will have undergone a lot of training, either in-house, or at an institution.

Commercial electronics

The commercial/domestic area covers such fields as domestic appliance repair (TV and the like), photocopiers, FAX machines, alarm systems, weighing machines – even computers. Those employed in this field are often known as technicians, but usually have trades level training (often with post-trade training as well).

Because the field is so varied, the training will be broad, and aimed at re-

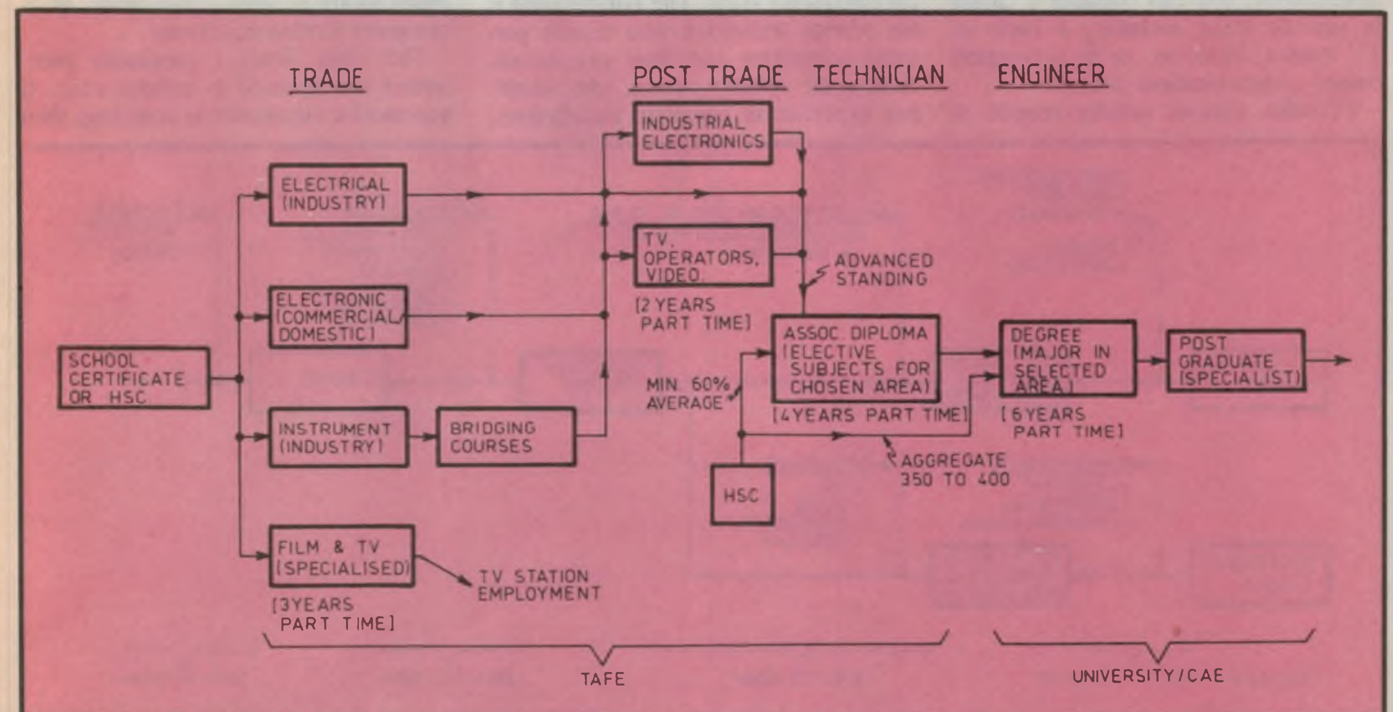


Fig.1: The flow diagram of careers in electronics has many possibilities, many of which require TAFE training. Of course we can't show all areas, because the field is so diverse.

pair of, rather than design of the equipment. You may be able to gain an apprenticeship with a servicing company, although some firms will decline an actual apprenticeship, but still permit your attendance at a TAFE college. Wages may vary depending on the generosity of the firm, but the work is usually varied and of a lighter and often cleaner nature than the industrial type.

If you plan starting your own repair/sales business, then commence your career as an apprentice for an established firm. This way you gain expertise in electronics, customer relations and business knowledge.

Communications

Telecom is by far the largest employer in this field. Most Telecom technicians will have completed either a degree or TAFE diploma, although it is possible to rise up through the ranks with a relevant trade background.

Communications is a large field, encompassing telephony, radio and digital data transmission. There is a trend towards private sector involvement in communications, and good jobs are available for those with expertise in the field.

Telephony as a stand-alone area is largely superseded, and most firms involved in this will provide their own training. If you are keen on radio communications, you can consider a career in various areas, including a radio or TV station, Telecom, or in a privately owned communications firm.

TV/radio stations usually require at least one member of their technical staff to have an Operator's Licence – a legal requirement where maintenance and operation of the transmitter is concerned. This extra training requires the holder of the licence to pass special exams, usually as a post-trade option to a trade course.

Computers

Many people see computers as the domain of electronics. However, an expanding area is computer programming, which often requires little or no technical knowledge of electronics.

Many universities and CAEs run programming courses, some of which can be undertaken by anyone. A good programmer can earn big dollars, but will need expertise in various programming languages and in a range of computing systems.

Industry, despite the popular belief, doesn't only use IBM PCs, and a knowledge of mainframe systems is usually required. However, many programmers start out with a personal computer, and extend their abilities by undertaking suitable training courses. You can either work for an established software development firm, or even contract yourself to various firms needing your expertise. Programming is very mind-intensive, although an addictive pastime if you like it!

Repair, installation and maintenance is the other side of the computing coin and does require the appropriate technical electronics skills. The bottom rung is the service technician who repairs personal computers and their peripherals. Next is the systems person, who usually has expertise in complete installations, and may be responsible for the initial installation as well as maintenance of the system. Usually, firms specialising in this field will cater for any business requiring their product, and field work is usual for the technical staff.

Typically, you will need either a degree or a TAFE diploma, as well as in-house training. Installers may only require a trade, probably electrical (with licence) and some electronic skills. As computing systems vary considerably in cost and complexity, so too will the skills required. The highest money is paid to those who can work with mainframe systems, although the larger area of opportunity is probably the more popular desktop computer systems.

The other fields

A study of job vacancies in the electronics area will show that opportunities lie in all sorts of areas. The greatest demand is in the trades or technician areas, although design engineers come a close second.

The defence forces offer great opportunities, coupled with excellent training. One problem, however, that has caused problems is that qualifications gained in a defence establishment are not always accepted 'outside'. However arrangements can usually be made to overcome this problem, should it ever arise.

The defence forces provide opportunities in many specialist areas, ranging from flight simulator maintenance to submarine electronics. Naturally communications is also a big field, as is computer hardware/software.

The other fields I previously mentioned are accessed in various ways. If automotive electronics is your bag, then

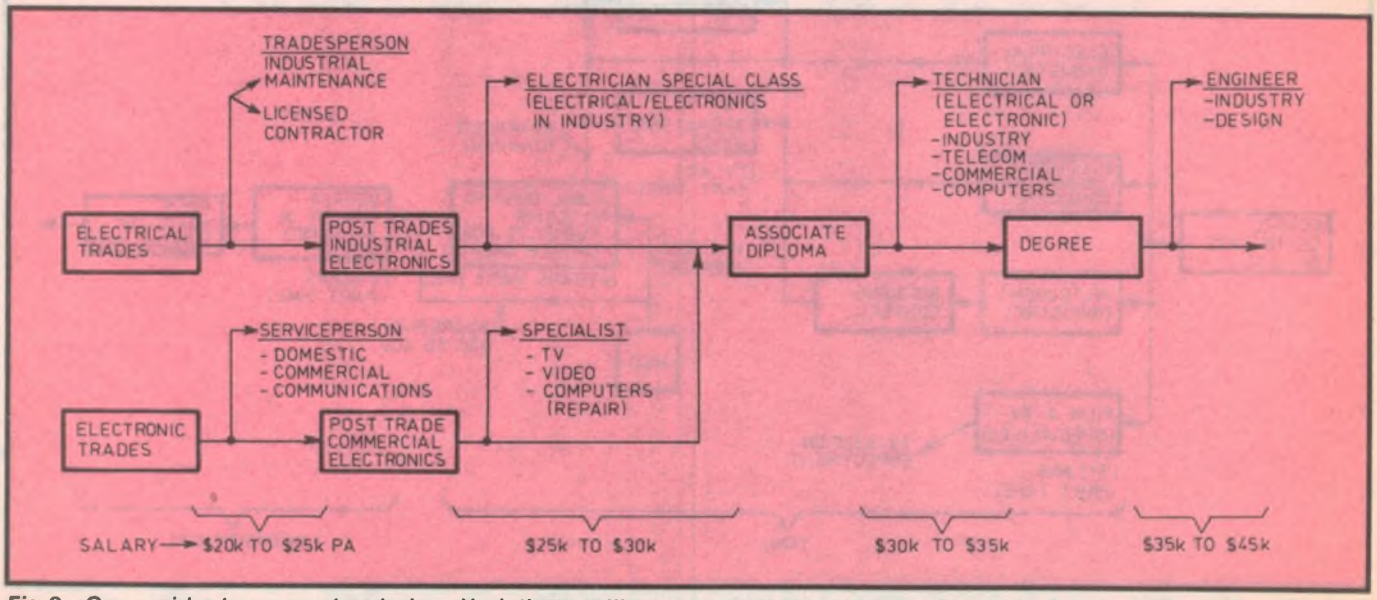


Fig.2: Our guide to current salaries. Variations will occur, depending on overtime, bonuses and other incentive packages. Self-employed people can also expect good returns.

consider approaching the field as an electrician with post-trade study. Going from the mechanical to the electronic side of the automotive industry is possible, but unusual.

The medical electronics field is usually the domain of the technician or engineer, as like the research fields, it is highly specialised and full of sophisticated gear. There is a tendency for high prices to be charged to repair this type of equipment, often exploited by the unscrupulous, as good technicians in this area seem to be scarce.

Training institutions

There are four basic avenues open to those seeking training in electronics: universities/CAEs, TAFE, in-house (defence forces etc.,) and private colleges.

The largest organisation is TAFE, although the university/CAE line-up is very comprehensive. It is probable that some 75-80% of people involved in the electronics field received their training in a TAFE college, so a close examination of the TAFE system seems warranted.

The TAFE system

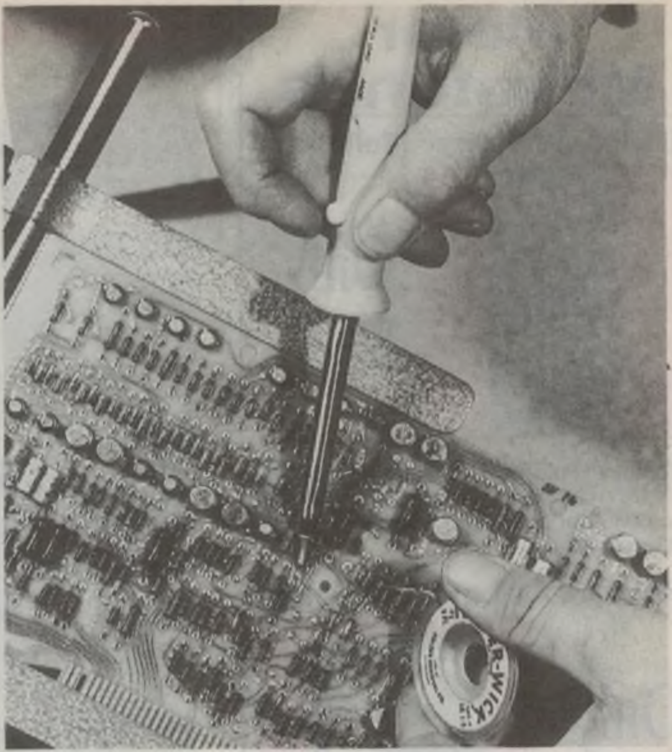
My experience is with NSW TAFE, although TAFE in most states would likely be rather similar. It is not possible to examine the TAFE structure for each state and still keep this article to a reasonable length, so I'll stick with the NSW version.

Electronics training is handled by two 'Schools' in NSW TAFE: the School of Electrical Engineering and the School of Applied Electricity. The latter is the largest, and handles all trade and post-trade training, while Elec. Eng. runs the technician level courses.

Within the School of Applied Electricity there are various divisions; Film and TV, Electrical Trades, Electronic Trades, Instrument Trades, and Industrial Electronics. The last of these (my old stamping ground) provides post-trade training to those from the trade courses, predominately the electrical trades. The Electronic Trades division caters for the commercial/domestic arena, and also offers various post-trade courses in TV, video recorders and so forth.

The Film and TV division (only at North Sydney) is not really electronic, as it provides only basic training in this area, concentrating more on camera work, set design and the like.

The School of Electrical Engineering contains two divisions, Electrical and Electronic which are rapidly merging anyway.



The practical aspects of electronics require particular skills. The ability to solder and desolder is certainly one of them.

As a consequence of recent government initiatives, things are changing in the TAFE system, and not only in NSW. Currently, TAFE all around Australia is undergoing an appraisal of its courses in an attempt to make each state's qualifications the same.

Previously, each state was autonomous, making it difficult for someone moving interstate to have his qualifications recognised. So – enter the National Re-accreditation scheme, which, although still in its early days, has already had considerable ramifications.

The main effect is the renaming of qualifications. For example, we now have the Associate Diploma of Engineering (Electrical) instead of the previous Electronic & Communications or Electrical Engineering Certificate courses. Now, you undertake various elective subjects pertinent to your selected area, but within the one course. And everyone gets the same award: an Associate Diploma, conducted, in NSW TAFE, by the School of Electrical Engineering.

Trades courses will become Certificate courses, awarding the appropriate trade certificate. The mid level is the so called Advanced Certificate, which will largely cover the post-trade areas. Other courses not covered by the scheme will offer a testamur, but having local recognition only.

This should mean that all Associate Diploma, Advanced Certificate and Certificate courses – anywhere in Australia – will have been assessed and approved as having met certain guidelines. Good news if you want to move interstate.

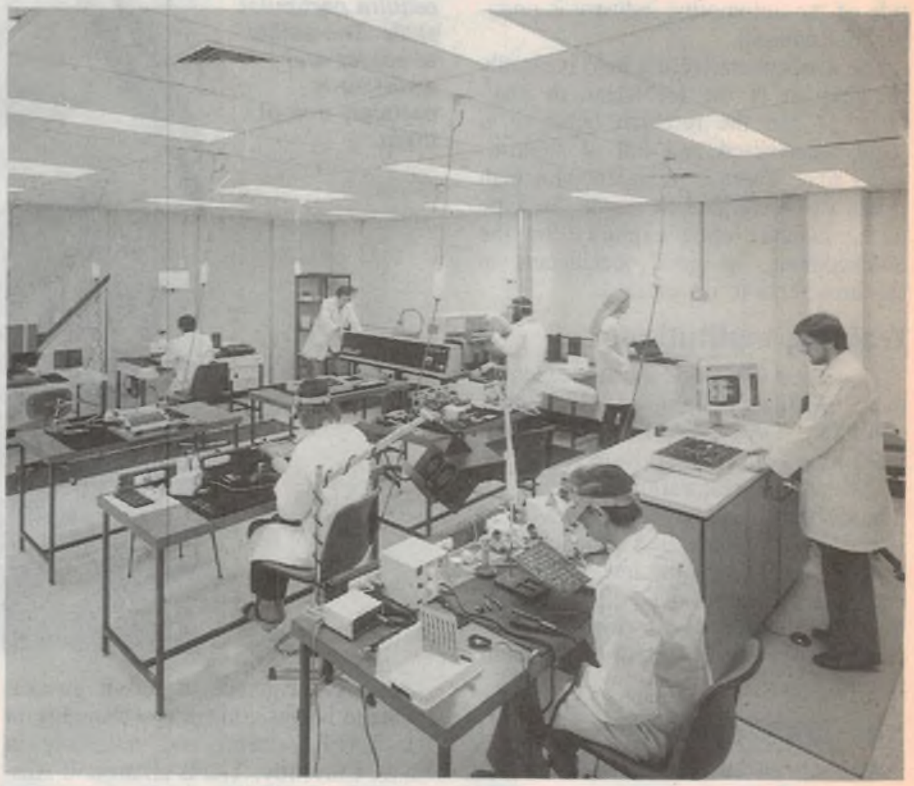
Universities and CAEs

Not all universities offer engineering courses, due to their high cost. However, the larger institutions certainly do, and it is often a matter of 'will they have you' at the one of your choice.

I cannot generalise about university courses, as each institution differs in its course offerings. However, the level of an engineering degree will be much the same where ever you go, although a university's 'reputation' (whether real or historical) is often worth considering.

A problem for any university student is money. Apart from the up-front fees and the running costs, there is often the small matter of earning a living while studying. For this reason many university students undertake their course part-time, and gain employment anywhere they can. Great if you can get a traineeship, but most engineers can relate stories of initial hardship.

Entry to a university is by way of HSC results, unless you have undertaken 'equivalent' studies. In fact, many of today's engineers will have completed other courses before deciding to do a degree. The so-called 'mature age' student is not uncommon, although doing a degree with a wife and family on hand has its own special difficulties, even if money problems are the least of them.



A typical small scale production set up. Computers now play a big part in manufacturing as well as design situations. (Courtesy Roysten Electronics)

In short, there is no easy way; dedication and hard work tend to go hand in hand with a degree, so be prepared.

In summary

So, what does it all mean? The block diagram of Fig.1 may help in deciphering the maze. This diagram is approximate only, but is an attempt to show possible 'articulation paths' or training avenues.

For example, you can start with a trade and work up, stopping when you have had enough. Alternatively, if you gain the necessary marks in the HSC, you can enter the chain at either a diploma or degree course level.

However don't under-estimate the value of a trade certificate. Many employers prefer their staff to have both the trade and diploma qualifications, rather than just the diploma. Also, there are more opportunities for electricians with post-trade qualifications than for those with only the Associate Diploma, particularly if you also have an electrician's licence.

In the commercial field, (where wages are sometimes smaller, by the way), you can work up from the servicing level to a specialist in a particular type of equipment. And, of course, you can eventually undertake a degree, even without the HSC. It just takes a lot longer.

The block diagram of Fig.2 shows things another way. The salaries shown are very approximate, and can vary considerably. Remember that overtime can bring a salary up to $50,000 quite quickly, and that engineers are often not paid overtime.

Also, this diagram does not show the whole field. There are other areas that can be followed, and the miscellaneous fields including instruments, defence, communications, automotive and the rest are not really shown. However it may give a general idea of the electronics field.

Electronics as a whole is an exciting business, and just about any of its individual areas can provide challenge and rewards as a career, if you arm yourself with the right training. You certainly don't have to have a university degree, as I've tried to make clear. There are levels of training and employment to suit almost everyone, and in any case you can progress up to higher levels as you go along.

The choice is yours – good luck. EA

Profile on Polar Instruments:

All the way from a garage in Guernsey

From humble beginnings 14 years ago, a small company based on the island of Guernsey in the English channel has quietly established its range of innovative and cost-effective test instruments. Today Polar Instruments has a thriving export business, and is actively challenging the large multinationals.

by JIM ROWE

The tiny island of Guernsey sits in the southern mouth of the English channel, in the Bay of St Malo. Although only about 30 miles from France, and nearly 80 miles south of the English coast, it is loyal to the British Crown – while still basically an independent 'bailiwick' with its own parliament.

Together with its six even tinier island neighbours (and larger Jersey, a little further away), the 24-square-mile Guernsey enjoys a very pleasant climate and is a popular holiday spot for English tourists. It also offers low personal and company tax rates, and this combined with a minimum of industrial legislation has attracted a surprising amount of light industry to the island.

Electronics firms in particular have found it attractive. US firms such as Tektronix, Dynatech and Nashua some time ago set up manufacturing facilities on the island, along with the UK group Eurotherm International and smaller UK firms such as Marine Electronics and Alma Components. They now form a significant part of the island's economy.

Currently the island's electronics plants employ over 700 people (over 1% of the total population), and annually export products worth over $US90 million.

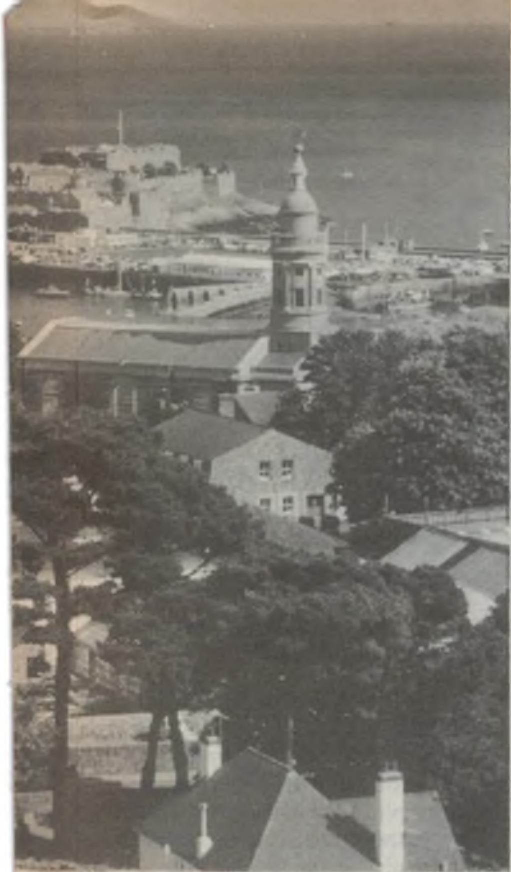
Back in 1974, there were signs that Tektronix would be scaling down its engineering design activities on Guernsey. Looking to the future, an engineer named Doug Campbell decided to set up a company to produce and market a novel test instrument he had developed to find short circuits on PC boards. The new instrument was dubbed the *Toneohm*, and the company set up to produce it was called Polar Instruments Limited.

For the first five years, Campbell ran the company as a sideline, out of his home garage. However the Toneohm became quite successful, and by 1979 it became obvious that the business really needed full-time involvement.

Doug Campbell himself stayed on at Tektronix for a while, but his colleague Martyn Munn left and began running it full time, in new and separate premises. Then in 1984 Campbell himself left Tektronix, together with Martyn's brother Nigel Munn, and the two also joined Polar as full time employees.

Checking out a new interface pod for the B3T micro tester, in Polar's R&D lab.

Outside view of Polar's facility in St. Sampson's, on the island of Guernsey.



Castle Cornet, one of the sights at Guernsey's St. Peter Port.

Since then, the company has steadily grown stronger. Still privately owned, its turnover has grown by an impressive 50 times since 1977. It now exports its test instruments all over the world, to countries such as the USA, Canada, France, Denmark, Sweden, Norway, Germany, Greece, New Zealand and of course Australia.

Currently Martyn Munn is managing director of Polar, with Doug Campbell and Nigel Munn its marketing and technical directors respectively. At present the firm has nine full-time employees and two part-time staff, most of them former employees of Tektronix.

Doug Campbell readily acknowledges the role of long-established firms such as Tektronix in particular, in creating the industrial climate and skills which allowed the island's own electronics industry to flourish.

From that first Toneohm PCB shorts locator, the Polar Instruments range has grown significantly. Before long it was joined by the 'T series' of in-circuit faults locators, using the equally innovative principle of analog impedance signature analysis. This is based on a dynamic voltage/current X-Y display on a CRT, to show patterns or 'signatures' indicative of various component parameters and fault situations.

Late last year it launched the B3T microprocessor board tester, designed to perform fast and efficient troubleshooting of microprocessor-based products. This has been very successful, competing strongly in many markets against the Fluke 9010 micro troubleshooter.

More recently it has launched the SPT series of low cost single processor versions of the B3T, which retain software compatibility with the larger troubleshooter but are designed for field service applications. The SPT units compete with the newly-released Fluke Model 90, and versions are already available for the Z80, 8085, 6809 and 8051 processor/controllers – with more under way.

Also released this year is the improved model T1500 fault locator, developed from the earlier T series instruments and like them it exploits the principle of analog signature analysis.

All in all, Polar Instruments has in 14 years established itself as a very credible and innovative maker of test equipment. From initial successes in specific 'niche' markets, it is now expanding into broader and more competitive fields, and starting to challenge the big multinationals on their own turf. It should be very interesting to see how it fares.

The instruments

The distributor for Polar Instruments in Australia is Emona Instruments, which very kindly loaned us samples of the main instruments in the current Polar range, for evaluation.

It seemed appropriate to begin with the model 850 Shorts Locator, as this is the latest 'top of the line' version of the original Toneohm instrument.

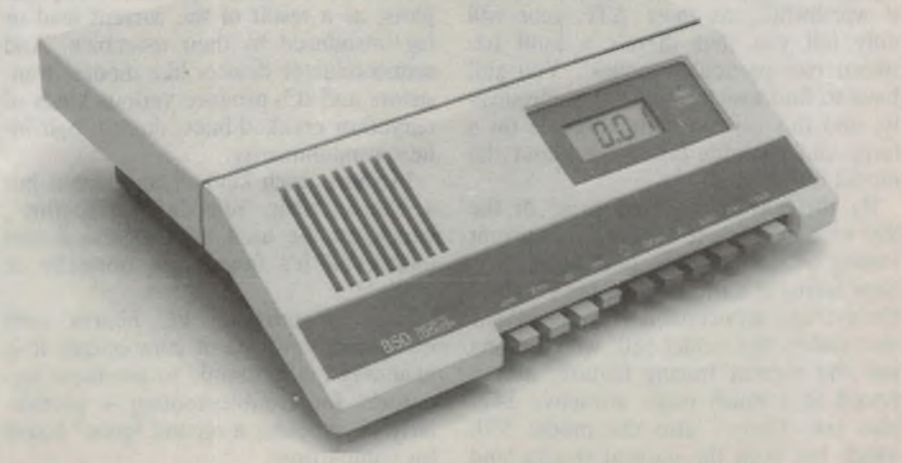
Although labelled a Shorts Locator, the 850 can in fact be used to find the exact physical location of a number of other kinds of faults on PC boards, as well. It will find faulty IC chips and leaky bypass/decoupling capacitors, for example, or other faults producing excessive current. And all without cutting any tracks or lifting component leads.

Essentially it's a sensitive milliohm meter, microvolt meter and current tracing meter, with indication via both a digital LCD display and a variable-frequency audio tone from a small speaker. The tone is very useful, because it allows you to track down the fault quickly without forever glancing over at the digital display, and possibly losing your place on the PCB.

To find 'hard' or true short circuits between PCB tracks, the 850 is basically used as a millivoltmeter with its two needle probes used to test the resistance between the PCB tracks concerned. As they are brought closer to the short, the pitch of the audio tone rises as the resistance falls. Finally, when you're within a couple of millimetres of the actual short, it begins to pulse.

There are a total of five ranges for this mode of operation, four of them calibrated with full-scale readings of 20k, 200 ohms, 2 ohms and 200 milliohms respectively. The fifth range is not calibrated but has a sensitivity of about 50 milliohms full scale.

For finding 'softer' shorts such as leaky capacitors and other components drawing excessive current, the 850 can be used as a sensitive DC microvoltmeter. Again the indication is via both the LCD digital display and the audio tone,



The model 850, Polar's current top of the line shorts locator. It provides three modes of tracking down PCB shorts and faults.

and the sensitivity is such that it can easily detect the working voltage drops in most PCB tracks.

These measurements can be made using either the board's own normal power supply, or a current 'drive source' built into the 850 itself.

It provides four voltage ranges, with full-scale readings of 20V, 2V, 20mV and 2mV respectively. Fairly obviously the higher ranges are used mainly for checking normal supply voltages and logic levels.

Finally, the 850 also provides a sensitive current tracing probe, with a Hall-effect element which responds to the magnetic field around PCB tracks (both on the surface and inside multi-layer PCB's), wires, and even IC packages and chips. Again this can be used to track down excessive current flow, using either the audio tone or LCD display as indication and with current supplied by either the board's normal supply or the 850's drive source.

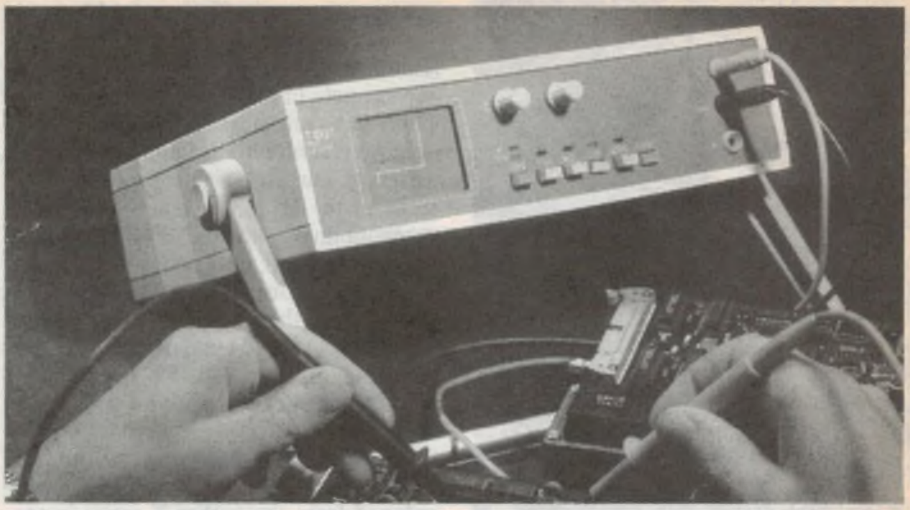
I tried out all of the the 850's modes, using both an amplifier PCB I had on the bench and a 'sample faults' board kindly made available by Emona. The latter is used for customer training on the 850, along with a small demo videotape which Polar has produced.

Frankly I found it delightfully easy to use. The combination of audio tone and digital indication is a very handy and practical one, making the 850 surprisingly fast and effective in tracking down faults that would otherwise be very elusive.

I'm sure that virtually anyone repairing and troubleshooting complex PCBs would find it almost indispensible.

Even those in well-heeled production environments with fancy automatic test equipment systems would probably find it worthwhile, as most ATE gear will only tell you that there's a fault between two particular 'nodes'. You still have to find exactly *where* it is physically, and this can be quite a hassle on a large and complex board – without the model 850, that is!

By the way the quoted price of the 850 with manual, test leads and current tracing probe is $1856 plus tax – perhaps taking it a little out of the range of the average serviceman. However Polar also makes the model 580, which offers just the current tracing feature, and is priced at a much more attractive $479 plus tax. There's also the model 550, which has both the current tracing and milliohm ranges, for a still very reasonable $888 plus tax.



The model T1500 fault locator, which uses the technique of analog impedance signature analysis. Sounds complicated, but it isn't!

The next instrument I tried out in the Polar range was the model T1500 Fault Locator. This is a little like a small CRO in appearance, but works rather differently. It is used only on *unpowered* boards, to test virtually any kind of component while it is in circuit.

The T1500 has a pair of probes like a multimeter, and these are applied across each component of interest. The instrument applies a small alternating voltage across the probes, from a current-limited source for protection. It then senses the dynamic current drawn, during the AC cycle, and displays the voltage/current characteristic as an X-Y plot on its 64mm diagonal CRT screen. Voltage is plotted on the X axis and current on the Y axis.

Needless to say, each kind of component or combination of components has its own characteristic voltage/current plot. Resistors produce a straight line, at an angle to the horizontal inversely proportional to their resistance. Capacitors and inductors produce elliptical plots, as a result of the current lead or lag introduced by their reactance. And semiconductor devices like diodes, transistors and ICs produce various kinds of curved or cranked lines, due to their inherent nonlinearity.

In short, each kind of component has a characteristic 'impedance signature', which can be used to recognise it and indicate if it's functioning normally or not.

Even in crowded PC boards with many combinations of components it is generally quite feasible to use these signatures for troubleshooting – particularly if you have a second 'good' board for comparison.

To make it easy to do this kind of comparative analog impedance signature analysis, Polar has actually provided the T1500 with *two* input channels. So you can apply one set of probes to the known good board, and compare the signature plot of this with that produced by the suspect board at the same location, directly on the screen. The second channel can be disabled when comparison is not needed.

The T1500 has four actual measurement ranges, three of them for testing analog circuitry and the fourth for checking logic. Marked 'Low', 'Med' and 'High', the three analog ranges apply 10V, 20V and 50V peak (open circuit), with currents limited to 150mA on the low range and 1mA on the other two. The 'Logic' range applies 10V peak as with the Low range, but here the current is limited to 10mA to avoid chip damage.

There is also a choice of either 'Lo' or 'Hi' frequency AC for the testing, giving frequencies of 80Hz and 1kHz respectively. The Lo range is appropriate for most general testing, but the Hi range can allow more convenient analysis in circuits with higher impedances.

As before I tried out the sample T1500 with the amplifier board on the bench, and also with a pair of sample boards which were kindly supplied by Emona. The latter were complete with built-in differences and 'faults', to demonstrate A-B signature comparison.

And as with the model 850, I found the T1500 very logical and easy to use. It gives very crisp and steady displays of the impedance signatures, and these turn out to be just as Polar suggests – quite easy to interpret.

It was quite easy to tell the difference between component values – like a 220uF electro fitted in place of a 100uF. And to detect that two parallel diodes

Polar's recently released B3T micro tester, which carries out many useful tests on micro-based PCB boards and systems.

were connected around the same way on one board, but in reverse directions on the other. Similarly it was quite easy to spot a transistor with a 'soft' breakdown, as opposed to the normal fairly sharp one.

And these kinds of decisions were quite easy to make, even though the components concerned were connected in circuit and shunted with various other components. It's surprising how quickly you learn to spot the effect of shunt resistance or capacitance, and make allowance for it.

Sometimes you have to change ranges on the T1500, of course, to make things clearer when the circuit impedance is either relatively high or low. This is quite easy to judge, as the trace gets either 'too horizontal' or 'too vertical'.

Overall, I was again very impressed with the T1500. It seems a very practical and easy to use instrument, and one that should be invaluable in many servicing and manufacturing test situations. There's no doubt it would save a great deal of time in tracking down assembly errors and faulty parts.

The price for the T1500 with manual and test probes is $1804 plus tax – again not cheap, when you consider the price of a typical small single-beam CRO, but I guess they're not made in anywhere near the same volume as yet. Polar also makes two other instruments in the same range, the T1200 which boasts transistor curve tracing ranges, and the T1000 which is similar but designed to use a conventional CRO as its display.

The next Polar instrument I tried out was the B3T. This is a rather more sophisticated beast, designed to test and troubleshoot microprocessor-based digital circuits. But like the simpler Polar instruments it is again designed to be easy to use. It *doesn't* require you to be familiar with the processor's instruction set, for example, or to be a whizz at assembly language programming (although these wouldn't go amiss!).

As with any microprocessor board tester, the B3T needs to get access to the bus lines of the board to be tested. And like other board testers it can do this by plugging into the processor chip socket, in place of the processor itself. However one of the features of the B3T is that it can also hook into the board via edge connectors, port connectors or other points, via its own optional 'user port' interface pod.

For plugging in via the processor socket it depends on one of a series of other 'optional' interface pods, which customise it to suit any particular microprocessor. Currently Polar makes a wide range of processor interface pods, catering for about 30 different processors – from the 1802 to the 68000.

Along with the processor and user port interface pods, the B3T also has a multi-function test probe, which can be used as a logic probe (either synchronous or asynchronous), for frequency measurement (checking the system clock, etc.), to identify system buslines or to identify address decoding ranges.

The B3T iself has a two-line LCD display screen and a small keyboard, which is used to feed in testing commands, addresses and data. The commands themselves are fed in via single keystrokes, the display then prompting you to feed in any appropriate addresses or data (in hex).

Testing functions the B3T will perform include *Learn*, where it runs through memory space and checks for the presence of RAM or ROM; *Shorts*, where it will search and identify shorts on address, data and control bus lines; *RAM* and *RAMLONG*, where it carries out tests on the read/write memory; *ROM*, where it calculates the checksum of a ROM; *PINS*, where it displays the state of the processor's control inputs; *MEMORY READ* and *MEMORY WRITE*, where it reads or writes data to a selected memory address; *I/O READ* and *I/O WRITE*, to do the same things for an I/O address; *TOGGLE DATA* and *TOGGLE ADDRESS*, which toggle data and address lines; *WALK*, which rotates a data pattern at a selected address; and *IN* and *OUT*, which reads to or writes data from the B3T's user port. There are also two commands for use when the B3T is programmed to perform a sequence of tests: *PAUSE* and *LOOP*.

Actually quite extensive testing programs can be loaded into the B3T's internal battery-backed memory, which will hold up to about 1500 test commands – either as a single fancy program, or in up to 99 separate test routines. Further programs can be loaded into an 8K EEPROM, which can be plugged into a ZIF socket into the instrument's lid.

Expected test results can be included in a program, so that the B3T can indicate the results of a test as either 'Pass' or 'Fail'. This makes it suitable for use with non-technical operators, in a production environment.

Incidentally the B3T can display the contents of memory in either hexadecimal, ASCII or disassembled code (mnemonics), as desired.

The B3T contains its own small printer, to print out the results of its tests if desired. The printer can be arranged to print out all results, or only where a test is failed. It prints in 24-character lines on calculator-type paper rolls, but the B3T also includes a standard Centronics-type parallel printer port, to drive an external printer.

There's also an RS-232C serial data port, to allow the B3T to be programmed using an external computer, and a Trigger output to trigger other instruments at the start of a testing program loop. And finally, a pair of jacks on the back provide 5V DC at up to 1A, to power the board under test if this is desired.

In short, it's a pretty powerful and flexible unit, and capable of performing a wide range of tests on micro-based systems.

By the way, the Polar's micro testers like the B3T (and the SPT discussed shortly) apparently use a technique of *simulating* the original processor, in contrast with others like the Fluke instruments which use *emulation*. I gather that this allows the Polar instrument(s) to be rather lower in price, although it doesn't allow testing at normal operating speed.

The sample B3T came complete with a Z80 interface pod, and even a small Z80-based computer board in case I didn't have one to try it out (they're thoughtful people at Emona!). I didn't really have the time to check out *all* of its extensive capabilities, but from those I was able to try out, I was most impressed.

A particularly nice feature for general troubleshooting is the ability to identify bus line tracks on the PCB. In this mode you simply touch the test probe tip to the line or IC pin concerned, at the B3T will tell you immediately what data or address line it is.

I also liked things like the ability to read the system clock frequency, and to write data to (or read it from) a memory or I/O address just by a few simple keystrokes.

Overall it seems a very comprehensive tester, yet one that is easy to drive at the same time.

Quoted price of the B3T is $5629 for the basic unit with test probe and manual, plus between $430 and around $1000 for the appropriate processor interface pod. The optional 'User Port' interface is $421. These prices are again all exclusive of tax.

The final Polar instrument I was able to try out was the new SPT Micro Board Troubleshooter. This is virtually the 'baby brother' of the B3T, capable of doing most of the same tests but without the User Port facility. It also lacks the internal printer, external printer socket, RS-232C serial port, EEPROM program socket and 5V/1A DC output.

In fact the SPT has no power supply of its own, drawing its power from the equipment under test via the processor socket. According to Polar's literature it typically draws less than the processor it replaces.

The Polar SPT, 'little brother' of the B3T micro tester. It uses the same multi-purpose test probe.

Unlike the larger B3T, the SPT doesn't have a separate processor interface pod. Instead there are different versions of the SPT itself, to cope with each variety of processor. Currently Polar has four SPT models, to suit the Z80, 8085, 6809 and 8051, with further versions under development.

The SPT does have a test probe, though. In fact it uses exactly the same probe as the B3T, and provides the same probe testing functions.

Actually in most other respects, the SPT is just like the B3T except that you can't feed in testing programs from the keyboard. The SPT will run programs, but they must be stored in an EPROM plugged into a socket inside. And the good news is that the SPT is software compatible with the B3T, so that programs can be prepared using the latter.

This means that you can use a number of SPT's for field servicing, with pre-programmed EPROMS prepared using a master B3T.

As with the B3T, I found the sample SPT very easy to use – which is not surprising, as the SPT's repertoire of tests and commands is just a subset of those for its big brother.

My impression is that the SPT should be very suitable for fast and efficient field servicing of micro-based equipment, particularly if it's fitted with an EPROM loaded with customised testing programs.

My only minor complaint about the SPT is that the plug used to mate with the equipment's processor socket seemed to have rather flimsy pins, which made plugging it in a bit tricky. In fact the pins tended to bend over even when you plugged it into a piece of conductive plastic foam, for protection when not in use.

Sturdier plugs are available, and one of these would be a distinct advantage. The same comment tends to apply with the processor plug on the B3T interface pod.

The price of the SPT varies according to the version involved, to suit various processors. The Z80, 8085 and 6809 versions cost $1596 plus tax, while that for the 8051 costs a little more at $1700 plus tax. These prices include a manual and a test probe.

So there you are. All four Polar instruments are very easy to use, and each performs a very useful and down to earth job. Overall they reflect an innovative yet practical approach to test instrumentation, which seems to be Polar's hallmark. It's a characteristic which should serve the company well in the coming years.

Further information on these and any of Polar's other instruments is available from Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.

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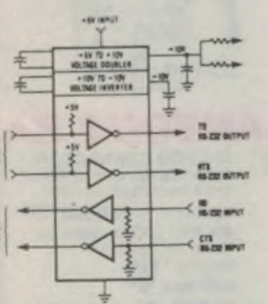

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EZ6453	1.09mm 16 DIL 2.54mm x1	5.45
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EZ6535	1.78mm 24 DIL 2.54mm x1	5.45
EZ6536	1.78mm 24 DIL 2.54mm x2	5.45
EZ6903	1.78mm 28 DIL 2.54mm x1	5.45
EZ6904	1.78mm 28 DIL 2.54mm x2	5.45
EZ6984	1.09mm 40 DIL 2.54mm x1	5.45
EZ6985	1.09mm 40 DIL 2.54mm x2	5.45
EZ6987	1.09mm 40 DIL 2.54mm x1	5.45
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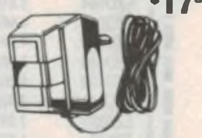

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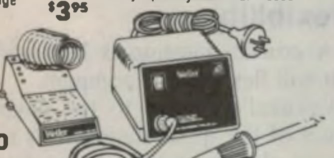

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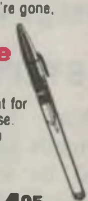

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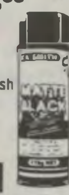

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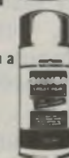

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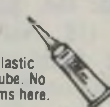

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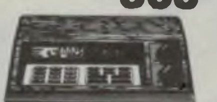

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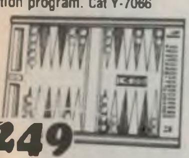

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DICK SMITH ELECTRONICS

The great space suit contest

A new generation of space suits is going to be needed for the next phase of space exploration. Two competing teams of NASA engineers are vying for the prestige of coming up with a successful design.

by STEPHEN ROBITAILLE

When tomorrow's space station astronauts slip out through the air lock to go to work each day, they'll be trusting their lives to their clothes. Not only will the space suits need to shield them from the vacuum, but also from the 400-degree difference between their sunlit and shadowed sides and from the man-made bits of junk zipping past.

Yet the suits also will need to be comfy places to work for three to five hours, offering snacks, drinks and "bathroom facilities". And they'll need to be easily repaired and modified, for the next user. That's more than today's space suits, designed for brief stints outside the space shuttle, can deliver. The US National Aeronautics and Space Administration's smart guys are working on the problem.

Engineers at Lyndon Johnson Space Center in Houston (Texas) are testing two prototype space suits to see how well they'd work outside the station.

For the NASA centers involved, the testing is a politically charged event that pits their respective engineers in a race for prestige and space program approval.

Engineers at NASA/Ames Research Center in Mountain View (California) designed an all-metal suit; the entry from Johnson itself is a fabric-and-metal suit.

Political hot potato

There's a good chance *neither* team will win. "I think what you're going to find is that they'll be taking the best of each suit and meshing them together," said Hubert "Vic" Vykukal, head of the Ames design team. "I don't think that politically either suit will win as it is."

"There were no negative comments" by astronauts during preliminary tests that concluded March 11 at Ames, Vykukal said, but he declined to discuss the specifics to the tryout. "I really don't want to say anything more about it," Vykukal said. "It's a very political thing because there's different opinions on the whole business and a lot of sensitive political issues."

According to NASA's plans, the $US14 billion space station, a 445-foot-wide matrix of girders containing four laboratory and living modules, will be assembled in space by astronauts beginning in 1994 and ready for occupancy in 1996. It will be staffed by eight astronauts and serviced by eight shuttle missions a year.

The challenge of Vykukal and Joseph Kosmo, project chief of the Johnson Center's suit, was to come up with a suit tough enough to handle the estimated 1,000 to 2,000 hours of work outside the station each year. Tests on Kosmo's suit begin next month.

Flexibility

A crucial question is how well each suit will flex with its occupant.

Vykukal's answer to the engineering issues of the space station suits is a 185-pound aluminum model that features a series of hinged joints at the body's major motion points. If the Ames suit wins the design competition, it would be the first all-metal suit employed in the US space program.

Ames' all-metal space suit provides up to 80 per cent of normal mobility. It also comes with food, drink, cooling, urine collection facilities and enough oxygen for up to 8 hours of work.

"You'll just design a hard suit to have enough range – that's what this test is all about, to find out how it does," Vykukal said. "You want to minimize the amount of work required to move the suit, so they can concentrate on work."

Kosmo's suit also relies heavily on aluminum. A two-piece metal shell covers the body from neck to hip and sports hinged metal shoulders. But the lower arms and legs are all fabric, which according to Kosmo will give astronauts the extra bit of flexibility that metal garb denies them.

"Naturally, what you try to provide is full body mobility at the waist, hip, shoulders, elbows, knees and ankles," said Kosmo. "I think we have a good 80% of full mobility."

NASA engineers conducted two sets of tests on the prototypes. In the first, suit-clad astronauts stand in front of a plexiglass wall with a grid imprinted on it and go through a series of mobility exercises.

The grid shows the movement that can be attained with each suit, while monitors connected to the suits gauge the amount of force needed to complete the move.

In the second round of tests, astronauts will go under water at the centre's Weightless Environment Test Facility, a swimming tank outfitted with "work areas" similar to those of the space station. The astronauts will perform routine tasks to evaluate the suits' peformance.

Protection

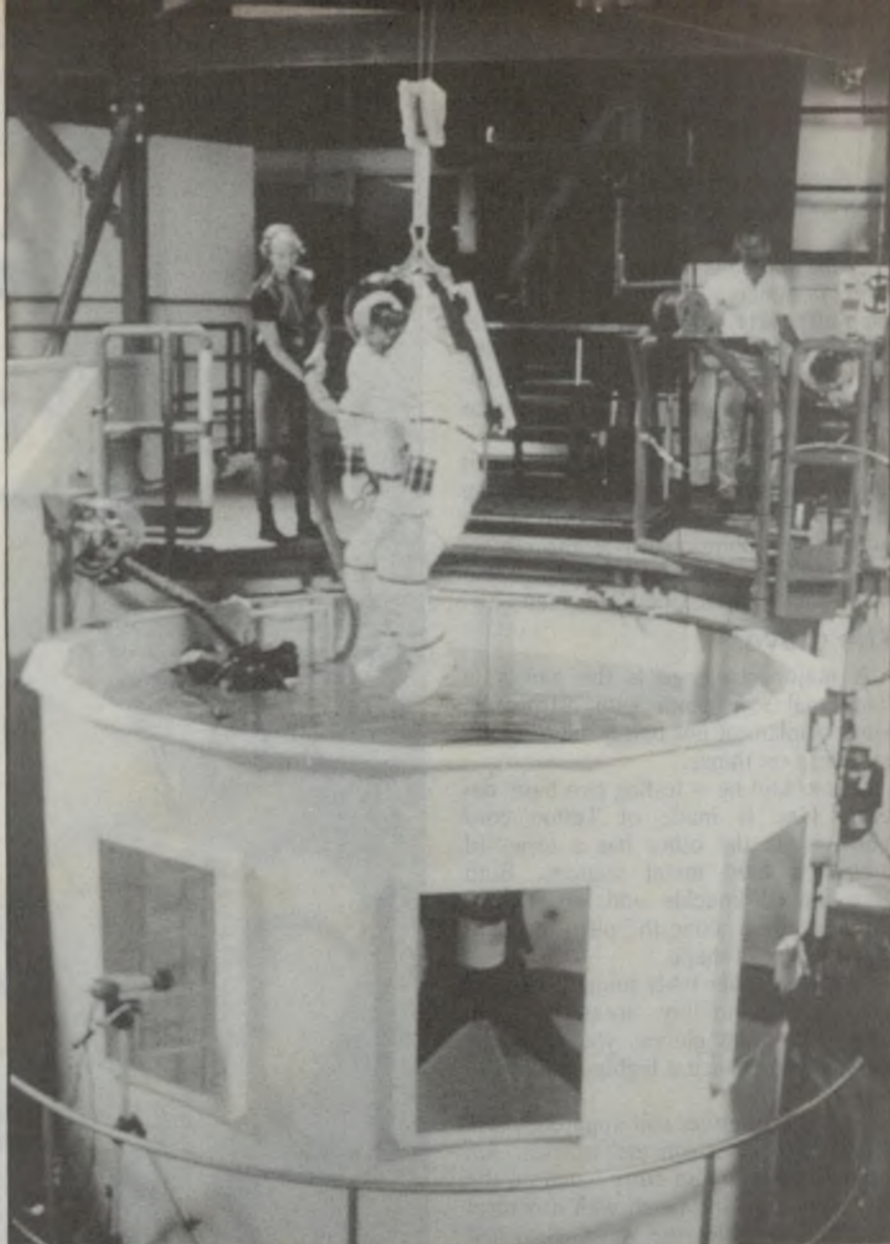
Another major design factor, Vykukal said, was to protect astronauts from micrometeroroids and the flotsam that is the legacy of 30 years of satellites and disposable rocket boosters. The Air Force currently tracks about 4,000 pieces of debris. Engineers estimate that millions of smaller pieces also orbit the Earth, moving as fast as 20,000 mph.

The threat is real: one shard of so-called "space junk" once put a gouge in a space shuttle windshield.

Suits worn by the shuttle astronauts have a fibreglass chest piece, while the shoulder, arm and leg section are made completely of fabric. The suits would not give astronauts enough protection.

"You've got to put more protection in the suit because the longer you're out there, the chances of getting hit by man-made debris go way up," Vykukal said. That's why his suit is all metal.

The fabric portions of Kosmo's suit will employ multiple layers of material to protect astronauts from passing debris. The layers will be made of Dacron, Mylar and a third material whose composition is classified, Kosmo said.



An astronaut wearing the Ames space suit is lowered into a 'zero gravity' water tank, to practice typical operations in space.

Harsh environment

The astronauts must also be protected from the extreme temperature variations in space. When facing the sun, the temperature on their chests will reach about 285°, while that on their backsides, facing the void, will drop to minus 200°.

For insulation against this, Vykukal's metal suit would be covered with a coating of gold five one hundred-thousandths of an inch thick. If more insulation is needed, a double-hull model filled with thermal material could be used.

In Kosmo's suit, the multiple layers of fabric, along with an overlay of another material that will cover both metal and fabric portions, will seek to insulate the astronauts.

Both suits will be pumped up to twice the air pressure of current shuttle suits. This would eliminate time-consuming and inconvenient preparations now required to avoid the bends, a fatal condition caused when air pressure surrounding the body is lowered too rapidly and nitrogen in the body bubbles into the blood.

Shuttle astronauts must spend about four hours breathing pure oxygen before donning their suits, to rid their bodies of nitrogen, or must lower air pressure inside the shuttle's cabin. Lowering cabin pressure can ruin experiments that rely on steady, sea-level pressures.

Another design constraint is that the suits will be hundreds of miles above the closest repair shop, so maintenance must be simple and the supplies recyclable.

Fixing the suits would be simple, say their designers, because both feature snap-off parts that can be easily replaced. Vykukal's suit has fewer moving parts than Kosmo's but the fabric components of the Houston suit take up less room than their metal counterparts.

Astronauts will tailor both suits to fit their body size with circular aluminum inserts, which will be attached to the suits at key points, such as the elbows and hips. The Ames suit has two torso sizes, one for men, one for women.

The gloves

A major challenge is the gloves, a traditional sore point with astronauts, who complain of not being able to get a good grip on things.

Kosmo said he is testing two basic designs. One is made of Teflon cord mesh, while the other has a series of connected hard metal sections. Both have hinged knuckle and wrist joints and a steel bar along the palm to maintain the glove's shape.

"With the other body joints, those are fairly gross mobility areas," Kosmo said. "With the gloves, you have the hand, which is such a highly mobile system."

Getting into either suit apparently will be the least of astronauts' worries. Astronauts enter via an entry hatch on the back and close the hatch with a control cord that encircles the waist. Attached to the back will be a backpack to dispense oxygen and remove both carbon dioxide and moisture.

"Everything must be regenerable," said backpack design chief Mike Lawson. "The shuttle suit is like a sprinter, but the space station suit must be like a long-distance runner."

Lawson is evaluation three prototype backpacks. The packs will contain an eight-hour oxygen tank and a canister to absorb moisture and carbon dioxide. After returning to the space station, astronauts will put the carbon dioxide through chemical processes to convert it back to oxygen.

A wax "radiator" on the backpack will absorb heat generated by the astronaut's body and the chemical reactions of the carbon dioxide absorption system.

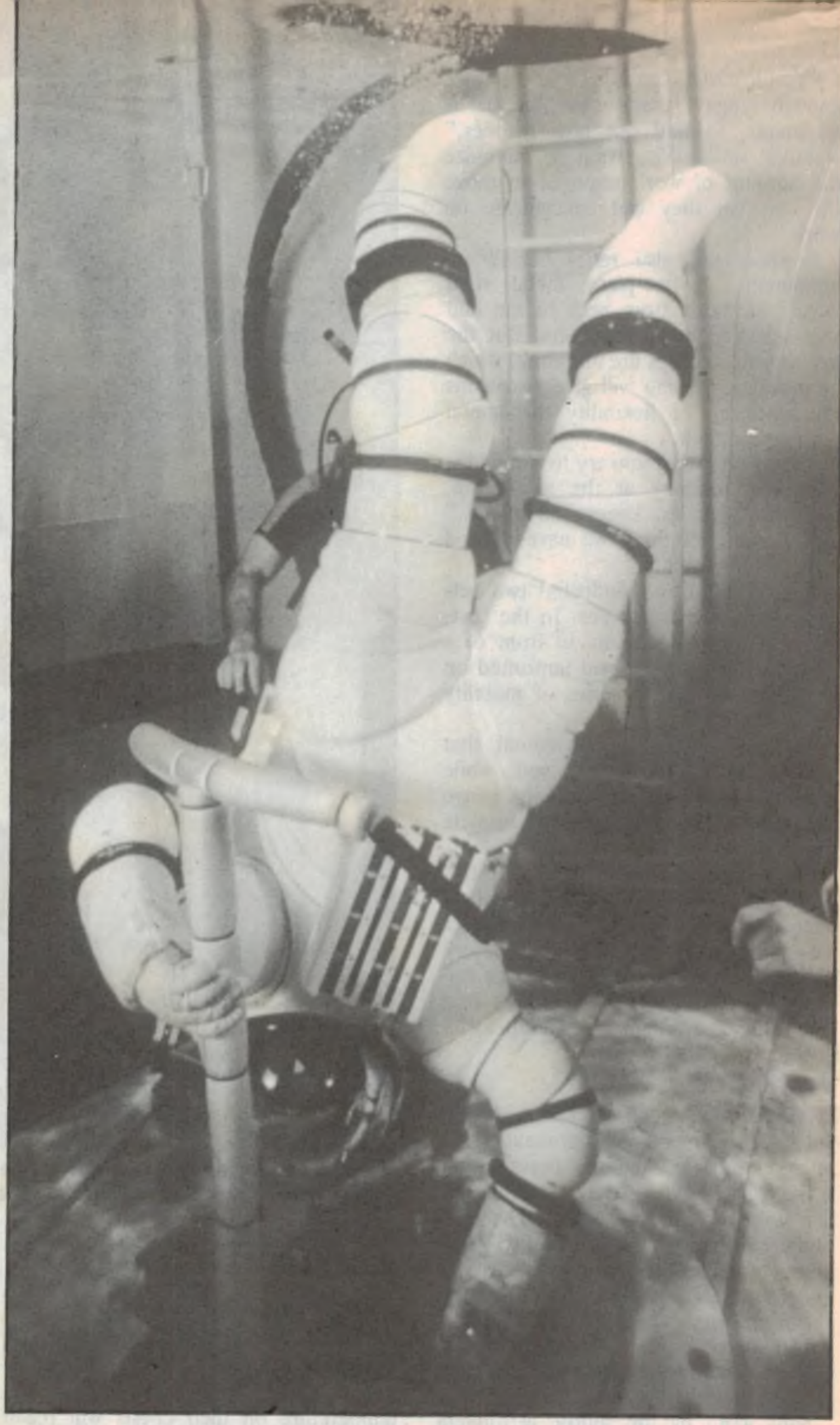
Standard issue on both suits will be a "cooling garment," a series of tubes encased in fabric through which passes cooled water. This will keep astronauts from steaming up their suits with perspiration.

For thirst and hunger pangs, astronauts will have a rectangular food stick and water bag mounted to the side of their helmet.

When nature calls, male astronauts will urinate into a bag using a latex tube that Kosmo likened to a an open-ended condom. Female astronauts will be outfitted with nappy-like panties that contain a chemical called "super slurper" that will draw the urine to the diaper's outer layer, Kosmo said.

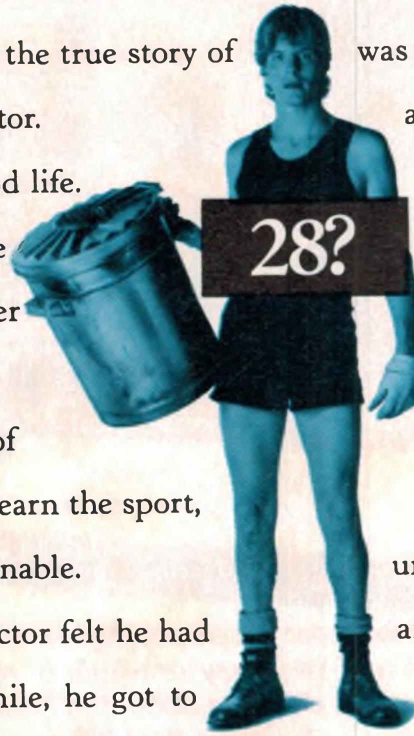
With the trials under way for the two suits, their designers already are looking toward the next big project.

"After a while, you're just giving it design tweaks, but the big challenge is over," Kosmo said. "I'm thinking about voyages to Mars next." EA



Inside the water tank, working conditions approximate those of space, and allow the suits to be evaluated.

At what age are you co



Allow us to tell you the true story of a SCUBA-diving instructor.

He had a pretty good life.

The small school he operated on the Barrier Reef was doing alright.

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All in all the instructor felt he had it made. But after a while, he got to thinking, "What am I going to do when I get older? I can't spend the rest of my life diving."

Too old for new tricks?

His friends thought he was worried about nothing. "Just about anyone would give their right arm to do what you do," they said. "And besides, you're only 22." Still, the instructor's concern continued, so he looked at a paper to see what was going, and made a few calls.

The enquiries led him to the conclusion he'd suspected; that he was too old for any worthwhile training or apprenticeship schemes.

Even if he'd been 18, he was told, he'd have been considered a dog too old for new tricks. This story does have a happy ending, however.

Can you do something about it?

The instructor sent off a coupon not unlike the one you see in the bottom corner, and subsequently found out about the RAAF's Adult Technical Training.

The instructor's plight, in fact, was not unusual. There'd be thousands of men and women who discover some time in their lives that they are dissatisfied with their jobs, and want to start afresh. This is where the RAAF can help.

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Out of your depth?

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nsidered over the hill?

environment. But there's a good chance that this may not be the case.

We could tell you, for instance, the story of the 30-year-old railway ticket collector who can now put a Hercules engine together in his sleep. Or there's the 28-year-old former bricklayer who's now an expert on F/A 18 airframes.

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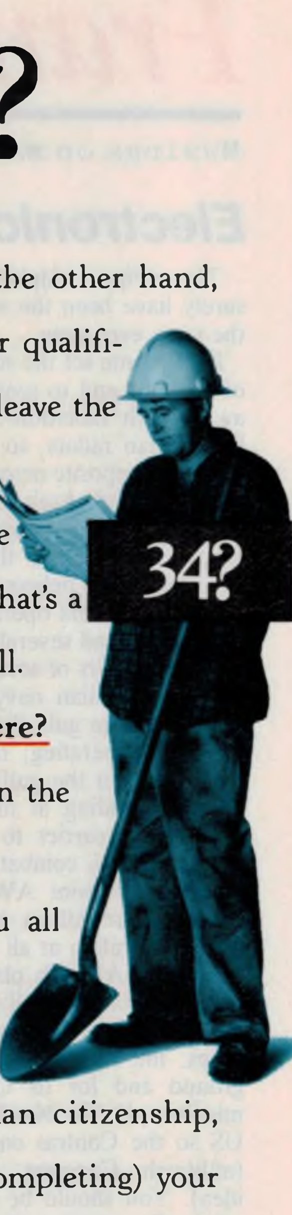

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ADULT TECHNICAL TRAINEES RAAF

Frankly Frank

Musings on matters electronic by FRANK LINTON-SIMPKINS

Electronic smog

The 'Piper Alpha' episode must surely have been the electronic issue of the year, even now.

First let me set the scene in the Straits of Hormuz and to seaward. The area is awash with radiations. Dhubai Airport has civilian radars, so does the Iranian civil port opposite across the gulf.

The United Arab Emirates' military forces have US and/or UK military ground radar gear; the UAE airforce has planes and helicopters aloft at most times with radars operating; the US has one cruiser and several destroyers in the gulf with radars of several sorts all operating; the Italian navy has several destroyers in the gulf also with more sorts of radars operating; the UK navy has one frigate in the gulf at all times with radars operating at all hours; the US has a large carrier to seawards of the straits and its combat air patrol, helicopters and mini AWACs (Grumman Tracker) are all in the air and with radars operating at all times; the Saudis have their AWACs planes up and their radars operating at all times; the US has its AWACs planes over the gulf at all times; the Iranian military radars both ground and for its Chinese Silkworm missiles, plus the Hawks supplied by the US so the Contras could be supported (although Congress had vetoed the idea). You should be able to cook the ship's dinner using the ambient microwave environment.

In that sort of electronic smog and with that sort of overcrowding of military forces, the accident (if that is indeed what it was) was probably inevitable. It also has to be pointed out that the last time the US navy actually engaged in a seabattle, with any risk to the US was the Battle of Leyte gulf in the 1940's. So the most charitable attitude must be taken to the events and we have to assume that the whole thing was a tragic accident, due to poor training and inexperience.

But the data doesn't read that way. Firstly the US tells us that the Iranian plane was out of the correct corridor; that it was emitting the IFF signal not just for a civil airliner, but for a military plane; that it was descending on a path right over the US ship and that the US ship was under attack by five Iranian naval units. It was also claimed that the radar on the Vincennes, supposedly the most modern US naval vessel in service, couldn't tell an Airbus from a Tomcat – which is nearly a quarter its size and nearly four times as fast. Shakespeare once wrote, "When my love swears that she is made of truth, I do believe her, though I know she lies." Here the bard speaks for me, I am afraid and sad to say.

Let us take the US story part by part. Dhubai civil radar and its Air Traffic Controller says that the airliner was in the corrider and now even a UK report agrees. Besides the US captain had the regularly scheduled flight on his list, but failed to see it.

Now the thing about the dual civil/-military signals coming from the transponder on the Iranian plane. Since these are separate units it would mean that the Iranian ground service people would have had to modify the air frame to fit both. No one else, not even the nearby US ships, confirms the Vincennes' story.

But on the other hand the other US ship says that the airliner was climbing, not descending. The UK information and Dhubai control confirm this.

It is true that the US Cruiser was under attack from five Iranian naval craft. The craft were inflatable speed boats, with machine guns and rifle grenade launchers on board. Presumably the crews would have personal arms as well.

Now let us look at the radar, which couldn't tell how an Airbus differed from an F14 Tomcat. Some five years ago the prototype Australian Jindalee "over the horizon" radar in the NT could detect and identify aircraft taking off and landing at the old Singapore airport. During the Falklands war the UK frigates, then up to several decades old, could identify by radar the types of Argentine aircraft at ranges up to 200 kilometres and identify different types of missile up to ten miles away. It was sad that the UK battle computers' programs identified Exocets as 'friendly' missiles because of the NATO navies which carry them, but there was no problem in identifying them as Exocets.

It would seem unreasonable that years later, US ships could not do what UK ships did in the Falklands. It sounds unbelievable, but it is possible that here the US may have been telling the truth.

Two years ago the US magazine *Discover* reported that the Aegis system used on the Vincennes couldn't detect missiles flying under 150 metres or aircraft over 15,000 feet. It also reported that the Aegis system had been tested on a landlocked base in New Jersey and not in realistic conditions.

Since the overthrow of the Shah and the taking of the hostages in the gigantic US embassy in Tehran (the embassy covered about the same area as the northern part of Hyde Park in Sydney) and the fearful mess of the attempted rescue raid that went so tragically and expensively wrong, the Iranians have pestered the US almost to the point of despair. They have used low tech mines to damage the latest US naval vessels and to damage ships travelling under US naval protection.

Those inflatable speedboats would truly annoy a US commander, even though they could do very little harm beyond breaking a few windows. It is hard to go past the thought that the US simply got tired and decided to teach the Iranians a lesson. With the US' lack of appreciation of what the world thinks of it, the inevitable conclusion is that it failed to realise the consequences.

Alternatively the electronic smog was too intense for the latest US high tech gear and the story told by their officials may be true. I hope so. I'd really rather they be proved massively incompetent than massively murderous. Oh, and one other thing: the downlink from the AWACs to the Vincennes must have failed also, as we know that the AWACs radars *can* tell an airliner from a fighter plane.

Frankly I don't believe a word of the US official version, coming from a na-

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Compact Disc Reviews

by RON COOPER

SYMPHONIC DEMO

The Symphonic Sound Stage
A Listener's Guide to the Art
and Science of Recording the Orchestra
Delos D/CD 3502
Playing time: 71 min 56 sec.

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Here is a very interesting disc of excerpts from the Delos library. Contrary to what the cover might imply there is no commentary about the art and science of recording the orchestra, but quite detailed notes and explanations telling why they made their various decisions when recording these works.

The excerpts are from *Thus Spake Zarathustra* (R.Strauss); *Roman Festivals* (Respighi); *The Three-Cornered Hat* (Falla); *Romeo and Juliet* (Prokofiev); *The Firebird* (Stravinsky); *Concerto for Orchestra* (Lutoslawski); *Piano Concerto No.2 In D Major* (Haydn); *Cello Concerto No.1 In C Major* (Haydn); *Nights In The Gardens Of Spain* (Falla); *Roman Festivals* (Respighi); *Dance Of The Seven Veils* (R.Strauss);

As you will notice, most of the selections are from the late romantic to modern periods and have considerable sonic impact, particularly the bass end which is excellently recorded.

As far as the overall balance and sound quality is concerned it is very good, but I did feel a slight lack of coherence compared with other top recordings such as Telarc and Denon. However, this is only a minor criticism.

A useful glossary of some of the terms used in stereo recording is also enclosed. A most interesting disc.

PROKOFIEV

Alexander Nevsky
Lieutenant Kije
Los Angeles Philharmonic
Andre Previn
Telarc CD 80143 DDD
Playing Time: 60 min 40 sec

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Prokofiev was an excellent composer of film music, in fact the Russian film director Eisenstein regarded him as a genius.

Alexander Nevsky was a serious film made in the late 1930's as a propaganda film to raise the morale of the Russian populace in the likely event of a war with Germany. However, although the film was very successful it was withdrawn from circulation after the signing of the German-Soviet pact of 1939. Prokofiev salvaged the score by turning it into a very successful cantata for concert use, which is beautifully captured on this recording.

Obviously this music is not everyone's cup of tea, but I certainly found it quite bright and refreshing. It does require two or three listenings to appreciate it but the overall effect of the sound of a very coherent choir and orchestra is excellent.

The second Prokofiev work on this disc, the Lieutenant Kije Suite, is a sheer delight from the start and an excellent hifi demo to boot. Telarc, I feel, are one of the few labels to produce consistent excellence with their products yet this one is probably one of their best, – great depth of sound – the best recorded bass drums in the business – no boominess and a very coherent overall sound.

Previn and the Los Angeles Philharmonica are simply superb and I can only award this disc a top score.

FLUTE WORKS

I Musici
Severino Gazzelloni
Flute Concertos by Tartini,
Pokorny, Boccherini,
Mercadante, Vivaldi
Philips 420 875-2 ADD
Playing Time: 61 mins 28 secs

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Apparently much of the music presented on this disc, which highlights virtuoso display, was written for the Venetian Orphanage of the Pieta. In this institution the female performers played behind grills and thick curtains, hiding them from the large audiences which came to hear them.

Vivaldi was the director of Pieta during the first two decades of the 18th

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FORUM

Conducted by Jim Rowe

Let's tie up some of those loose ends, before the next onslaught!

After last month's little set-to with the advocates of standardised symbolic rectangularity, I thought we'd have a quieter and more sedate little discussion this time around. It seemed like a good time to tie the ribbons on some of the topics we've looked at earlier in the year, by looking at points raised by people who wrote in afterwards...

But just when I thought it was safe to leave the symbolic maelstrom, with our circuits still intact, two more letters arrived on the same touchy subject. So before I can tip-toe into calmer waters, we'll have to devote a few more words to it. Hold onto your life jackets!

One letter was from a Mr Ian Homer, who is apparently 'Electrotechnology Standards Officer' at the Department of Transport and Communications in Canberra. The other was a rather more impersonal and formal one signed by someone in the Electricity Commission of NSW called M.J.Begg (I think – the signature is a little hard to decipher), but with the qualification 'FOR SECRETARY'. This suggests that M.J.Begg may be the secretary of the secretary, who although the originator of the letter, wished to remain nameless.

Only in this kind of umpteen-level organisation, methinks, could you have secretaries with secretaries – and all paid for by the public purse. Out here in the real world, we're lucky if we only have to share our secretary with *one* other magazine! Ah well...

I should note that both of these later letters were rather less aggressive than that from Telecom's Mr Van der Zwan. However they both took much the same general line: disappointment that my original article on reading circuits had used 'obsolete', 'superseded' and 'non-standard' symbols. Mr Homer added the comment that while not suggesting it was intentional, the article might well undermine the "considerable effort and expense involved in establishing Australian standards for graphical symbols used in electrotechnology."

What I did notice about both of these later letters is that they were again surprisingly similar in both tone and wording to the two earlier letters. Of course this *might* be sheer coincidence, but it's beginning to look as if there could be some kind of an organised mini-campaign going on. Perhaps I have indeed upset one of the SAA mandarins, and he or she is getting all of their friends in the statutory authorities to write me letters of complaint...

One might be excused for suspecting something along these lines, surely. Perhaps the fact that only four letters have turned up simply shows how few friends an SAA mandarin may have. (All you need is a little paranoia, and you can explain anything!)

But what about those wonderful SAA standards AS 1102 and 1103 – whose establishment has apparently involved so much time and effort. Did my article really undermine their credibility?

Perhaps it might have, I suppose. But if their credibility can be so easily undermined, it surely can't have been all that strong in the first place.

All four of my disappointed correspondents seem to regard these 'standards' as sacrosanct, with the implied automatic obligation upon all of us to acknowledge and slavishly use them. But I for one don't see things this way at all.

As far as I'm concerned, these 'standards' are simply a set of conventions that happen to have been agreed upon and 'endorsed' by people representing certain statutory authorities and large engineering organisations, and they are used accordingly by people working in those authorities and organisations.

That's fair enough, of course. It's still a reasonably free country – these organisations can get together and decide upon whatever they like.

But it by no means follows from this that they automatically have the right to bludgeon the rest of us into accepting and using their 'standards'. No matter how fervently their advocates and custodians believe they have this right, and how aggressively they try to force the 'standards' on us.

The fact is that the people concerned really represent only a particular group of organisations within the industry. So their authority really only extends to that particular sub-set of the industry. Those of us outside the organisations concerned didn't have any real say in either the appointment of the standards committee members, or their deliberations.

Without any representation in determining the 'standards', it seems to me that we're accordingly under no obligation to observe them. Certainly not automatically, unthinkingly or just because their advocates claim the authority to force them down our throats – supposedly for our own good.

Frankly, it seems to me that the only way they're likely to get us to use them is by *selling* them to us. By explaining carefully and persuasively *why* their 'standards' are clearly better than the way we're all doing things at present – so we can see the logic in jumping on the bandwagon. Not by simply proclaiming in righteous tones that we've offended them by our heretical use of 'obsolete' symbols.

When someone resorts to this technique, it's not unreasonable to suspect that either they're not terribly good at selling, or they haven't got much to sell.

So I'm sorry, gentlemen of the SAA, I don't feel guilty at all about using those circuit symbols. Right at the moment, you haven't given me a single logical reason as to why I should have used your symbols instead.

I still believe the symbols we've been using for years are much more descriptive and helpful than all your little rectangles. And judging by all those other magazines around the world still using

the same 'obsolete' symbols, an awful lot of people agree with me.

Perhaps you can yet convince us we're wrong. Why not try? But have a go at using logic next time, rather than force. Volunteers are always better motivated than conscripts...

By the way I'm not against having standards – far from it. But surely standards should be the best possible way to achieve the desired result, not just uniformity for its own sake.

OK then, that's that off my chest. Now for those follow-up looks at topics we've discussed over the previous few months.

Not surprisingly, there was one subject in particular which didn't fail to attract some more letters. In fact it's amazing how much response it has generated, for such a little thing.

Oh no – not that again, I hear you exclaim! That's right, you guessed it:

The nanofarad

One interesting little follow-up letter came from regular correspondent and contributor Mr Bill Jolly, of Nambucca Heads in NSW. Bill didn't have much to say on the subject himself, apart from commenting that he hoped the subject would soon fade into oblivion. But he did quote a couple of comments from a letter sent to him from a friend, a retired university professor:

All this talk about nanofarads is a load of cobblers. It is no more difficult to convert .002uF to 2nF than it is to convert 1500 ohms to 1.5k ohms – and I'm quite sure EA readers can do that!!

With regard to the much-discussed multipliers (4k7, 6u8 etc), we used them in the early 1950's at Astor to obviate (reduce?) drawing office errors. The system was a great success, and I don't recollect any great backlash from the servicemen of the day – who welcomed the idea after a short breaking-in period. It would be a very good move for EA as well.

Fair enough. I can't seriously argue with Bill's friend. And as you've no doubt noticed, we're using the nanofarad in our circuits. My only reservations about using the multipliers instead of decimal points are that (a) they probably aren't as self-evident as their protagonists claim, and (b) I'm still mindful of that possibility of being the star of a lynching party, if we change too much in EA too quickly. But more about this again shortly.

A few weeks before Bill Jolly's letter there was a much longer and more detailed letter from Mr Hugh Harrison, of Brighton in Victoria. Mr Harrison apparently worked for many years as a professional engineer with the State Electricity Commission of Victoria, and has only recently retired.

His letter is quite long, so I won't be able to quote it at length. But he raises quite a few interesting points, and sent copies of various references to back up the points made.

One point he raises is that the nanofarad as a unit has been used by that venerable British journal *Wireless World* (now *Electronics and Wireless World*) for at least 13 years. A copy of articles from their December 1975 issue certainly demonstrates that this is the case.

Copies of advertisements from the October 1983 issue also demonstrate that at least three *EWW* component suppliers were advertising capacitors in nanofarad values, as early as 5 years ago – even though Radiospares still may not do so, as Jim Lawler pointed out.

This leads Hugh Harrison to comment thus:

I suggest it is the old story of supply and demand. If enough customers start asking for capacitors in nanofarads, some suppliers will start to scratch their heads, dust off the odd textbook or

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handbook and realise that they have to move with the times. And I submit that Electronics Australia has a responsibility to assist in the education process, not just tag along with the lame and blind. You concentrate on all the latest "hi-tech" in your features and New Products sections – so why stay "lo-tech" in your Projects and technical articles?

There is another practical reason supporting the usage of this unit, which appears to have escaped notice. In the days of valve radios, it was unusual for a radio to contain more than a dozen resistors. So there was generally plenty of room on the circuit diagram to show a plate resistor of say "250,000 ohms".

Designers of today's solid-state circuits are not so frugal in the use of components, and a relatively "simple and cheap" AM/FM receiver can easily employ 100 or so resistors and a like number of capacitors. So it is a real struggle to produce a circuit diagram of reasonable size, not helped if layout is dictated by component descriptions. Using 'nF' in place of a decimal part of a uF or 4-figure multiple of pF, will usually save two digits with each entry.

But another point seems to have been missed by all, here. For quite a long time now it has been universally accepted that the unit symbol of resistance may be omitted. It is quite good enough to show just the value alongside the resistor pictograph, which everyone understands – e.g., '470', or '33k'. Why, then, is it necessary to add the unit symbol of capacitance to its value for every capacitor pictograph, which is surely understood by everyone also?

Why not just 100p, 1n, 1u – and dare I suggest it, 2.5m (in place of 2500uF)? Even WW didn't brave this last one, although they have adopted the rest.

Just to wrap this one up, I refer to the document "Metric Conversion for Australia", 1971, issued by the Metric Conversion Board. Only a few people, such as Mr Jolly, now seem to be aware that a formal stance on units was adopted by the Australian government then, and that it behoves the population to observe the policy then declared.

A booklet based on that document and produced by the SECV makes it quite clear that the multiplier should be chosen "as far as possible" such that the value lies between 0.1 and 1000. That should definitely put paid to things like 8,200pF, 10,000uF and .001uF.

Finally, it appears that you still completely baulk at the idea of supplanting the decimal point by the unit symbol. May I join with Messrs McInnes, Heinemann and Jolly in advocating this principle. Wireless World has been using this principle regularly for at least 13 years also. Are we more backward than the English?

Hmmm – your comments are certainly relevant, Hugh, and you've touched upon some aspects we didn't cover before, which were certainly worth airing. However even though I'm personally in favour of the nanofarad, and we're now using it in the magazine, I'm not sure if I can agree with everything you write – even on this aspect.

Your analogy of the 'lame and blind' is a graphic one, together with your contrasting of the various sections of the magazine. But is use of the nanofarad necessarily 'higher-tech' than continued use of the alternative units?

Essentially they're just different ways of conveying the same meaning, after all. There may be differences in their efficiency in communicating that meaning, and in their elegance in so doing, but frankly I can't see that the nanofarad is 'higher tech'. It's only more *modern* in the narrow sense, meaning that it simply hasn't been around as long as some of the other units. And I doubt if the 'youthfulness' or 'age' of a measurement unit is of any real relevance – I don't think they get tired with continued use, requiring eventual replacement!

If that were the case, we'd surely have to be considering urgent replacements for units like the metre and the second, which have been around for much longer than the microfarad.

Surely the important thing about a unit is its ability to convey the component value concerned. I doubt whether even 'old' units are less suitable for coping with new technology.

That said, I do tend to agree with you about the dubious need to add the 'F' after all capacitance values on our circuits. It probably isn't necessary, as you suggest. Our dropping of the omega sign from resistance values some time ago certainly supports what you say. And as you've perhaps noticed, we've already started to use the *millifarad* in place of 'thousands of microfarads'.

We've already had a complaint about it too, from one of the kit suppliers!

I'm also glad that you brought up that reference from the Metric Conversion Board, advising that multipliers should be chosen as far as possible to keep the indicated value range between 0.1 and 1000. Perhaps by sheer chance, that's exactly the rule we've been trying to apply, in the last year or so. And it does seem to save significant space on circuit diagrams, as you suggest.

By the way, a third letter on the same topic of nanofarads and multipliers came from a Mr John ten Velde, of Tokoroa in New Zealand.

Mr ten Velde proclaims himself not only happy with our use of the nanofarad, but also very much in favour of the use of multipliers in place of the decimal point:

I disagree that the use of the format 4n7, 2k2 etc can lead to confusion. I rather believe the contrary to be the case.

I often receive magazines of poor quality print, where parts of the letters appear to have worn away. This can easily lead to the decimal point being faint or worse – non existent, which could lead to incorrect component values. By placing the multiplier instead of the decimal point, there can be no confusion.

Incidentally while it may be true that the nanofarad is less commonly used than the microfarad, the millifarad *almost never appears in print, as yet. Surely with all the multi-thousand microfarad capacitors now being used in power supplies, we should start using this multiplier more frequently.*

On a similar note, I haven't heard the term megametre *used very often. Surely this is a very useful term also, if only to car salesmen and mechanics.*

Thanks for your comments also, John. Presumably you too will be happy to see that we've started to use the millifarad for large electrolytics.

Now about that vexed subject of using multiplier symbols to replace the decimal point, which Hugh Harrison, John ten Velde and Bill Jolly's friend all raise. Lynching jokes aside, I have to confess I'm still in two minds about it.

I can see their point about decimal points being unreliable, because of their small size and the increased possibility of them disappearing in processes such as printing and photocopying. Fair enough – if that were the only consideration, I'd be all for the use of multipliers instead.

It's just that I *don't* think they're quite as self-evident as the system we currently use, especially for people like beginners struggling to come to grips with all the other aspects of electronics. Or for old-timers, who generally find it difficult enough keeping up with changes to the technology.

For example I really don't believe that '3p9' is nearly as self-explanatory as '3.9pF', which is the way we'd currently show the same value. I agree that it's more *efficient*, and you're undoubtedly right that it's less capable of becoming ambiguous when subject to the vagaries of printing/photocopying. But if you try to imagine what it would look like to the uninitiated, I think it would seem rather cryptic and arcane.

In fact I suspect that the move to things like '3p9' and '4R7' could very easily put off a significant proportion of both beginners and old-timers, by giving electronics an even harder and more difficult to penetrate 'shell' of mysterious jargon.

Like all specialised languages, it might be great for those already safely ensconced inside the industry/hobby 'in-group', but also very effective in repelling those outside wishing to enter!

I note your point about *Wireless World* having used this system for at least 13 years, Mr Harrison, and Mr Jolly's friend's recollection that Astor was using it in the 1950s. But does our not using the system necessarily mean that we're 'backward' – compared with either Astor or the English?

Or perhaps if we *are* backward, that mightn't be such a bad thing, if the direction concerned isn't really such a desirable one...

If I'm right about the multiplier system being less self-evident, for example, we might well be more backward in turning beginners away from electronics. That's a competition where I'm happy to lag well behind the rest of the field!

By the way please don't think I'm raising this point in a frivolous or superficial manner. Quite the contrary – I take it very seriously.

Electronics as both a vocation and a hobby seems to have declined somewhat over the last few years. You only have to look at the circulation figures for almost all of the electronics magazines throughout the world, to see evidence of this. Including *EA*, I'm sad to say, although we've suffered rather less than most and even pulled up again recently by a few thousand.

Perhaps the fact that we have suffered less than most is because we have consciously tried *not* to become too arcane and inaccessible, to beginners in particular. So there may well be an *advantage* in being 'more backward than the English' as Mr Harrison puts it, or even 'tagging along with the lame and blind'.

It's certainly worth thinking about, at least. And it's this kind of concern that has so far kept me from adopting *either* the use of multipliers in place of the decimal point, or those 'modern' rectangular circuit symbols so beloved of the SAA and its supporters.

At risk of labouring the point, I don't believe that 'modern' is necessarily better, or sufficient in itself to justify a change. It could just be change for change's sake, and one which could turn off a few more readers and enthusiasts.

OK then, enough of that topic for a while. Just to end up this month's pot-pourri, let's look at a letter that came in rather belatedly on the topic that I tackled back in the January and April issues: projects and kits that don't work.

The letter came from a service technician in Wellington, New Zealand, who prefers not to have his full name published because his comments might cause embarrassment to his employer. The reason for this might become clear from his comments themselves, which I'll quote directly:

I work in the final test unit of a small firm that designs, develops and manufactures microprocessor-based circuit boards. This means that we are the designers, developers, parts purchasers, kit assemblers, kit builders, kit testers and in reality the final users as well. So that with regard to all of your previous discussion, we really are the whole works.

In the test unit we have numerous multimeters, so that we can monitor various parts of a circuit. We also have multi-beam storage scopes, and our designs have built-in signatures so we can use signature analysers as well as data and logic analysers. We also have the bloke that designed the circuit, upstairs. So you might think that we have it made – but it isn't so.

Let's start from the worst case. We have runs (rarely) where the whole production batch doesn't work, usually because the purchasing people bought components from different manufacturers from those used in the prototype. An example is where the designer specifies a particular manufacturer's IC, but the purchasing people get talked into buying a supposedly 'equivalent' one, which doesn't always work.

Then of course we have such things as faulty components. I once struck a pull-up resistor network with the dot on the wrong end, for example. Sluggish data buffers are also quite common.

Now all this is more or less run of the mill, but it is not unknown for us to reach the point where economically it is prudent to throw a board away, rather than spend hours trying to find an elusive fault. In a run of say 300-400 this is the right thing to do.

However in the kit builder's business the whole aspect is very different. One unworkable kit is 100% failure, not 0.3% or less as we may have.

With all our extensive test procedures and equipment, we still have boards that we cannot fix. Even though we have the designer upstairs, that usually doesn't help much, because he designed it to work. When it doesn't, he generally doesn't have much to offer.

Before this subject came up in your very good magazine, I often used to say to my colleagues "How would a kit builder get on with this project?"

I do not offer an answer, but I do want to emphasise that it is really very difficult to lay the blame anywhere.

Many of your correspondents apparently set great store on access to the designer. But I believe this is a red herring, because frequently they have no more idea of why a circuit doesn't work than anyone else. We can have nasty things like coffee dust covered by varnish on PCBs, or extra tracks that look as though they are the real thing.

My message is buy a kit, make it up and if it doesn't work, don't give up. You will learn a lot trying to find out WHY it doesn't work. And if you can't find the answer, take courage in the fact that very clever and experienced technicians also get PCBs that they can't fix!

Thanks, Mr 'P' – couldn't have said that better myself. In fact your letter was very interesting, and seems to back up much of what I wrote in the columns concerned.

That's all for this month, then. I hope you'll join me next time, for verbal battles anew. And if you disagree with what you've read here, write in and explain why. But please use logic, rather than emotion or sermonising...

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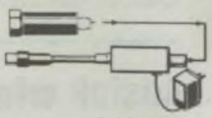

10dB IN-LINE COAXIAL AMPLIFIER
Reduces loss from splitters and long cable runs. Suitable for use with antennas, coaxial feed lines and VCR's. A/C adaptor included.

SPECIFICATIONS:
Frequency Range: 5-900MHz
Gain: 10dB
Power Requirements: 12V A/C Adaptor (included)
Input Impedance: 75 ohm
Output Impedance: 75 ohm

Cat. L15043 **$39.95**

DELUXE UNIVERSAL BATTERY CHARGER AND TESTER
Save money on expensive batteries with this universal battery charger. Features include meter tester, and provisions for up to 8 pieces of any size. (D, C, AA or AAA type batteries) at once, plus positions for a button and cell battery. Two times 9V, and one times N type batteries. Recharging lead with alligator clips, 9V clip and 4-way universal. Select currents from 2.5-3V 150mA, 1.2-1.5V 80mA, 1.2-1.5V 25mA, 6-9V 14mA, 12V 50mA. Includes detailed instructions.

Cat. M23535 **$49.95**

P.A. SPEAKERS
Low dual cone, wide range 200mm (8in.). Ideal for public address, background music, etc. Tremendous Value at these prices!

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1-9 **$6.95**
10+ **$5.95**

ECONOMY 4 CHANNEL MICROPHONE MIXER (MM1)
Its size and simplicity makes this mixer very portable and easy to operate.

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

Cat. A12001 **$44.95**

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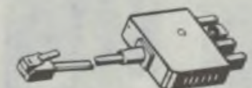
Cat. C14950 .... **Normally $34.95**
SPECIAL, ONLY $29.95



TELEPHONE EXTENSION ADAPTOR CABLE
- Australian plug to U.S. plug
- Length 2.5 metres

Y16009 .... **$5.95**

UNIVERSAL BATTERY CHARGER AND TESTER
Save money on expensive batteries with this universal battery charger. Features include meter tester, and provisions for D, C, AA, AAA, N button and cell batteries, 9V and 6V (square types). Comes complete with detailed instructions.

Cat. M23533 .... **$29.95**

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- Australian plug to U.S. socket

Y16008 .... **$8.95**

NOW OPEN IN SYDNEY!
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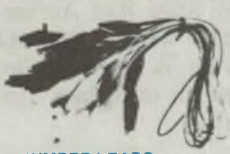


JUMPER LEADS
Set of 10 high quality leads approx 450mm long. Normally $4.95

Cat. W12000 **NOW $2.95**

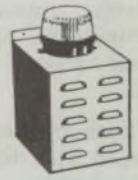
IEC PLUG
3 pin, female line plug 250V, 6 Amp

P10251 .... **$2.95**

IEC MAINS LEAD
3 pin mains plug to 3 pin IEC plug 1.8 metres long.

P10252 .... **$5.95**

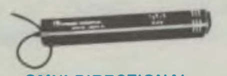
ELECTRONIC CASSETTE DEMAGNETISER
Cat. A10006 **$22.95**



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**



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 RECEIVER
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

SPOTLIGHT 12V
Quartz halogen spotlight. Hand held with moulded plastic grip. Brilliant beam up to 55W, can be seen for miles. Orange lens cover emergency flasher switch, 3 metre curled cord, cigarette lighter plug and replaceable H3 halogen bulb.

Cat. A15050 .... **$26.95**

CAR REPLACEMENT SPEAKERS
All are rated at 4 ohm. Nominal 3W. Maximum 5W with 3 inch magnets, and feature dust proof covers.

5" x 7" Oval Cat. C10757 **$11.95**
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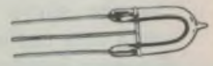

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As used in projects or as replacements

Cat. S14050 **$2.95**

TRIGGER TRANSFORMERS
Cat. M10104 **$1.45**

TELEPHONE INDUCTION COIL
- For recording or amplification
- 3.5mm plug with 1 metre cord
- Peel-off stick-on adhesive back

A12032 .... **$5.95**

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MasterCard VISA

News Highlights

Data device lets Club members win prizes

Members of the Harbord Diggers Club in Sydney are earning themselves free goods and services simply by enjoying the club's facilities, thanks to a small data capture device from National Business Systems.

The NBS devices are magnetic stripe readers which enable data encoded onto plastic cards carried by members of the club to be read and transferred to the house computer.

Built into small data capture terminals placed strategically around the club, the NBS devices make it possible for the computer to credit members with price-winning bonus points every time they enter the premises, buy food and drink, or play the club's poker machines.

Members can withdraw accrued bonus points from their accounts simply by inserting their plastic cards into an ATM-like machine which issues them with a ticket equivalent in value to certain goods and services.

Based on the outcome of the Harbord Diggers trial, the new promotional scheme may become a common feature in registered clubs across Australia.

Energy Management

Alcatel-STC, Australia's largest telecommunications company, in conjunction with Telecom is running a pilot energy management system project in a south eastern suburb of Melbourne.

The application, for the State Electricity Commission of Victoria, involves 100 customers whose premises have been equipped with Alcatel-STC's Australian designed and manufactured Energy Management Terminal (EMT). The total service includes computer controlled network management equipment at a regional centre, and links to the EMT at each of the premises using a standard existing phone line.

There is constant two-way communication between the central controller and the EMTs, achieved without disturbing the normal telephone functions of the line. The two main features of the system are remote meter reading, and vastly improved remote load control.

Industrial, commercial and residential premises are all included in the pilot system, and similar pilot schemes with the Alcatel-STC Energy Management System are being run in Brisbane and in Baltimore, Maryland, USA.

British Telecom sells to SRA

British Telecom's Australian subsidiary Teletrade Services has won an order to supply the NSW State Rail Authority's Electrical Branch with a command and control system for its Electrical Operating Centre adjacent to Sydney Terminal Station.

The British Telecom CBP designed command and control equipment is based on the same technology that has earned BT a reputation as a world leader in the development of dealing room equipment for the banking and broking community.

The system consists of eight colour plasma touchscreen terminals which provide the operators with access to a wide range of telephony and data facilities.

Each operator sees 64 keys on the screen with different colours to indicate their function. At the touch of key they can select a line, dial a short-code, access a page of data, connect onto a computer system or perform any one of the many telephony functions possible on the system.

The advantage of this system to the SRA is that a single terminal can provide facilities that would conventionally require two ot three terminals per desk, and can simplify the presentation to the user – making it faster and more convenient.

Similar systems have been installed around the world for users including British Rail, The Metropolitan Police, Air France, China Light and Power and Qantas Airways here in Australia.

Austek wins high-tech defence contract

Austek Microsystems has won a $1 million contract to develop a VLSI chipset for sophisticated sonar signal processing, as part of a new Commonwealth Government defence program.

Austek was awarded the contract by Sonobuoys Australia, prime contractors for Australia's new generation sonobuoys, which require the chipset.

Austek Microsystems designs, develop and markets system level VLSI components, and recently beat Silicon Valley in the production of a memory cache controller for Intel 80386 microprocessor-based systems.

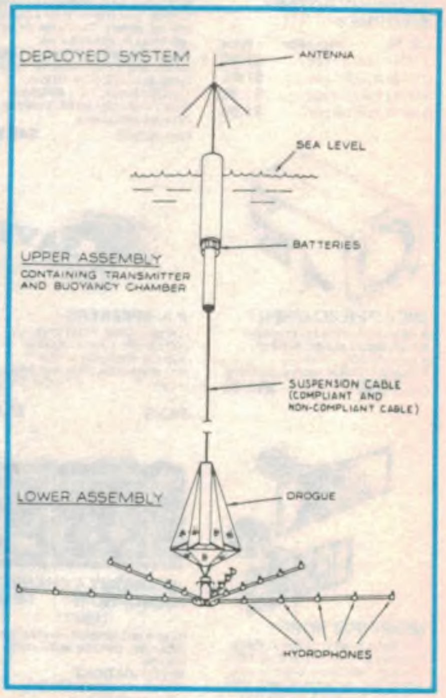


Diagram showing the proposed new Sonobuoy when deployed. It features sophisticated in-buoy acoustic signal processing, carried out by a VLSI chip set being developed by Austek Microsystems.

Local production of railway equipment by Mitsubishi

After twenty years as a major supplier of electronic and electrical equipment for railway rolling stock in NSW, Mitsubishi Electric Australia has commenced local production. The plant introduces unique testing equipment and facilities, and results from an investment of $1.1M.

The plant produces chopper and static inverter equipment incorporating associated microprocessor control units and a train management system (TMS).

The successful application of this advanced system to suburban and interurban trains in NSW encouraged the SRA to apply the system to its new Tangara trains, resulting in a contract worth around $150M and 225 units, causing Mitsubishi Electric to introduce Australian production.

Pioneer receives Marconi Award

Dr. Federico Faggin, president of Synaptics, Inc., and a key figure in the development of current technology, has been selected to receive the 14th Marconi International Award. Dr. Faggin was cited for his work in the creation and implementation of the microprocessor, as well as for his extensive contributions to MOS silicon gate technology.

Dr. Faggin's work was key to the development of the first microprocessor, the Intel 4004. Under his supervision, the MCS-4 was brought to market; the first 8-bit microprocessor, the 8008, was developed, and the 8080 chip became the first microprocessor to break the performance barrier.

In 1975, Dr. Faggin founded Zilog, a company dedicated to the microprocessor market. At Zilog, he conceived and developed the specifications for the Z80 and directed its development. As it became the 8-bit standard for microprocessor applications, the Z80 was crucial to the growth of microprocessor applications. Dr. Faggin continued as president of Zilog until 1980.

Dr. Faggin remains an innovative force in electronics. As president of Synaptics, he is working to develop a new class of integrated circuits that work according to the principles of information processing of the animal nervous system.

Revamping the radio network

The Commonwealth Government has recently announced a number of changes to the AM and FM radio networks in the National Plan for Metropolitan Radio. Under the plan, announced by then Minister for Transport and Communications Senator Gareth Evans, new commercial FM radio services will be provided in all capital cities.

To make way for the new services, two existing AM services will be converted to FM in each city, and the AM frequencies will be relinquished for non-commercial allocation.

Another change, welcomed by the ABC in particular, is the planned establishment of a national radio network for the broadcasting of Parliamentary proceedings.

One of the released AM frequencies will be used for this purpose, and listeners in Sydney, Perth and Adelaide will be able to tune in to Parliament on the new service in 1989. Melbourne and Brisbane will be converted in 1991 and 1992 respectively.

Radio for the Print Handicapped (RPH) services will become available to most of the nation's estimated 1-2 million print handicapped people under the plan. It is planned to make this type of radio (currently operating in several capital cities) far more accessible than is currently the case.

Undetectable radar

A new type of naval radar that is virtually impossible to detect, because of its very low radiated power has been developed by Hollandse Signaalapparaten (SIGNAAL) in Holland, and Philips Electronikindustrier (PEAB) in Sweden.

Based on research from the Philips Research Laboratories in the United Kingdom, the radar design operates on the frequency modulation of continuous wave transmission (FMCW) principle. This radiates just a few watts, in contrast with the tens of thousands of watts peak power of conventional pulsed radars, making it detectable only at ranges of less than a few miles.

The new radar system, code named PILOT (Philips Indetectable Low Output Transceiver), is seen as a major technological breakthrough. Up until now, military radar has been limited in use as its pulsed transmissions can be detected far beyond the range of its own effective operation.

This has forced ships to maintain radar silence, thereby losing a necessary navigation and surveillance instrument.

Joint development of extended CD-ROM

Philips and Sony, in co-operation with Microsoft, recently announced their agreement on the joint development of an extended CD-ROM format, called CD-ROM Extended Architecture (CD-

ROM XA). This extended format will incorporate audio and graphics technology from the CD-I format and will serve as a bridge between CD-ROM and CD-I.

There are currently strong demands for the creation of further standards consistent with ISO 9660 for CD-ROM format, especially in the area of multimedia applications for personal computers. These require not only text and data, but compressed sound, graphics, still pictures, and eventually moving pictures as well.

Meet our new Technical Editor

Technical Editors are difficult to find, and we are pleased to introduce Peter Phillips, who has just joined us in this capacity.

Peter may be known to readers as a regular contributor in the past for one of our competitors. He comes directly from the NSW TAFE system, where he has spent the last 14 years as a lecturer in electronics. Prior to this, he has worked in the power generation industry, the Lithgow Small Arms factory and a variety of part-time enterprises.

Apart from electronics, Peter has a strong interest in music and his first article for *EA*, written in 1978, was about his involvement with a piano playing machine as soloist with the Sydney Symphony Orchestra. His electronic interests encompass most of the field, and we anticipate his knowledge and experience will be of great benefit to *EA* and its readers.

Datacraft wins important comms contracts

Datacraft Australia has won a contract to supply the Commonwealth Bank with a system to allow customers to select or change their own personal identification number (PIN) at their own branch. The PIN can be either a combination of numbers or letters that form an easy to remember word.

The system is expected to be installed in 1989, and will allow existing and new customers alike to select their own PINs.

As well, the Melbourne based company Datacraft Manufacturing, a subsidiary of Datacraft Ltd, has recently been awarded a contract to manufacture printed circuit board assemblies for a Communications Server Unit being produced by Honeywell Bull for Telecom Australia's TranSend network and the Telecom New Zealand TTS Network.

News Briefs

- A printed circuit board service has been launched in Cairns to cater for mail orders Australia wide. Contact ***The PCB Centre*** on (070) 55 4252.
- ***The International Robot Show*** will be held at Centrepoint, Sydney from 7-10 November. Details are available from the organisers on (03) 267 4500 or toll free (008) 335 010.
- Queensland company ***Mitec*** has been awarded a contract by Hughes to supply componentry for the second generation Aussat B satellites.
- ***Racal-Guardata Australia*** has appointed Bill Spencer as its Victorian Branch Manager and Chris Burke as its Technical Support Manager.
- Denis Lamb, formerly general manager of ***IRH Components*** has been appointed managing director of the company.
- ***Dick Smith Electronics***has recently announced the appointments of Adam Benecke to the position of Public Relations Manager, and Chris Ayres as specialist product buyer in the field of amateur radio.
- Mitel Semiconductor has signed the ***George Brown Group*** as its exclusive Australian distributor.
- Peter Jeffrey, who worked in production on Concorde has joined ***Hypertec*** in Sydney, with similar responsibilities.
- ***Philips Components*** in Melbourne has moved to 23 Lakeside Drive, Tally Ho Technology Park, Burwood East, 3151. Phone (03) 235 3677.
- Keith Murray has been appointed as Systems and Marketing Manager for ***Datacraft*** in NSW.
- The new General Manager of ***Voicecall Mobile Communications***, a newly formed company within Voicecall Ltd, is Ian Smith.
- Australian telecomms company ***Voca Communications*** has appointed ***Atlas Gentech*** as its distributor in New Zealand.
- A contract to produce ICs for consumer electronic appliances has been signed between ***Philips Industries*** and Shanghai Radio Factory No.7 in the People's Republic of China.
- ***Rod Irving Electronics*** has just opened a retail outlet in Sydney, at 74 Parramatta Road, Stanmore.

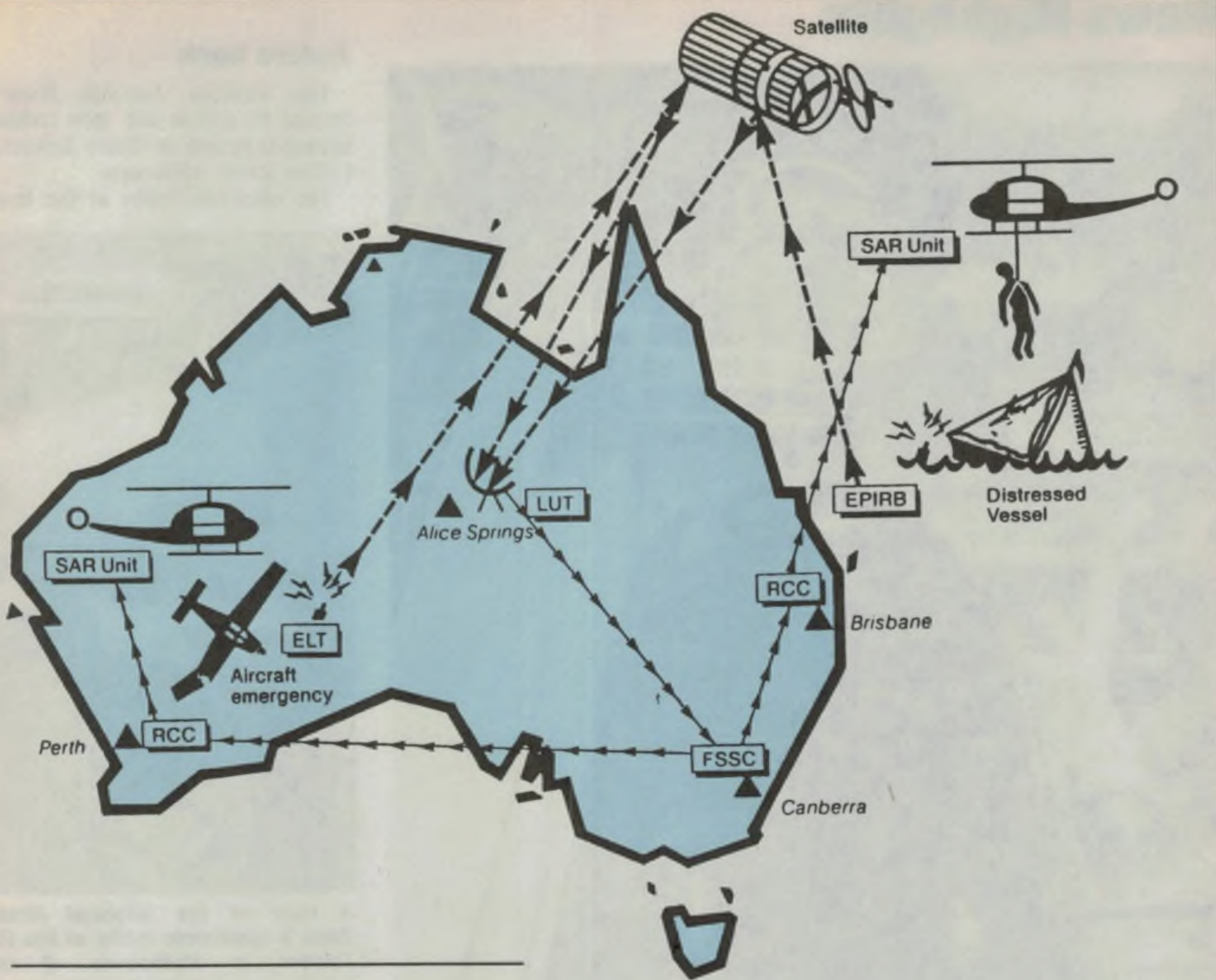
Phone ships at sea through OTC

Australians can now make direct dial telephone calls to ships at sea, using OTC's international satellite telecommunications facilities.

Previously, access from Australia to ships at sea required manual connection of calls through the Telecom domestic network to OTC's international maritime system, because local telephone exchanges could not meter the calls at the appropriate rate. Modification of the exchanges means that Australian callers can now dial direct to all ships fitted with standard-A satellite earth stations.

The system uses Inmarsat, the 54 nation International Maritime Satellite organization of which OTC is a founding member. Calls to some 7,000 ships at sea can be made by dialling the International Direct Dial (IDD) code 0011 followed by the appropriate Ocean Code and ship's Inmarsat telephone number.

A basic tariff of $12 per minute applies and there is no minimum charge for IDD calls, whereas operator connected calls will continue to attract a minimum charge of $36 for three minutes.



COSPAS/SARSAT	International Satellite Distress Alerting and Locating System
ELT	Emergency Locator Transmitter
EPIRB	Emergency Position Indicating Radio Beacon
FSSC	Federal Sea Safety Centre
LUT	Local User Terminal
RCC	Rescue Co-ordination Centre
SAR	Search and Rescue

Basic idea of the new search and rescue system, using polar orbiting satellites in the COSPAS/SARSAT system to pick up a distress signal emitted by an EPIRB (Emergency Position Indicating Radio Beacon). It will then be flashed to the LUT, which will relay the EPIRB's position immediately to the Federal SeaSafety Centre.

Search and rescue by satellite

Australia will use international satellite technology in future to speed the search for victims of marine disasters.

Under the plan the Government will fund a new satellite ground station capable of direct monitoring of radio beacon distress signals over a huge area of Australian and international waters.

The Government will spend $1.24 million in 1988-89 on equipment purchases, installation and operational costs to acquire the new facility known as a Local User Terminal (LUT). The LUT would provide almost immediate notification of mishaps at sea.

The scheme will operate using the polar orbiting satellites in the COSPAS/SARSAT system, which will relay to the LUT a distress signal emitted by an Emergency Position Indicating Radio Beacon (EPIRB) on the ship. This will replace the present system that relies on high-flying aircraft on commercial air routes to detect EPIRB signals.

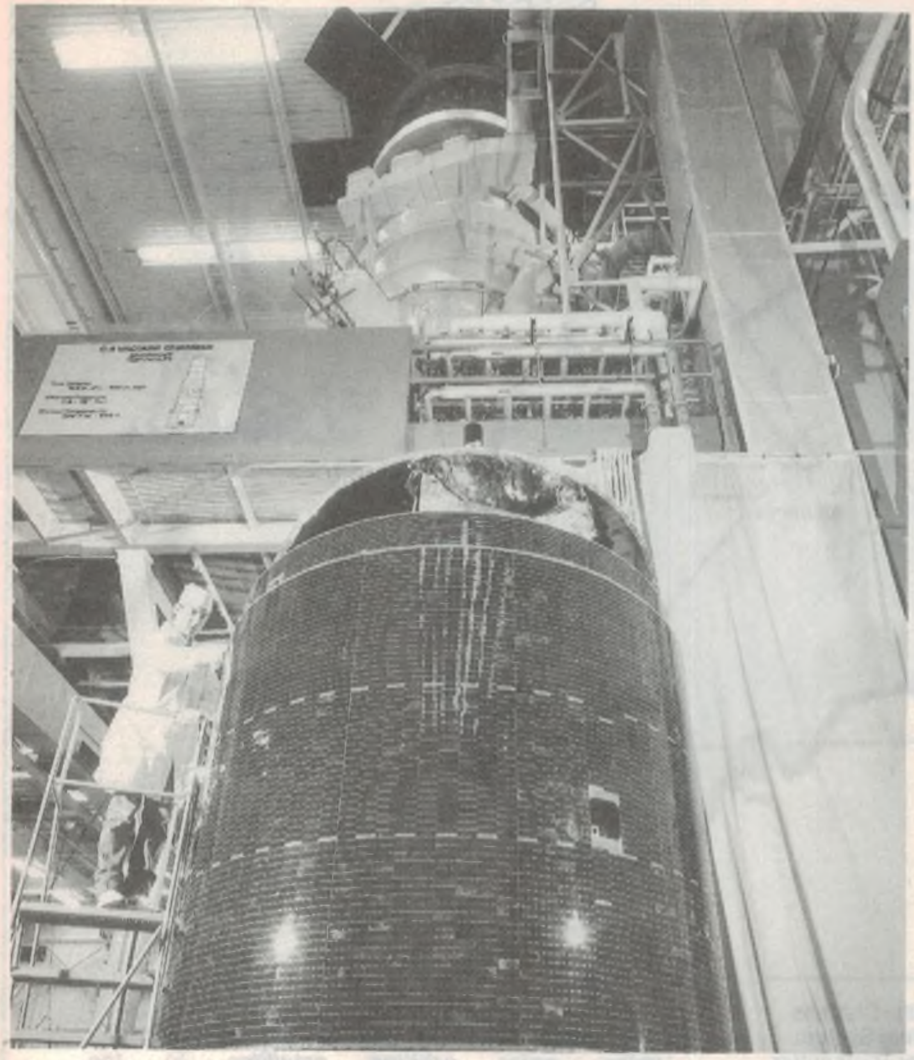
Solar '88 conference

The Australian amd New Zealand Solar Energy Society will be holding its national conference in the University of Melbourne, Parkville, on November 17, 18 and 19.

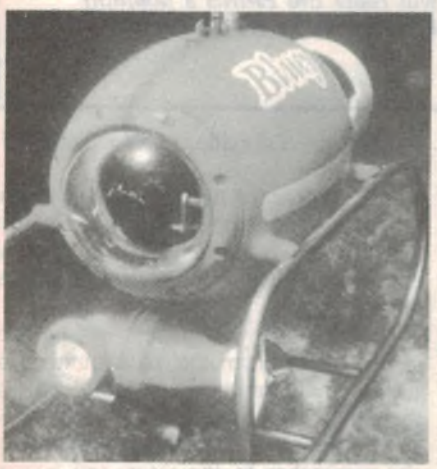
The conference theme is Environmental Improvement through Solar Energy. This theme is particularly relevant as concern about the greenhouse effect increases.

A wide variety of papers will be presented, and excursions to a number of locations featuring renewable energy techniques will be held. The conference should appeal to a wide spectrum, from the researcher to the interested layperson. Enquiries to Victorian Solar Energy Council, 270 Flinders Street, Melbourne 3000, or phone (03) 654 4533.

News Highlights



The fifth in a series of specialised business communications satellites built by Hughes Aircraft Company has been launched from Kourou in French Guiana. The new satellite is similar to those operated by Aussat in Australia.



Finding those fish is now made easy with 'Bluey', an inexpensive miniature submarine fitted with a video camera. This remote controlled device is manufactured by the Perth based company Remotely Operated Vehicles, and is marketed by GEC throughout Australia.

Future bank

The National Australia Bank has opened its newest and most technically advanced branch at Rialto Towers, 525 Collins Street, Melbourne.

The electronic lobby at the front of

A view of the National Australia Bank's 'electronic lobby' at the Rialto Towers in Melbourne. It offers 24-hour access to full service cash

$629,000 grant to study solar energy

A team from the University of NSW's Joint Microelectronics Research Centre will receive $629,000 over three years from the NSW Department of Energy, for further research into photovoltaic solar cells.

The grant supplements a grant of $336,786 from the Commonwealth Department of Primary Industrial and Energy.

The two grants will be used to study how advances over the past 10 years in the theory and manufacture of silicon chips can be applied to producing very thin silicon solar cells.

These advances have changed the direction of research into photovoltaic solar cells and the grants will maintain Australia's – and UNSW's – prominence in worldwide research into this important new technology.

the centre has 24 hour access to full service cash deposit/withdrawal facilities for customers with an electronically-striped card.

Using IBM's 'Electronic Brochure', the Centre's staff can handle all customer enquiries and provide a computer printout of any information required.

deposit/withdrawal facilities, for customers with a magnetically striped card.

Mr Chee Mun Chong loads a wafer into a diffusion furnace at UNSW.

Silicon Valley NEWSLETTER . . .

Seagate having problems

On the surface, business could hardly be better for Seagate Technology Inc. The Scotts Valley company dominates its principal market – 5-1/4" hard disk drives for personal computers. Seagate rolled to record sales for a third straight fiscal year, exceeding $US1 billion for the first time.

The 10-year-old company shipped 5 million disk drives during the fiscal year ended June 30, almost as many as it sold during its first years of operation.

Nonetheless, business isn't exactly rosy for Seagate. In the company's warehouses, and on its balance sheet, problems have been mounting. So much so, Seagate said it even expects to report a loss for the current quarter.

The troubles became apparent recently, when Seagate reported fourth-quarter earnings of $US16.5 million, or 33 cents a share. The figures fell far below Wall Street expectations.

In its announcement, Seagate placed the blame, in part, on the shortage of dynamic, random-access memory chips, or DRAMs. The company said the limited availability of DRAMs constrained production of small computer systems that use Seagate disk drives.

Seagate's corporate headquarters in Scotts Valley, California. Although sales are good, the future seems cloudy.

Financial analysts quickly concluded, however, that the company's problems went far beyond a DRAM shortage. The official explanations "were not that persuasive," said John Rossi, an analyst for Alex Brown & Sons in San Francisco.

The company's announcement suggested that the latest expansion might be slow to pay off. Seagate said its capacity now exceeds the demand for its products and the overcapacity may persist into 1989.

The Seagate report also showed that inventory ballooned by $US50 million in the most recent quarter while the company's cash fell nearly as much.

Though the company dominates the market for 5-1/4" drives, it is a late starter in producing the newer 3-1/2" drives. Led by Apple Computer and IBM, manufacturers of personal computers are moving rapidly towards the use of 3-1/2" drives, a market where Seagate is an also-ran.

"They're badly positioned" for the transition to 3-1/2" drives, said James Porter, president of Disk/Trend, a market-research firm based in Los Altos. "Ninety percent of their product mix is going to be different in two years," and Seagate will have to play catch-up in those markets, he said.

UCSB receives $US1.6M for semi research

Electronics and materials engineers at University of California at Santa Barbara have received a $US1.6 million grant from the National Science Foundation for basic research into crystal growth for the next generation of compound semiconductors.

The project will be carried out by a seven-member materials research group, headed by Professors Pierre Petroff and Art Gossard of UCSB's materials department and electrical and computer engineering department.

Compound semiconductors are made from mixtures of materials such as gallium and arsenic. Integrated circuits made from compound semiconductors are faster than those of silicon and can also be made into tiny lasers for use in fiber-optic circuits.

UCSB researchers will be exploring ways to produce compound semiconductors with special structures that can serve as the basis for new and better types of microelectronic devices. To do so, the scientists are attempting to increase the degree of control, or confinement, such materials can exert over the movement of the electrons.

"The next logical progression in the field of semiconductor devices will attempt to produce structures with additional degrees of carrier confinement and will exploit the new physical phenomena that may result from them," said Petroff. "The difficulties associated with the fabrication of structures with two and three degrees of carrier confinement require a more profound understanding of crystal growth."

The researchers will use new molecular-beam crystal growth and focused ion-beam technologies in fabricating the structures.

Natsemi wins round 1 in trade theft suit

Cypress Semiconductor and its subsidiary Aspen Semiconductor have been ordered by a Santa Clara County Judge to temporarily stop development, production and marketing of a new family of high-performance computer chips pending the outcome of a trade secret theft lawsuit filed against the two companies by National Semiconductor.

According to the lawsuit, Aspen and Cypress are basing their new ECL-type chips on the revolutionary "Aspect" process technology developed by Fairchild, which dramatically boosts the speed and circuit density of ECL chips.

"It is a technology that was one of the primary interests we had in the acquisition of Fairchild," commented Jim Smaha, executive vice president in charge of National's semiconductor operations. "A company cannot take technology developed by another. We're not willing to subsidise research and development for our competitors."

According to the court documents filed by National, the Aspect technology has fallen into the hands of Cypress and Aspen via Narpat Bhandari, a former Fairchild employee who was involved in the development of the Aspect technology, a project that took Fairchild five years and cost more than $US7 million.

Fairchild began shipping the first Aspect-made chips in January.

Acording to National, Bhandari conspired to take trade secrets pertaining to the Aspect process with him when he left Fairchild in 1987 and joined Aspen as president. He has since left Aspen.

At Cypress, company president T.J. Rodgers strongly denied National's allegations that his firm had engaged in theft of trade secrets.

"Aspen does not use and has never used any secrets from National and Fairchild, "Rodgers said. He added that he asked for a meeting with senior National executives to resolve the issue before it could reach the courtroom.He said he would show then that Aspen's ECL chip technology "is radically different" from National's.

80486 to challenge the RISC leaders

Intel, which has a lock on the PC chip world, is preparing a new chip to run minicomputers and work stations.

The 80486, according to Intel senior vice president Dick House, will be introduced some time in 1989. He said the chip will be somewhat of a departure for Intel, which has designed microprocessors primarily to command IBM personal computers and compatible machines. Intel's latest PC microprocessor, the 80386, is one of the hot-selling chips on the market today.

With the 80486, which will contain about 1 million transistors and feature five times the speed of the 80386, Intel plans to take on the flurry of high-powered RISC microprocessors released during the past year by Sun Microsystems, Mips Computer Systems, Advanced Micro Devices, Motorola and others.

Intel's chip has some RISC-like features, but Intel says it's not a RISC chip.

Even though the company is months behind the competition and won't begin showing the chip to computer makers until early next year, analysts think Intel could still become a force in the workstation and minicomputer market.

The 80486 will be able to run all the software the 80386 can run, which means it will be able to handle IBM PC software, programs written for the new IBM PS/2 line and engineering software written for Unix.

In the meantime, Intel isn't slowing 80386 production, and it's still developing faster versions of the popular chip. Earlier this year, it introduced a 25 MHz 80386, which means the chip tackles instructions 25 million times a second. The company has a 33 MHz 80386 planned for next year.

Noyce is new Sematech chief

At long last, Sematech announced it has found a chief executive. And one thing the chip manufacturing research consortium won't have to worry about is any lack of credibility on the part of its new boss. For his name is Dr. Robert Noyce, inventor of the integrated circuit, co-founder of Fairchild, co-founder and current vice chairman of Intel, and generally viewed as one of the leaders of the semiconductor industry at large.

Noyce's appointment was announced at a press conference in Washington and was immediately hailed by both industry executives, congressional leaders, and top officials at the Pentagon. All agreed that the move had instantly erased a rapidly growing fear that Sematech had failed, after it appeared it would be unable to find a qualified chief executive.

According to Noyce, who was instrumental in the formation of Sematech and the lobbying effort to get Congress to support it financially, it was precisely that perception that prompted him to change his mind and step forward. About a year ago, Noyce had turned down a request to head Sematech because of both personal reasons and because Intel was in the midst of a management shake-up.

Noyce, who will remain as vice-chairman at Intel, changed his mind about a month ago during a meeting with industry executives in Boston. "Finally, it dawned upon me that this was just too important to let somebody else do it. I had to do it myself."

Noyce, along with National Semiconductor president Charlie Sporck and AMD chairman Jerry Sanders headed the search team for a chief executive.

Industry analysts agree Noyce may be one person who will be able to get things done at Sematech, both in the areas of technical achievement, reporting back to Sematech's member firms, and in the all-important dealing with the Pentagon and Congress where many have come to know him on a first-name basis after years of lobbying for the chip industry.

California acquires AMI

California Micro Devices in Milpitas announced an agreement with Gould to acquire Gould's struggling American Microsystems Inc. (AMI) semiconductor operations in a cash deal worth $US70 million.

The move will elevate Cal Micro into the ASIC big league, making it fifth largest producer of custom chips in the United States. Without AMI, Cal Micro's revenues have been rising rapidly and were expected to reach $US130 milion this year, compared to only $US21 million in 1987.

AMI's sales, meanwhile are currently running at the rate of about $US100 million and the group is operating at break-even level.

With the divestiture of AMI, Gould will put an end to a decade-long, very costly struggle to become a major force in the semiconductor industry. In 1979, Gould tried to force its way into the field by trying to acquire Fairfield Camera & Instruments through a hostile take-over battle with Fairchild's management. Fairchild was saved at the last minute from a Gould take-over by Schlumberger.

After several other ill-fated attempts at acquiring a semiconductor operation, Gould finally found a willing partner in American Microsystems Inc. for which it paid some $US200 million. AMI, however, failed to live up to Gould's expectations. In 1985 Gould took a $US165 million write-off against the reduced value of the loss-plagued chip operation.

H-P buys into voice messaging company

Hewlett-Packard has bought a 10% interest in Octel, a Milpitas-based voice messaging systems manufacturer.

Under the terms of the agreement, H-P will buy $US13.8 million worth of newly issued shares, or 5% of the company, directly from Octel. Over the next 18 months H-P will buy an additional 5% worth, and has the option to increase its equity position to a maximum level of 20%.

H-P has also agreed to sell Octel's voice messaging system to European customers which already use the lectronic mail features that are built into H-P business computers.

The Serviceman

A surprising cause for an unusual fault

After a while, most service technicians learn to recognise certain kinds of symptoms and quickly 'home in' on the faults most likely to produce them. But sometimes you can be tricked, by a set of symptoms which suggest one type of fault but are in reality caused by something quite different!

The story actually began in a very normal fashion. A bit over a year ago, I was asked to install a combination VHF-UHF antenna for one of my regular customers.

He had just bought a new National colour TV and was not getting as good a picture as he expected. He had been getting an acceptable picture on his old set with an indoor antenna, but the new set showed up the imperfections of that arrangement.

His location was reasonable, just below line-of-sight to the nearest TV transmitter and the signal strength was quite good. I had no doubt that he would get perfect pictures once we got a proper antenna up, and a good coax lead-in.

In fact, when I got to his roof, I could just see the top of the nearest transmitter tower (channel 2) above a nearby hill. Allowing that he was only about 5 miles from the tower, I reckoned that the proverbial piece of wet string should be an adequate antenna, providing that it was mounted in the right place!

The job was made easier because there had been an outside antenna in the past, and the chimney brackets were still present and rock solid. There was also a hole in the brickwork in just the right spot for the new lead-in. (Sometimes I'm sure that there *is* someone up there who likes me.)

I selected a Channel Master CK20 combination antenna and an Aerovision balun. I had used these items together many times before, and had no reason not to use them in this installation.

The antenna was up and the cable installed almost before I knew it. The lady of the house was delighted, not so much with the good picture but with the riddance of the untidy indoor spiral antenna that they had put up with since moving into the house some months before.

They continued happily with the system for something like twelve months. Then one day, when I was seeing the customer on another matter, he mentioned that the picture wasn't as good on the high channels as it was on channel 2.

He couldn't quite explain why, but it just wasn't as it used to be. His attempt at describing the fault was complicated by the fact that they rarely watched anything but the ABC, so they had not had the chance to study the deficiencies of the other channels.

There are customers, and there are nice customers. He is one of the latter group, because he wasn't blaming me or my installation. He wasn't even really worried by the fault. It was just there, and he would like an explanation.

He rang back a few days later to tell me more clearly what the trouble was. And the symptons he described were like nothing I have ever come across in a domestic situation.

The main complaint was a thick white line down the screen. It was usually in the centre, but sometimes was at one side or the other.

A secondary complaint was a thin white line with a 'blob' in the middle, running from side to side. This was also usually in the middle of the screen, but could sometimes be at the bottom or the top.

When it moved to the top of the screen, the vertical sync became unstable and the picture might roll for several minutes at a time.

And the clincher was the final symptom, seen whenever both lines were away from the center of the screen. This was a near perfect negative image of the channel 2 picture.

You will recognise these symptoms if you have ever come across intermodulation in a wideband distribution amplifier. In the amplifier a strong signal can modulate the weaker ones, to give symptoms like those described above.

However, in this case there was no amplifier, and no 'stronger' signal. In fact all signals were within 5dB, something I rarely find in my hilly territory.

When I eventually got to see the symptoms, I had to agree that it was intermodulation – but I couldn't imagine a mechanism by which it could occur. All I could think of was a fault in the tuner.

Faulty tuner?

If the RF amplifier transistor became faulty, it could conceivably cause these troubles. I tried the RF AGC control, and the 'No Snow' setting was the same for all three channels, which seemed to clear the tuner. But it had to be *something* involving a transistor or diode, surely.

I left the problem for a few days while I checked out the situation regarding the set. It was still under a 3 year warranty, and I am not an accredited National agent. In the event, I came to an agreement with National's state agent, and returned to do battle with the set.

This time I came better equipped to examine the trouble. I still wasn't certain that it was the set, so I brought with me a small portable set of the same brand but earlier vintage.

The portable worked perfectly on its indoor antenna, but when connected to the outside antenna, it immediately cleared the customer's set of all blame. The fault was clear to be seen on whichever set was linked to the main antenna.

I must admit, this was a nasty letdown. It meant that I couldn't blame the set and the trouble had to be in my installation. I still had no idea of what sort of trouble I was looking for. I have only ever had to deal with broken leads or short circuited leads, both of which produce snowy pictures, not intermodulated ones.

I started by checking the wall socket, and I replaced the flylead, all to no avail. So the trouble had to be on the roof – and it was blowing half a gale outside.

On the roof, with one arm round the mast, I loosened the brackets and brought the antenna down close enough to reach. I removed the cover on the balun and looked inside. I wasn't sure what I would see, but I didn't expect to see the saddle clamp and screws red with rust.

The antenna had only been in place for a year, and it was not a location noted for a wet atmosphere or salty air. Yet the saddle clamp and screws appeared so rusted as to be about to fall apart. In fact they weren't quite as bad as that, but still far worse than I would have expected in only twelve months.

In the event, I cut the end off the coax and remade the junction, after scraping most of the rust off the screws and clamp. I gave the balun a good squirt of CRC-226 moisture inhibitor, then rested the mast on the roof with the antenna pointing roughly in the direction of the transmitter.

A check of the picture showed near perfect performance, with just a trace of ghosting. The ghosts were not unexpected because the antenna was low down, close to the roof and not yet securely fixed. But the intermodulation had disappeared.

So it was back onto the roof, in the teeth of the now howling gale. I squirted a generous dollop of silicone sealant into the balun to protect the works against further corrosion, then raised the mast to its full height and secured the whole assembly back in place.

If that was all there was too it, there would have been little point in telling this story.

But when I got back inside, the picture was as bad as it had ever been. The intermodulation was, if anything, more intrusive than before I started the exercise!

Now that I knew about the corrosion in the balun, I had something to blame. I have never struck the problem personally, but I have heard of an oxide layer forming a crude diode. Although I had removed much of the loose rust, I couldn't remove it all and there must have been enough left to reform a diode, once the antenna was back in place and handling the full strength signals.

So it appeared that I would have to replace the balun, and as luck would have it, there was no spare in the van. I left the job that day, hoping that next time I went on the roof there would be less wind to worry me.

A couple of days later I was back with a new balun and a determination to solve the problem, once and for all. I got the antenna down onto the roof and prepared to remove the old balun. And in the process I think I solved the mystery.

The antenna terminals were two steel round-head bolts, secured with diecast wingnuts. Under the nuts were several aluminium washers, and a steel star washer. The aluminium leads from the balun were terminated with circular brass terminals crimped on to the wires.

The whole assembly, on both leads, was thick with a whitish powder and the centres of the brass terminals had a ring of gray, crystalline corrosion covering the area that would have made contact with the aluminium washers. Just think of the possibilities in that lot for chemical and electrical interactions!

The odd fact is that I have used these antennas and baluns in dozens of installations, and never come across this intermodulation problem before.

These Aerovision baluns are (or were) locally made and appear to be of the highest quality. I can only assume that the problem balun in this story missed out on its share of cadmium plating during manufacture.

The new balun which I have now fitted has rigid anodised aluminium wings, in the place of the wire and brass terminals of the original one. I don't think I will have the same kind of trouble again, but then, you never can tell...

A shocking secret

My second story this month concerns electrical safety – or lack of it. I notice that *EA*'s editor has been discussing this lately in *Forum*, in a general kind of way, but as a serviceman my interest in safety has to be much more direct. My life and that of my customers could depend on it!

In this particular case, I discovered a nasty hidden shock hazard, in a piece of equipment that I had been relying on for my own safety during service work. But I'll start the story at the beginning, and give a bit of background.

Many modern colour TV's use a transformerless power supply, to simplify design and save weight and money. The system works well but makes servicing dangerous, because the chassis is live, tied to one side of the mains input irrespective of which way the power plug is inserted.

Traditionally if we have to service one of these sets, we have to do it with one hand in our pocket. Even this doesn't stop you getting a belt occasionally, but at least it doesn't floor you.

And connecting an oscilloscope or frequency counter to the chassis is the quickest way I've yet found to blow fuses. They go off with a beaut 'crack' that brings the neighbours running in to see who has been shot.

The answer, of course, is to connect the set to the mains through an isolating transformer. These are 1:1 ratio units that deliberately break all connections (even earth) between the input lead and output socket.

In my early days of servicing colour tellys, I used an old transformer from a junked black and white set. It was not quite 1 to 1 – as I recall it had a 220 volt secondary – but it could supply one amp comfortably and was suitable for the job in hand, at least on a short term basis.

Later, I decided that I needed a professionally made transformer to take into customer's homes. My home-made unit was OK for the workshop, but it didn't look right anywhere else.

The unit I bought was heavier than the makeshift one, and provided a full one amp continuously, at 240 volts. It also cost sixty-odd dollars, at a time when that was real money.

I was quite happy with my two transformers and may never have changed anything if I hadn't gone to the local tip one day, to dump a load of rubbish. I had just disposed of my trash when a car pulled up beside me and the driver asked if I would help him unload his junk.

He lifted his boot lid and exposed a metal box about a foot square and fifteen inches high. The front of the box carried a large knob, a toggle switch, a 3" diameter moving iron meter calibrated to 250 volts, and a standard three pin power socket. There had once been a heavy power lead fitted through a grommet in the front panel, but this had been cut off short.

The driver warned me that the box was heavy, but that didn't alert me to just how heavy. The two of us had to struggle to get it up over the edge of his car's boot.

By this time I had realised that it was some kind of power transformer and that whether or not it worked, it would contain quite a few dollars worth of scrap copper. The meter would have been useful, too. The driver didn't know what it was, only that he had found it in the garage of his new home and he wanted to be rid of it.

So rather than help him dump it on the tip, I suggested that we dump it in my van. The thing weighed near enough to a hundred pounds and we sank up to

Serviceman

our knees in the mud as we struggled the few feet to my waggon. It hit the floor with a dull thud and I imagined I could hear the springs groan.

Back in the workshop, I lost no time in cleaning the box up to see what I had won. The specification plate on the front panel had been painted over, but I managed to clean it up and learned that I had a 1000VA transformer with a 180 to 250 variable input at 6.12A, and a 230 volt output at 4.35 amps.

When I opened the box up, I found a really massive transformer that took up almost the whole interior. It was covered with dust and spider webs, and also quite a few spiders who didn't take kindly to being evicted.

After a good clean up, I was able to see just how it was arranged. One side of the mains input was taken to a rotary slider connected to the front knob. The primary was wound on the outside of the coil, and some twenty turns had been left uncovered. Part of the enamel insulation had been removed from these turns, and the slider could make contact to adjust the primary voltage.

The toggle switch on the front panel connected the meter to either the input at the mains terminals, or to the output at the three pin socket. This transformer was obviously designed to provide a stable 230 volts output from a very unstable input.

Every test that I could give the unit, short of putting it on the mains, showed it to be in first class condition. I could measure no leakage between the windings, but I wanted a better test than my workshop multimeter. So I called on a friend who had access to a megger.

A megger is really a high voltage ohm meter. It uses a hand cranked magneto to generate 1000 volts, which is placed across the insulation under test. The meter shows any leakage present and can read the insulation resistance up to hundreds of megohms. My new transformer came through with flying colours. Not a skerrick of leakage.

The final test was one to check that there was no leakage between the earth pin on the newly fitted power input lead and the outlet socket on the front panel. This test was carried out by putting an uncovered plug in the socket, and testing for leakage between the earth pins on the lead and the socket.

The box was given a coat of wrinkle enamel, then duly installed under my bench, where it has done sterling duty for about four years. The fact is, it's four times bigger than is necessary for the job, but then it cost me nothing. (I priced a similar transformer, just for fun. The quote was 'about $650', four years ago!)

Over the years, hundreds of transformerless tellys have been plugged into this transformer and used with CRO's, generators and so on with never a sign of trouble. Until yesterday.

This time, the TV was already plugged into the mains, so rather than rearrange the leads, I plugged my oscilloscope into the transformer. The main requirement is to break the earth link between the TV and the CRO, and in theory it doesn't matter which is plugged into what.

This is not the safest way to do things, of course, but it was convenient on this occasion and acceptable so long as there were no grounded items around that I might connect myself to.

Everything worked perfectly until I accidentally pulled the CRO power lead from the transformer and trod on the plug. I didn't realise at the time that this had bent the earth pin.

I simply pushed the plug back into the socket on the transformer and turned back to the TV. Next time I switched the set on there was a tremendous 'splatt', and a cloud of smoke drifted out of the cabinet.

Both mains fuses and three of the four bridge diodes were gone. Only an earth on the chassis could do this, yet the only link was the CRO lead and that was isolated through the transformer, wasn't it?

It turned out that the CRO wasn't isolated, through the oddest accident you could ever imagine.

When I had first tested the transformer, I had checked for an earth on the output by putting a plug in the socket and testing for a connection through

(Continued on page 142)

TETIA Fault of the Month

National CP-2000

SYMPTOM: Erratic start-up. Sometimes gives short burst of sound at switchon and sometimes nothing at all until five minutes or so have passed. If set does start normally, it may sometimes shut down with a faint squeak.

CURE: C805, a 1uF 50 volt electro in the power supply regulator circuitry low value, or intermittent open circuit. This cap provides drive to the chopper by feeding in 100Hz pulses from the bridge rectifier output.

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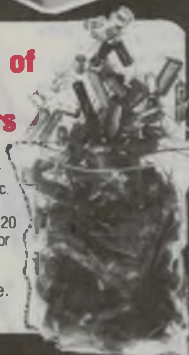

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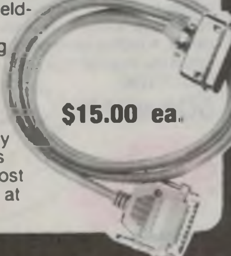

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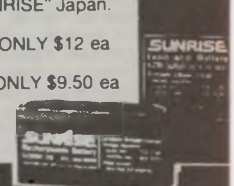

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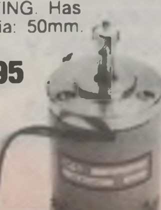

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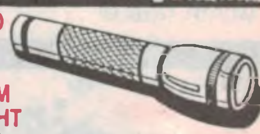

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At last! A driver set incorporating those obscure shaped heads!
Have you ever needed recently to service an electric tool? Chances are you would not have been able to do so because the screws holding the appliance together had strange shaped heads.
Well now you can with our 30 piece driver set! This set contains all the driver bits you are EVER likely to encounter (See Below).
Basic to the set is an 8 1/2" Chrome-Vanadium driver which will accept any of the 28 hardened steel bits supplied. They are held into the socket of the driver by a small magnet - so you can use the driver in any position. The screw-together hollow handle will hold several tips so you don't have to take the whole set with you into the field.
There is a tip here to suit almost any screw/nut you may come across.
Here's what you get:
• 5 Slotted Bits 0-1, 3-4, 5-6, 8-10, 12 • 5 Hex Bits 3/32", 5/64", 7/64", 1/8", 9/64" • 4 Philips Bits No. 0, 1, 2 & 3 • 4 Square Recess Bits No. 0, 1, 2 & 3 • 6 Torx Bits T10, T15, T20, T25, T30, T40 • 2 Pozidrive Bits No. 1 & 2 • 1 x 1/4" Drive Socket Adaptor • 1 x 1/4" Drive Hex Bit Holder
And its all housed in a sealable tough plastic case
Cat. TD-2000 **$19.95**

Porcelain Standoff

Ideal for electric fences. A round glazed porcelain insulator measuring 30 dia & 25mm high, with a 10mm hole thru the centre. A roofing screw would be ideal to fasten the insulator to a post.
Cat. LF-1090

50¢ each

DIRT CHEAP!!

GLOBE BARGAINS

Bargain 1: 1.25V MES lenshead globes. Ideal for single cell torches.
USUALLY 50¢ ea
25 for $2 (only 8¢ ea)
100 for $6 (only 6¢ ea)
Cat. SL2660

Bargain 2: 5 volt MES torch globes. Works OK on 6V.
USUALLY 50¢ ea
10 for $1
Cat. SL-2661

Bargain 3: 12 volt BC car replacement globes suit tail lights, blinkers, garden lights, etc.
USUALLY ABOUT $3 ea
2 for $1
Cat. SL-2662

Bargain 4: 6.3V MES globes
USUALLY 50¢ ea
4 for $1
10 for $2
100 for $15
Cat. SL-2654
Limited quantities on all globes.

GREENCAP PACK

• Metallised polyester. 60 top quality prime spec greencaps supplied from 0.001uF to 0.22uF, all 100V.
Cat. RG-5190
60 in pack $7.95 DON'T PAY $12.95

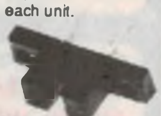
Car Bonnet Locking Device

This device will lock the Bowden Cable (i.e. the 'wire' that goes between the bonnet release handle and the bonnet catch) AUTOMATICALLY when you switch your car alarm on. The unit will give COMPLETE under-bonnet security! The locking device includes solenoid lock, control box, emergency Bowden cable release, screws, connector bracket and other hardware for universal fitting. Instructions supplied.
Cat. LA-5400

A BARGAIN AT ONLY $19.95
WOULD NORMALLY COST ABOUT $70

PHOTO INTERRUPT

This device enables you to turn a circuit on and off optically.
APPLICATION
• Counter sensor • Tachometer • Opto Ignition • Edge Sensor • Tape End Sensor
Full specs supplied with each unit.
Cat. ZD-1901
$8.95 ea
10+ $7.95 ea



Micro Hi Fi Speaker

70mm long x 34mm wide oval speaker - with butyl rubber surround! Respectable 1W rating. Hi Fi in a matchbox. Quantities very limited.
Cat. AS-3002 **$5 ea**

CAR SPEAKER GRILLS

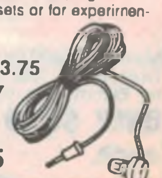
1. 7" x 5" metal grill. Black in colour.
Cat. AS-3035
ONLY $2 ea
SAVE $6

2. 9" x 6" quality metal black grill.
Cat. AS-3036
ONLY $3 ea
SAVE $7

You would expect to pay about $8 for the 7 x 5 and $10 for the 9 x 6 nonrmally.

CRYSTAL EARPIECE

High Impedance with 3.5mm plug. Suitable for crystal sets or for experimental use.
Cat. AS-3305
NORMALLY $3.75
NOW ONLY $2.50
SAVE $1.25



ULTRASONIC PEST & INSECT REPELLERS

- Frequency range 30kHz to 65kHz variable
- Output level 130dB
- Both units include 240V power adaptors

DIRECT IMPORT

Single Transducer

ONLY $29.95
SAVE $10
Cat. YS-5510

DUAL TRANSDUCER

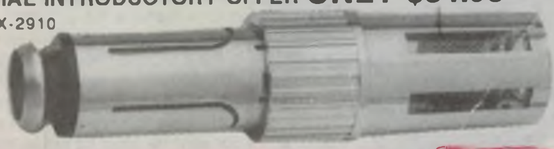
ONLY $39.95
Cat. YS-5512

CAR NEGATIVE ION GENERATOR

Now you can have all the benefits of your home ioniser in your car.
This great new Jaycar direct import is durable, stylish and compact, measuring only 110mm in total length. It simply plugs directly into the cigarette lighter socket in your car. It can generate large amounts of negative ions for purifying air, and some ozone for eliminating odour.

Jaycar's direct importing cuts out the middle man and saves you money.

SPECIAL INTRODUCTORY OFFER **ONLY $34.95**
Cat. YX-2910

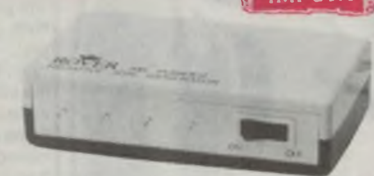


NEGATIVE ION GENERATOR

DIRECT IMPORT

240 VOLT - SAVE $50
Cat. YX-2905
ONLY $29.95

HUNDREDS SOLD



ULTRA THIN SHIELDED CABLE

Quality English made shielded cable with a total diameter of 1mm. Ideal for screened wiring in small spaces! Packet 5 metres
ONLY $2.50
Cat. WB-2310

GREEN RECTANGULAR LED BARGAIN

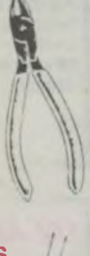
NORMALLY 40¢ each

1-10	20¢ ea
11-99	16¢ ea
100-999	14¢ ea
1000+	12¢ ea

including tax!
Cat. ZD-1765

JUST ARRIVED QUALITY NIPPERS

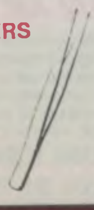
130mm wire nippers
Cat. TH-1891
$7.95
SAVE $2



125mm flush cutters
Cat. TH-1892
$7.95
SAVE $2

POINTED TWEEZERS
Cat. TH-1765
SAVE $1
ONLY $1.95

DIRECT IMPORT



'T-REX' WIRESTRIPPER

Strip all sorts of cable without damaging the conductors.
- Automatically adjusts to insulation diameter.
- One hand operation.

Cat. TH-1824
WAS $12.95
SAVE $2.00
NOW $10.95

DIRT CHEAP!!

DIRECT IMPORT

TURN YOUR SURPLUS STOCK INTO CASH!!

Jaycar will purchase your surplus stocks of components and equipment. We are continually on the lookout for sources of prime quality merchandise.

CALL GARY JOHNSTON OR BRUCE ROUTLEY NOW ON (02) 747 2022

FREE GAS!!!!

If you own a Portasol soldering iron, bring it into any Jaycar store for a FREE gas refill.

1/2 PRICE PLASTIC FEET

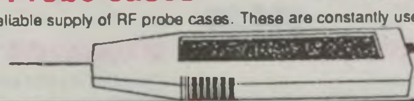
Ideal for turntables, speakers, large amps, etc. Easy mounting with one 4mm diameter bolt or self tapper. Diameter 35mm at base.
USUALLY 85¢ ea
40¢ each
10+ 35¢ ea Cat. HP-0830

CARLINGFORD STORE HAS MOVED TO **PARRAMATTA**
355 CHURCH STREET
(Cnr. Victoria Road)

DIRECT IMPORT

AT LAST - Probe cases

We finally secured a reliable supply of RF probe cases. These are constantly used in kits.
Size 200 x 24 x 20mm
Cat. HB-6400
$12.95



DIGITAL STEREO HEADPHONES

SAVE UP TO 39%

SA700

Features Mylar drivers, sponge earpads, metal 3.5mm stereo plug. Cat. AA-2021
WAS $29.50
NOW $17.95 SAVE 39%

SA880

Mylar drivers, freq. reponse 20Hz-25kHz. Quality muff pads.
Cat. AA-2022
WAS $39.50
NOW $24.50 SAVE 38%

SA888

Top of the range, excellent sound. Quality phones. Cat. AA-2023
WAS $59.50
NOW $39.50 SAVE 34%
For full details see our catalogue.

DIRT CHEAP!!

HI QUALITY GOLD RCA PLUGS

Similar to those used on those expensive gold audio leads. Clearly marked in red or black.
RED Cat. PP-0236
BLACK Cat. PP-0237
$3.50 ea
10+ $3.20 each

DIRECT IMPORT

Solar Powered Exhaust Ventilation

Remove gas, fumes, humidity, etc by using the suns free power - solar. It will remove about 35 cubic metres of air every 1/2 hour in bright sunlight.
Ideal for:
- Boats • Caravans • Port-a-loos
- Greenhouses • Sheds • Holiday homes • Backyard dunnies
- Kitchens • Weekenders, etc.

Cat. YX-2500
SAVE $5 NOVEMBER
ONLY $44.95

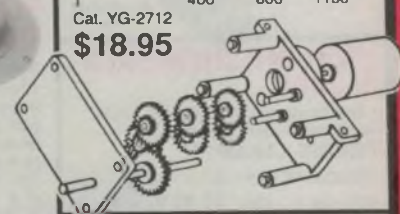
GOVERNMENT INSTRUMENTALITIES, SCHOOLS, PUBLIC COMPANIES
IF YOU WISH TO PURCHASE FROM US, SIMPLY SEND US YOUR OFFICIAL ORDER AND WE WILL GIVE YOU A COMPLIMENTARY 30 DAY ACCOUNT

Motor/Gearbox Kit

This kit contains a motor with press-fit brass cog, gearbox housing, 3mm x 110mm steel drive shaft, 2 intermediate shafts, 7 gearwheels and 6 nylon bushes.
Runs off 1.5 - 4.5 volts DC.

No of gears	1.5V RPM	3V RPM	4.5V RPM
6	2	4	6
5	5	10	14
4	16	32	45
3	44	88	125
2	150	300	410
1	400	800	1150

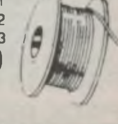
Cat. YG-2712
$18.95



WIRE WRAP KYNAR WIRE ON SPOOLS

We have been after this for years, and have finally found it. It's high quality SILVER PLATED (other companies sell wire which is not silver plated) on 50 foot spools. Available in 4 colours.
RED Cat. WW-4340
BLACK Cat. WW-4341
BLUE Cat. WW-4342
GREEN Cat. WW-4343

ONLY $6.50 per reel
That's only 13¢ per foot!



WIDERANGE
MAGNAVOX 8JX $31.50
The 8JX is a 8" twin cone speaker suitable for medium power handling applications.

SPECIFICATIONS

Power Handling	40 watts RMS
Resonant Freq.	44Hz
Freq. Range	fo - 12kHz
Sensitivity	93dB

Cat. CE-2333

MAGNAVOX 8WR $36.50
The 8WR is a high fidelity wide range twin cone 8" driver.

SPECIFICATIONS

Power Handling	65 watts RMS
Resonant Freq.	43Hz
Freq. Range	fo - 12kHz
Sensitivity	96dB

Cat. CE-2338

JAYCAR FOR MAGNAVOX SPEAKERS

WOOFERS
MAGNAVOX 8W
The 8W Mk6 is a high fidelity woofer.

SPECIFICATIONS

Power Handling	65 watts RMS
Resonant Freq.	43Hz
Freq. Range	fo - 5kHz
Sensitivity	96dB

Cat. CW-2109

$39.50

MAGNAVOX 10W
The 10W is a 10" high quality, high power, medium price woofer.

SPECIFICATIONS

Power Handling	75 watts rms
Freq. Response	30Hz - 5,000Hz
Resonant Freq.	33Hz

Cat. CW-2118

$43.50

MAGNAVOX 12W
12" woofer, medium power, low cost, high quality. 25mm voice coil wound on aluminium former. Polyurethane foam roll surround.

SPECIFICATIONS

Power Handling	80 watts rms
Freq. Response	30 - 5,000Hz
Resonant Freq.	30Hz

Cat. CW-2122

$56.50

MAGNAVOX 8MV
8/30 Replacement

If you own a pair of 8/30 woofers, you can now easily update them. Your old 8/30's handle 30 watts rms, the new 8MV's handle 120 watts rms. No need to buy new cabinets, 8MV's mount in the same hole, otherwise it's a high quality, high power 8" woofer for most applications.

SPECIFICATIONS

Power Handling	120 watts rms
Resonant Freq	31Hz
Freq. Range	fo - 4kHz
Sensitivity	96dB

Cat. CW-2110

$99.50

MAGNAVOX 12MV
The 12MV is a high power high fidelity woofer.

SPECIFICATIONS

Power Handling	150 watts rms
Resonant Freq.	19Hz
Freq. Range	fo - 3kHz
Sensitivity	96dB

Cat. CW-2125

$99.50

MADE IN AUSTRALIA

POLYPROPYLENE MAGNAVOX WOOFERS
JC 150 6" WOOFER
SPECIFICATIONS

Resonant Freq.	49Hz
Sensitivity	95dB
Power Handling	50 watts rms
Freq. Response	80 - 8000Hz

Cat. CW-2105

$39.95

JC 200 8" WOOFER
SPECIFICATIONS

Resonant Freq.	39Hz
Sensitivity	95dB
Power Handling	65 watts rms
Freq. Response	50 - 5500Hz

Cat. CW-2112

$49.95

JC 250 10" WOOFER
SPECIFICATIONS

Resonant Freq.	26Hz
Sensivity	97dB
Power Handling	75 watts rms
Freq. Response	45 - 4500Hz

Cat. CW-2120

$64.95

ELECTRONIC ANVIL!!!
Ideal for the hobbyist. Hammer that IC into that socket on our anvil! Weighs 2.7kg

Cat. TD-2040

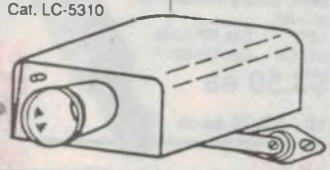
Size 180mm long 80mm high

$13.95

DUMMY CAMERAS

1-4	$49.95	5-9	$42.95
10-19	$39.95	20+	$37.95

Cat. LC-5310



QUALITY JEWELLERS SCREWDRIVER SET
Quality easy to use colour coded screwdriver set with swivel plastic heads.

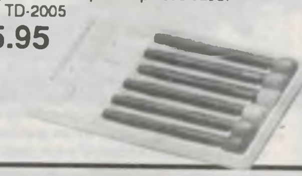
Screwdrivers include slotted 1.0, 1.6, 2.4, 3mm

Philips No. 0, 1

Supplied in transparent plastic case.

Cat. TD-2005

$5.95



ETCHANT CHEMICALS IN JARS
• Safe for storage, childproof lids - safe from kids, no mess, no fuss.

FERRIC CHLORIDE

200g Cat. NC-4251 **$4.95**

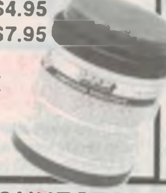
400g Cat. NC-4252 **$7.95**

AMMONIUM PERSULPHATE

400g

Cat. NC-4254

$6.95



PLUG & SOCKET TERMINAL STRIP
Brand new product. It's like a standard type 12-way barrier strip or terminal strip but it has 2 strips of 12 which can be unplugged from each other. So if you have any number of semi permanent wires from 1 to 12 that you have to unplug, this is the ideal way.

Cat. HM-3202

$4.95

Insulated Staples - No Staple Gun Required
Grab a packet of these!

Pack of 100 plated U-shaped staples with soft-nylon saddle, you can hammer them in to wood, particle board etc. Nylon saddle cushions the wiring. Ideal for burglar alarms, speaker flex, TV coax etc., and NO expensive staple gun needed!

SMALL SIZE: Suitable for speaker flex, alarm cable, etc.

Cat. HP-1185 **$2.00**

MEDIUM SIZE: Suitable for 3C-2V or RG58 coax and heavy speaker flex.

Cat. HP-1186 **$2.00**

DIRT CHEAP!!

CONTACT CONNECTOR BARGAIN
Easy to use automatic connectors. Simply wrap around the existing wire and new wire and squeeze.

NORMALLY $1.25 for 4 or 31¢ ea

(Two styles supplied in pack)

PACK 15 for $1.95 (only 13¢ ea) Cat. HP-1207

PACK 100 for $10 (only 10¢ ea) Cat. HP-`1208

KIT'S COLUMN
Hi,

I know you are not going to believe it but my name is Kit. (It's really Kitty). Well, I work with a bunch of other girls in the Kit Department at Jaycar.

You wouldn't believe it, but the other day the boss stalks in and tells me that I have to write a column to go in our ads! He says he will let me write anything, mind you, even stuff about him (not everything about him). Well, here goes. (Hope he doesn't sack me).

Well, the other week the boss called me into his office. Would you believe it - just after knock off time. I knew that it was going to be interesting when he locked the door behind me. . .

"Let me turn the lights off" he said. I thought, well here we go!

But the next thing that happened was - he turned on this fantastic new lamp that we had just produced as a kit, It's the Plasma Discharge lamp/display that was described in 'Silicon Chip' in August this year.

I knew they were great but this was really something. He had the blue coloured Plasma Display jar in the unit. It was really spectacular in the dark!

Then he showed me his red one. . . Plasma Jar of course! You naughty boys!

I told him that it was just the thing for an orgy but that seemed to go over his head. He kept looking at the display and not me! The fact that I wasn't getting paid overtime for this product orientation evening seemed to go over his head as well!

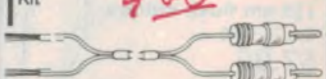
Anyway Big Boys, be the first on your block to have one of these new toys. You can really impress your not-so-clever-as-you friends with your own lightning storms in a jar.

But don't all order at once. The girls in the kit dept. are flat out doing our best already.

Meantime keep your iron hot!

Regards,

Kit



1/2 AN RCA LEAD?
Well, not quite. These are a stereo lead, (figure 8 shielded) with two RCA plugs on one end and tinned stripped leads on the other. Leads with 2 RCA plugs on both ends sell for $4.95.

Cat. WA-1040

ONLY $1.95

10+ $1.75 each

Multi-purpose preamp board

Need to amplify or process an audio signal? This universal board design may be the answer – it will accommodate almost any circuit requiring a dual op-amp and power supply.

by ROB EVANS

How often have you found yourself scanning through data books or back issues of EA, searching for the audio circuit you require? This can be quite a time consuming process, particularly when an appropriate printed circuit board (PCB) has to be designed from scratch or modified from an existing layout.

To avoid this inconvenience, we have designed a multi-purpose PCB that allows for a wide variety of component positions around a standard dual op-amp. This lets us assign the one universal PCB to a diverse range of circuit configurations, by simply rearranging the component positions.

As an example of some of the common applications, six circuits have been developed and tested, and are presented here with matching component overlays. Also, a number of power supply alternatives may be accommodated on the PCB, and are presented in a similar manner.

So, to build the circuit that you require, it's simply a matter of selecting the op-amp design, nominating the type of power supply, and installing the components as shown in the overlays. If the circuit is not one of the six presented, only a little planning is needed to arrange the component positions correctly.

Suitable op-amps

Although a similar, universal PCB could have been designed for a quad or single op-amp, the dual configuration was found to be the best compromise between complexity and versatility.

A single op-amp board does not allow us to easily add a following stage for extra processing, or another identical stage for stereo applications. Conversely, the PCB design for a *versatile* quad op-amp circuit would be physically too large for many applications.

Another factor in favour of the dual op-amp is the wide range of devices to choose from, all with the same pin-out. This allows us to consider the price versus performance aspect of the op-amp for each application. They range from dual versions of the ubiquitous uA741, to the high performance LM833 and NE5532 devices.

The LM833 is of particular interest, since it is a relative newcomer to the audio arena and offers very high performance – not unlike the popular NE5534 single op-amp. However, the LM833 is a *dual* op-amp and costs only slightly more than the NE5534 – that adds up to excellent value for money. This IC was tested in a couple of our more demanding circuits, and found to produce impressive results.

Naturally, ICs such as the humble LM1458/4558 are quite suitable for the published circuits, and cost around one third the price of the LM833. These will deliver quite respectable results, particularly in the circuits configured for a low voltage gain. Also, much the same applies for the common TL072 dual JFET op-amp, which offers a very low input bias current and low-noise performance at around two thirds the price of an LM833.

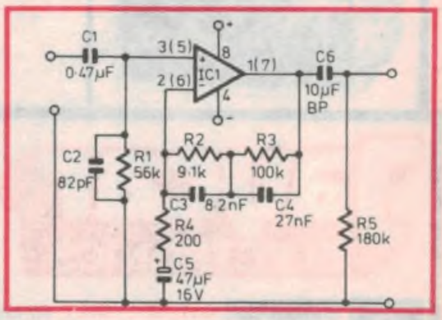
So there we have it. Select a suitable IC, the style of power supply you want, and position the components to create the circuit that you require. The six circuits shown here are mainly preamps, with a tone control and mixing stage thrown in for good measure. However, with a little imagination, this universal PCB will easily accommodate many other two op-amp configurations.

RIAA phono preamp

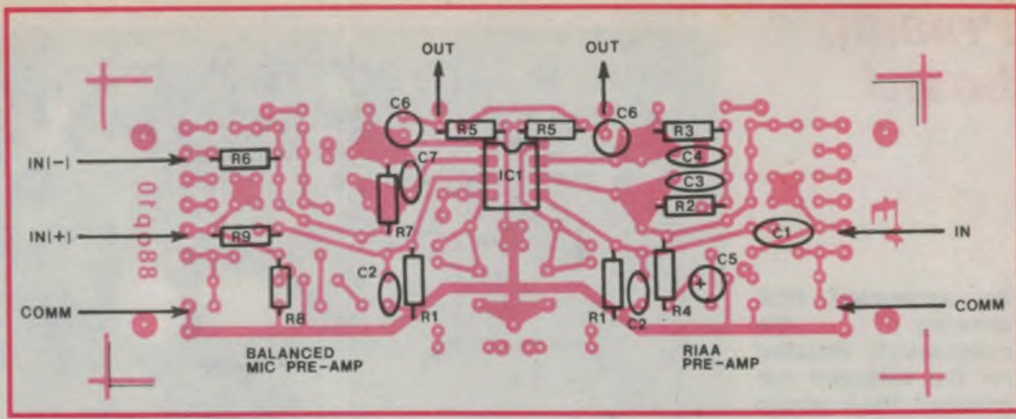
This stage is designed to amplify and equalise (to the standard RIAA curve) signals from a standard 'moving magnet' type magnetic phono cartridge.

Despite the simple appearance of this design, it is capable of excellent performance when configured around an IC such as the LM833. In fact, our prototype delivered signal to noise ratio and distortion figures of 88dB and 0.008% respectively, when connected to power supply '1'.

Although the circuit diagram of the RIAA preamp shows the use of close tolerance resistors, an alternative range of standard preferred values is listed in the parts table. With these values, the preamp will track the RIAA curve with only a little less accuracy than the close tolerance version such as our test circuit, which followed within +/– 0.5dB.



This simple RIAA phono preamp is capable of excellent performance when used with a high quality op-amp.



Component overlay for the balanced mic preamp (left hand side of PCB) and RIAA preamp (right hand side of PCB).

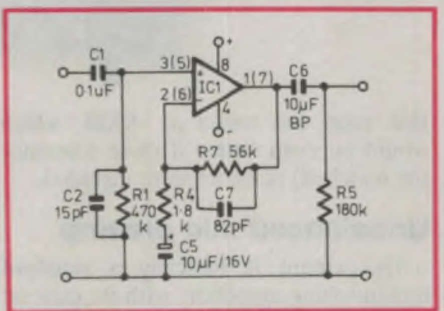
The circuit itself has a mid-band (1kHz) voltage gain of about 35dB, and a frequency response set to the RIAA curve by R2, R3, C3 and C4. The response is rolled-off at very low frequencies by the combination of R4 and C5, and C1 and R1, while any extraneous high frequencies from the source signal are limited by C2.

The low frequency gain of this circuit is set to about 55dB by the combination of R2, R3, and R4, reaching this peak level at about 30Hz. This leaves the circuit very susceptible to mains hum interference, which may dominate the background noise. In fact, if a high quality op-amp is used, the noise performance tends to be limited by the hum alone, which in turn depends on the power supply and shielding around the PCB.

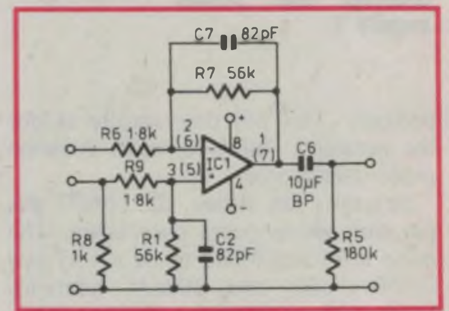
NAB tape preamp

An NAB tape preamp is designed to amplify and equalise the low level signals from the playback head of a tape recorder. The basic circuit configuration is identical to the RIAA preamp, with the exception of the frequency selective feedback network. This network, comprising of R3, R4, R7 and C3 sets the equalisation curve to the NAB tape playback standard.

This response curve heavily boosts the low frequencies (+35dB) in the same manner as the RIAA equalisation, and care must be taken with circuit shielding and the prevention of power supply ripple.



The circuit for a tape head playback amplifier which follows the NAB equalisation curve.



A simple high performance balanced mic preamp based around a subtracting amplifier. Note the input impedance matching resistor R8.

Balanced mic preamp

In effect, this circuit is simply a high gain subtracting amplifier. One of the anti-phase signals from a balanced microphone is applied to the inverting input, while the other is applied to the non-inverting input of the op-amp IC1, at R6 and R9/8 respectively. Since these signals are out of phase, they will be amplified by the op-amp, while any signals common to both inputs (such as electrical interference) will be subtracted or rejected.

The gain at each input is matched when R7 is the same value as R1, and R9 is that of R6, and may be calculated using standard gain equations. However, when calculating the gain at the non-inverting input, the inverting input should be considered to be grounded.

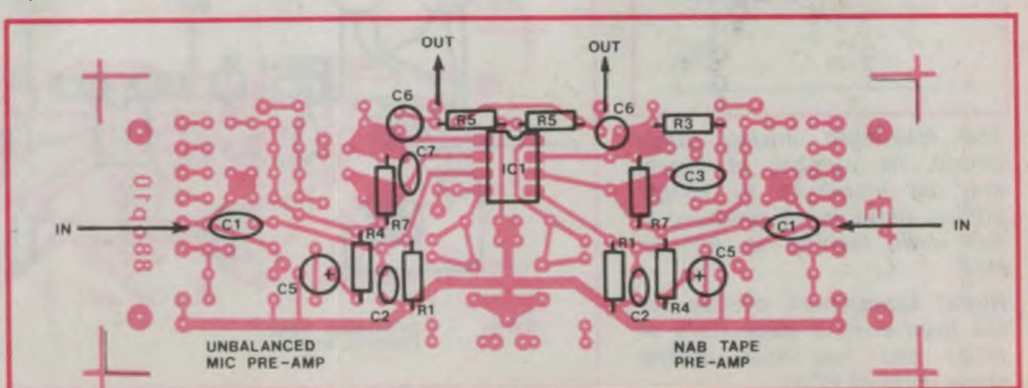
In our circuit, R8 pads the impedance of the non-inverting input down to that of the inverting input, which may be calculated by the equation:

$$Rin = R6/(1+Att) = 914 \text{ ohms}$$

where: $Att = R1/(R1+R9)$

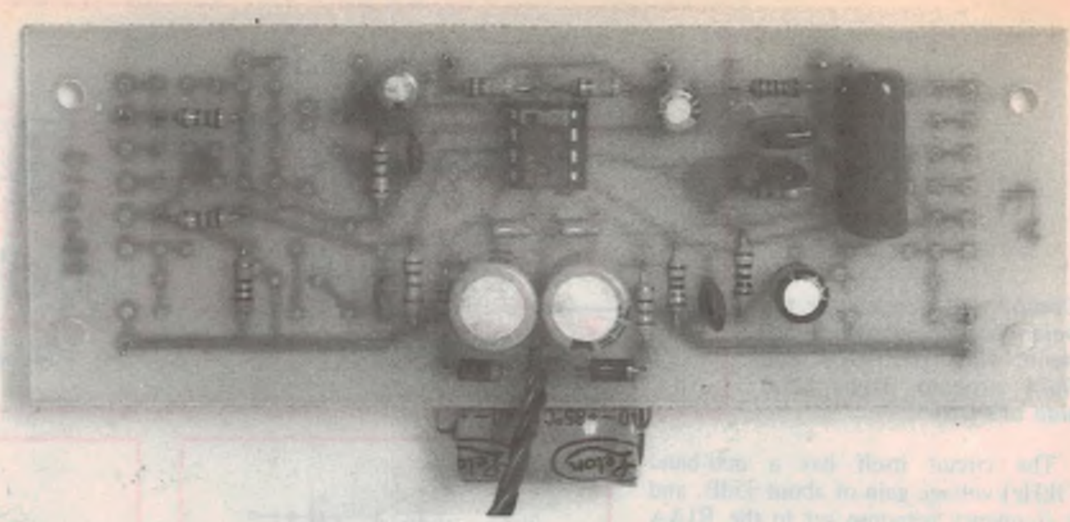
Therefore, to correctly pad the non-inverting input, R8 should have a value of 929 ohms, or the preferred value of 1k ohms.

The above calculation is important if this preamp is to be truly 'balanced', since differing impedances at the two inputs will unbalance the signal source – which invariably has some output im-



Component overlay for the unbalanced mic preamp (LHS of PCB) and NAB tape preamp (RHS of PCB).

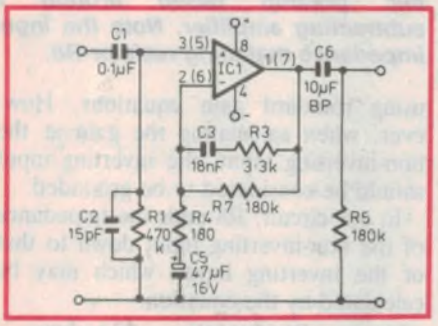
Preamp board



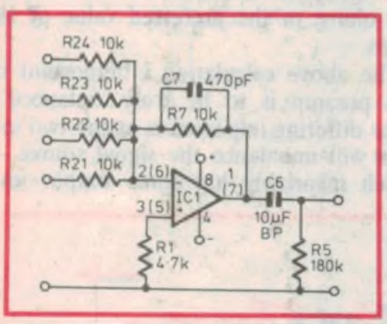
An assembled PCB showing the components installed for the balanced mic preamp, RIAA phono preamp and power supply 1.

pedance. This will dramatically reduce the preamp's ability to reject common mode interference.

In testing this circuit, the LM833 was put through its paces once again. The noise level was found to be a very low –92dB below the 100mV reference level, with a distortion figure of less than 0.01%. The common mode rejection ratio was tested at –85dB, which would be even better if close tolerance (or matched) resistors were installed.



The unbalanced mic preamp is based around a standard non-inverting op-amp stage, with the input impedance set by R1.



The four-input mixing stage circuit. Its number of inputs may be increased by simply adding more input resistors in the same fashion as R21 to R24.

Unbalanced mic preamp

This circuit is basically a standard non-inverting amplifier, with its gain set to about 30dB by R7 and R4. It has a relatively high input impedance of about 470k as set by R1, which allows it to be used with high or low impedance microphones. Naturally, this circuit could be used wherever a high input impedance, high gain stage is required.

To reduce the sub-sonic signals generated by microphone handling noise, the low frequency response is limited to about 19Hz by the filtering action of R4 and C5. Conversely, the high frequency response is restricted by the capacitors C7 and (depending upon the source impedance) C2.

Mixing stage

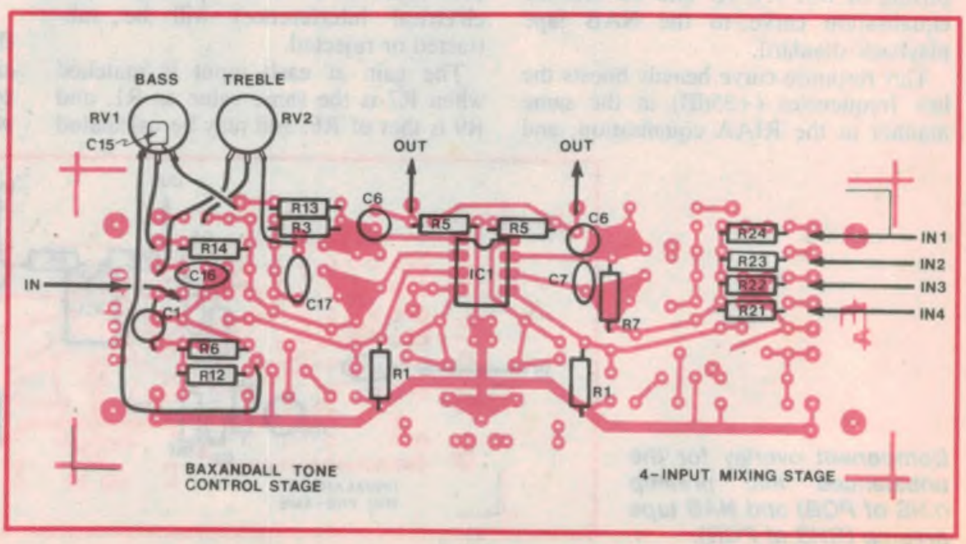
This stage is a standard virtual earth summing amplifier, and is used to add (or mix) a number of inputs to produce a single result. For example, a series of microphone preamps may be mixed together in this stage, and the output used to drive a power amp or other signal processors.

The gain for each input is set by its series resistor (in this case R21 to R24) divided by the feedback resistor R7. The gain of the whole stage may be varied by simply replacing R7 with a suitable potentiometer. Again, the high frequency response is restricted by C7 and the op-amp input currents matched by the addition of R1.

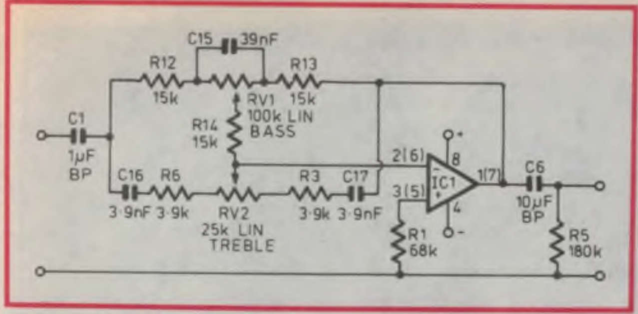
Tone control stage

A Baxandall type tone control stage uses two distinct feedback networks around an inverting amplifier, one for low frequency (Bass) adjustment, and the other for high (Treble) frequencies.

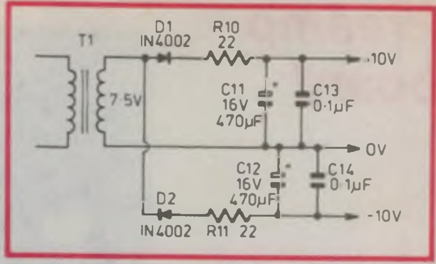
The Treble network is composed of R3, R6, C16, C17 and RV2, and may be regarded as open circuit at low frequencies, due to the high impedance of C16 and C17. However, at high fre-



Right: Component overlay for the tone control stage (LHS of PCB) and four-input mixing stage (RHS of PCB).



Left: The tone control circuit uses the familiar Baxandall feedback network to control the level of bass and treble frequencies.



Power supply 2 configuration: This arrangement will suit an AC plugpack style of transformer.

quencies the stage may be regarded as a normal inverting amplifier, with a series input 'resistor' comprised of C16, R6 and one section of RV2. Since the feedback 'resistor' is formed by C17, R3 and the remaining section of RV2, the gain of this stage will depend upon the ratio of these two 'resistors'. As may be seen from the circuit, this ratio is determined by the 'Treble' potentiometer RV2.

The Bass network of this stage is formed by R12, R13, C15 and RV1, and may be analysed in a similar manner to the Treble network. The series input 'resistor' in this case is comprised of R12 and one section of RV1, while the feedback 'resistor' is R13 and the remaining section of RV1. Once again, the ratio of these resistors is determined by the level potentiometer RV1, which is bypassed at high frequencies by C15. The additional resistor R14 is included to reduce the loading effects between the two networks.

Power supplies

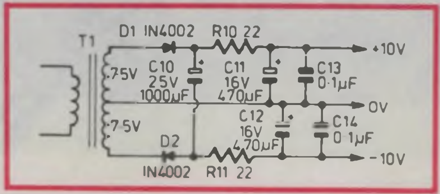
All of the above circuits require a split, or dual rail power supply between about +/-5 volts and +/-15 volts when used with most op-amps. We have elected to use power supplies delivering +/-10 volts, with the exception of the battery based power supply (number 4). This will supply about +/-4.5 volts, which may be a little low for op-amps such as the LM833, which have a minimum recommended rail supply of +/-5 volts. But in practice, we have found that this device will perform quite satisfactorily from the lower voltage.

The type of power supply chosen for the selected audio circuit will depend upon the availability of a suitable voltage source (AC or DC), and the final application. The described power supplies should cover most situations.

Power supply 1

This supply employs a transformer with two secondary windings, or a centre tapped single winding. Each section is half wave rectified (by D1 and D2), and applied to a filter network consisting of R10, R11, and C10 to C14.

The positive supply rail is filtered by R10 and C11, with C13 providing a high frequency bypass to ensure the op-amp's stability. The negative rail is similarly treated by R11, C12 and C14. To reduce output ripple, C10 has been included as extra filtering between the supply rails, which acts as further reservoir between half cycles.



Power supply 1 configuration: Note the addition of C10 to provide additional filtering for the more sensitive circuits.

If the final unit is to be mains powered and housed in a separate case, a transformer with a split (or dual) secondary should be used with this power supply configuration. However, if the circuit board is to be installed into an existing piece of equipment, this configuration may be supplied from a spare split winding of the equipment's existing power transformer.

Power supply 2

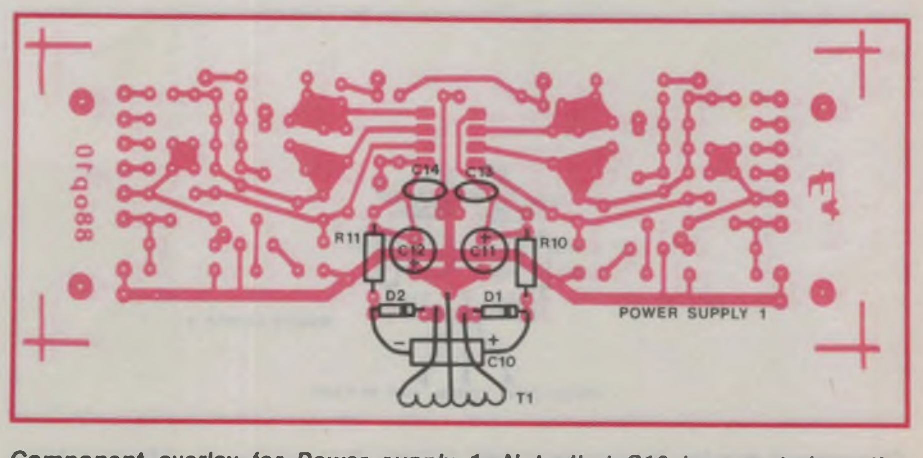
The rectifying and filtering process of this supply is identical to that of power supply 1, with the exception of the transformer configuration – only a single winding is required. In this case each alternate half cycle is rectified to produce the two supply rails. Since the half cycles are passed to each rail in an alternate fashion, the extra filter capacitor (C10) of power supply 1 will provide no extra benefit, and has not been included.

This power supply configuration is the logical choice when only a single transformer winding is available, such as the AC output of a plugpack. However, the ripple content may be a little high for heavily equalised, high gain circuits such as the RIAA and NAB preamps. In this situation, another configuration should be used or additional filtering included.

Power supply 3

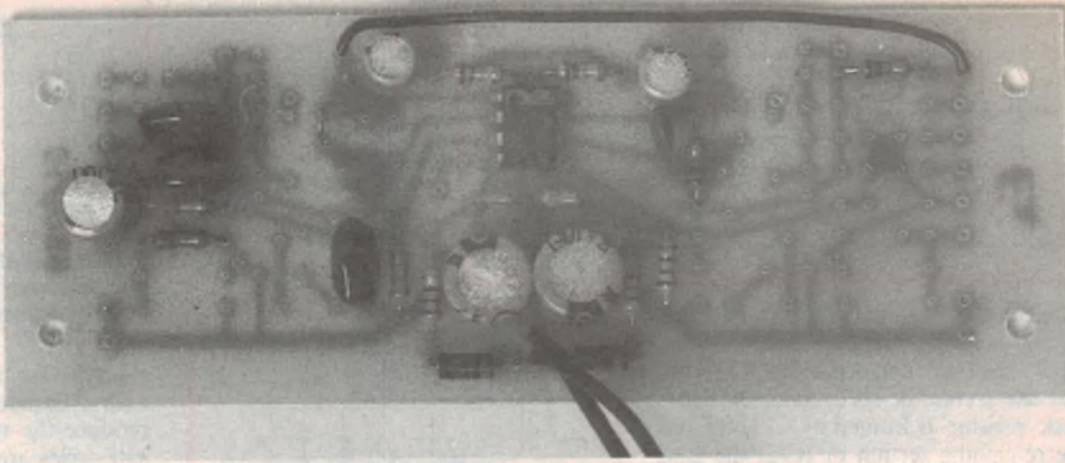
A typical application of the described circuits may be to install a preamp or tone control stage into an existing audio amplifier. In this case, a spare transformer winding is unlikely to be available, and the amplifier's DC supply rails must be used to power the circuit board. For this situation power supply 3 is required.

Each half of this supply is composed of a standard zener diode regulator circuit (R10, R11, ZD1 and ZD2), with output filtering as previously described. The two diodes (D1 and D2) are in-



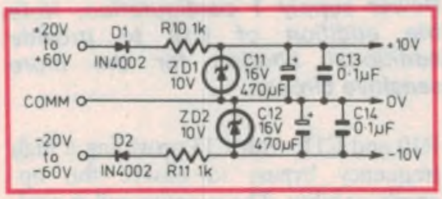
Component overlay for Power supply 1: Note that C10 is mounted on the underside (copper side) of the PCB.

Preamp board



An example of the PCB used in other applications. The LHS is arranged as a second order low-pass filter, while the RHS is a unity gain inverting amplifier.

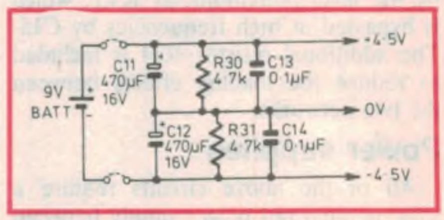
cluded to prevent the output voltage from being rapidly discharged by the collapsing source voltage, which occurs when the amplifier is turned off. Consequently, the preamp's supply voltage is maintained until the power amp has shut down, which in turn prevents any discharging transients (from the preamp) from being transferred to the loudspeakers. In effect, this is a dethump facility.



Power supply 3 configuration: This arrangement will produce a stable low voltage supply from existing higher voltage rails.

Power supply 4

Where a low cost portable design is required, this circuit may be used to generate a pseudo balanced power supply of +/-4.5 volts. In most audio circuits, virtually all of the power supply current flows from the positive rail to the negative rail, with very little DC current flowing in the common or zero-volt line. In fact, this line is more of an

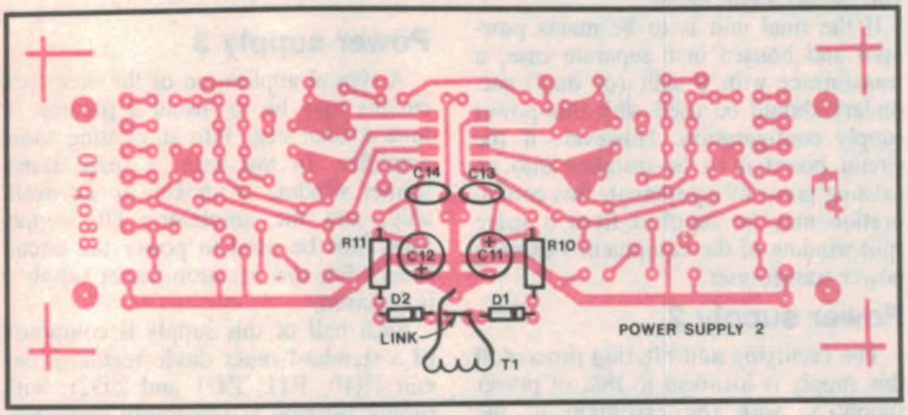


Power supply 4 configuration: This single battery arrangement produces a pseudo zero-volt line by the voltage divider action of R30 and R31.

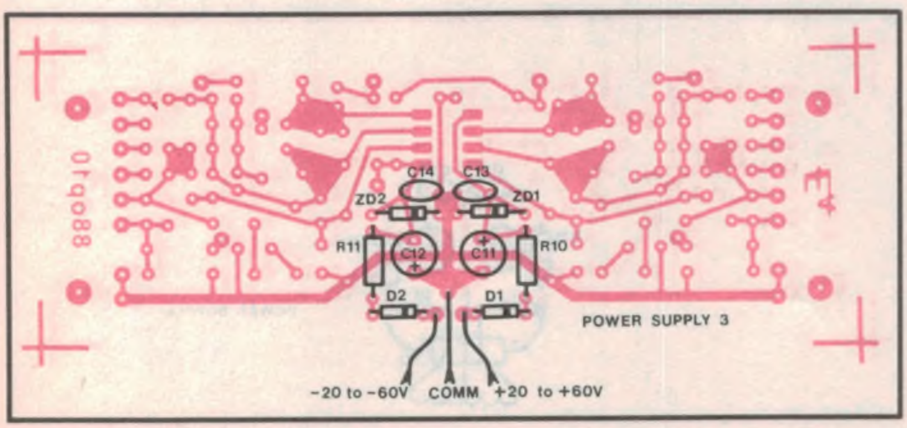
AC reference and is held to a low impedance by the action of C11 and C12, which allows the DC referencing resistors (R30 and R31) to be a reasonably high value. The aim of course, is to keep the battery current consumption to a minimum.

For a higher supply rail and increased output headroom, two 9 volt batteries may be wired in series, with their centre connection taken to the zero-volt line. In this case, R30 and R31 may be omitted.

When using one battery or any other single DC source, the negative side of this source may be tied to ground or the common connection of other circuitry. In this situation the input and output of our circuit is biased at half of the supply rail, and must be AC coupled to the other circuitry. The resistor which establishes the DC potential at the output



Above: The component overlay for Power supply 2.



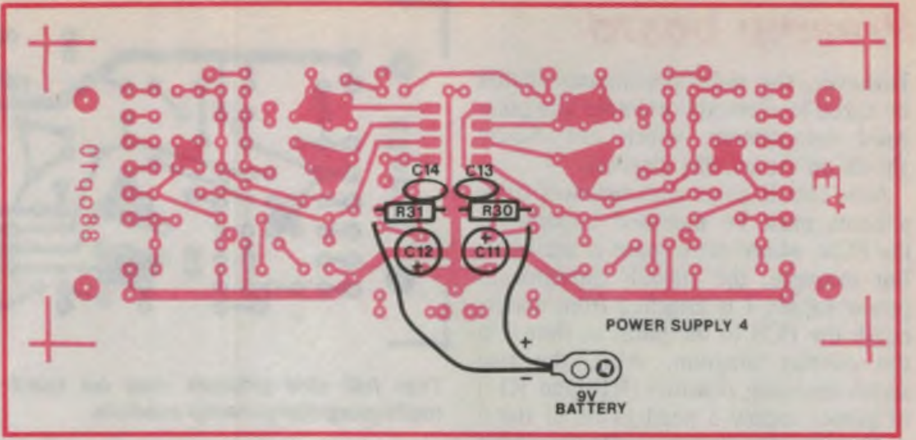
Component overlay for power supply 3: Note that for supply voltages above 35 volts, R10 and R11 should be 5 watt types and mount underneath the PCB.

(R5) is normally returned to the common line, as shown in the component overlays. In the above circumstances, this resistor should now be connected to the negative rail (now the common point) via the alternative pads on the PCB.

Construction

Once the components have been selected for the chosen audio stage/power supply combination, and the PCB checked for any etching anomalies, the construction may begin.

Assembling selected components on the PCB is quite straightforward, and there should be little difficulty in constructing any of the described circuits.



Component overlay for power supply 4. See text for the alternative connections when using two batteries.

PARTS LIST

All versions

1 PCB code 88op10, 125 x 45mm
1 dual op-amp, LM833 or similar
1 10uF 50V bipolar electrolytic
1 180k 1/4W resistor

RIAA preamp

Resistors

(1/4 watt, 5%): 1 x 56k
(1/4 watt, 1%): 1 x 200 ohms (R4), 1 x 9.1k(R2), 1 x 100k (R3)
Alternative resistors (1/4 watt, 5%): 1 x 390 ohms (R4), 1 x 18k (R2), 1 x 220k (R3)

Capacitors

1 47uF 16V PC-mount electrolytic
1 0.47uF metallised polyester
1 27nF metallised polyester (C4), alternative: 15nF
1 8.2nF metallised polyester (C3), alternative: 3.9nF
1 82pF ceramic

NAB preamp

Resistors (all 1/4W, 5%)

1 x 180 ohms, 1 x 3.3k, 1 x 180k, 1 x 470k

Capacitors

1 47uF 16V PC-mount electrolytic
1 0.1uF metallised polyester
1 18nF metallised polyester
1 15pF ceramic

Balanced mic preamp

Resistors (all 1/4W, 5%)

1 x 1k, 2 x 1.8k, 2 x 56k

Capacitors

2 x 82pF ceramics

Unbalanced mic preamp

Resistors (all 1/4W, 5%)

1 x 1.8k, 1 x 56k, 1 x 470k

Capacitors

1 10uF 16V PC-mount electrolytic
1 0.1uF metallised polyester
1 15pF ceramic

Mixing stage

Resistors (all 1/4W, 5%)

1 x 4.7k, 5 x 10k

Capacitors

1 470pF ceramic

Tone control stage

Resistors (all 1/4W, 5%)

2 x 3.9k, 3 x 15k, 1 x 68k

Potentiometers

1 x 25k linear, 1 x 100k linear

Capacitors

1 1uF 50V bipolar electrolytic
1 39nF metallised polyester
2 3.9nF metallised polyester

Power supply 1

1 transformer, 7.5-0-7.5V AC at 150mA (or similar)

Resistors

2 x 22 ohm, 1/4 watt 5%

Capacitors

1 1000uF 25V axial-mount electrolytic
2 470uF 16V PC-mount electrolytics
2 0.1uF monolithic ceramics

Semiconductors

2 1N4002 diodes

Power supply 2

1 transformer or AC plug pack, 7.5V AC at 200mA or similar

Resistors

2 x 22 ohm, 1/4 watt 5%

Capacitors

2 470uF 16V PC-mount electrolytics
2 0.1uF monolithic ceramics

Semiconductors

2 1N4002 diodes

Power supply 3

Resistors

2 x 22 ohm, 1/4 watt 5%
2 x 1k, 1 or 5 watts (see text)

Capacitors

2 470uF 16V PC-mount electrolytics
2 0.1uF monolithic ceramics

Semiconductors

2 1N4002 diodes
2 10V 1 watt zener diodes

Power supply 4

Resistors

2 x 4.7k ohm, 1/4 watt 5%

Capacitors

2 470uF 16V PC-mount electrolytics
2 0.1uF monolithic ceramics

Preamp board

However, the usual precautions should be taken to correctly orientate any polarised components, which are clearly shown on the overlay diagrams.

Note that in some circumstances components must be mounted underneath the PCB, where more space is available. For example, the 1000uF capacitor in power supply 1 is attached from underneath the PCB to the pads, as shown in the overlay diagram. Also, the two series dropping resistors (R10 and R11) of power supply 3 need to be of the 5 watt type for source voltages above about 35 volts, and need to be mounted underneath the PCB.

If the available components are too large or small for the indicated positions, there will usually be an alternative pad position to suit the spacing of this component. In fact, it is quite easy to chop and change the layout of a given design to suit most physical requirements. Such are the joys of a multi-purpose PCB!

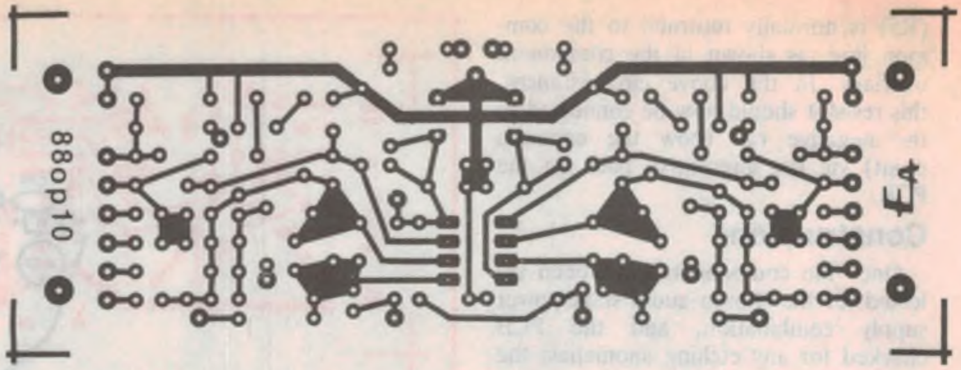
Component changes

Although the described circuits have been tested with the component values as shown, the performance parameters may be modified quite easily. By using standard op-amp equations and noting the text for each of these circuits, alternative components may be calculated to satisfy most requirements.

Depending upon the associated circuitry, many of these circuits may be direct coupled by omitting the input and output capacitors. However, bear in mind that the input bias current of a typical bi-polar op-amp (such as the LM833), will produce a slight *positive* offset voltage at its input terminals. Also the output will tend to compensate by sitting at a slightly *negative* potential.

These small offsets may be used to advantage if the circuit does not have to cope with external DC levels. That is, the more expensive bipolar style capacitors may be replaced with standard polarised electrolytics, and biased with these offset voltages in mind.

So there it is, a universal function block that should have many times the number of applications we have shown. There's no doubt it will be popping up in the future for other two op-amp circuit requirements. In fact, the PCB has been designed with active filters in mind – a subject we have not recently covered...yet!



This full size artwork may be used to etch your own PC boards for the multi-purpose preamp module.

Construction project:

16-channel UHF Remote Control – 1

Here is part 1 of the description of a complete remote control system which offers features rivalling commercial units, but at a fraction of the cost. The system can be used to remotely control many different appliances such as alarms, central locking systems, door openers and much more. It features 16 channel operation, a range in excess of 200 metres, easy construction, high security and an expandable design. We start with the transmitter...

by BRANCO JUSTIC

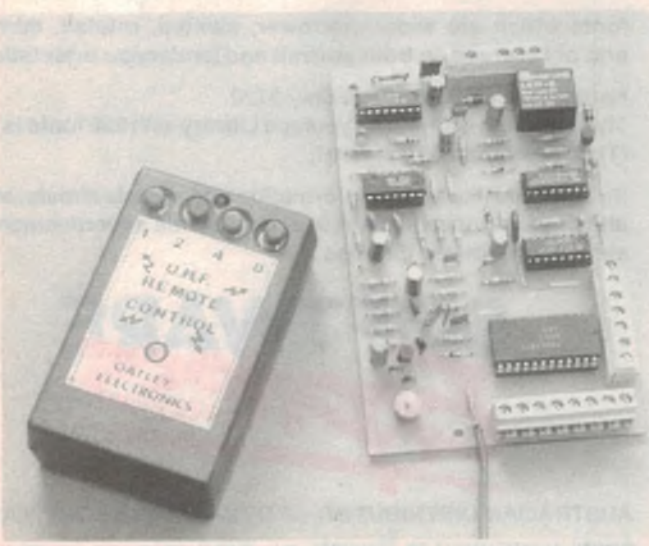
Over the next few months we will present a complete UHF remote control system, intended for applications such as remote switching of alarms, appliances – in fact anything needing remote control on-off operation.

The system features a 16-channel transmitter that can control one or more receivers, which in turn operate up to four, 4-channel relay/indicator PCBs.

The whole project is designed to be both flexible and inexpensive, and the choice is yours as to how sophisticated the final result is. For example, a receiver using only 2 channels could be installed in a car to allow remote activation of the car alarm and/or operation of a central locking system. Another receiver, also operating from the same transmitter, could be installed in your house to control lights, door openers, appliances and so forth.

Maybe you just want bedside on-off control of the TV, or perhaps activation of the house alarm that you forgot to set before bedtime.

Because the system has 16 channels, a house alarm could be arranged into 'zones', allowing the various detectors to be activated independently; a feature not normally found on commercial wireless controlled alarm systems. The system is tamper-proof, has nearly 5 million user selectable codes, providing high security combined with simple construction and low cost. What more could one ask for?



The transmitter and the associated receiver module. The receiver will be described next month.

System details

The complete system starts with a 16 channel UHF transmitter, fully described in this article. Next month the receiver/decoder will be presented, followed later by the 4 channel relay-indicator board and how to interface it to the devices being controlled.

Because many readers may not want full 16 channel operation, the relay board has been kept to 4 channels only, to minimise cost and complexity. If you want to use all 16 channels to operate 16 independent devices, you simply expand the system up to its maximum of four relay boards. Alternatively, a number of receivers (up to 4), each with one 4 channel relay board can be used; versatility that should solve any typical remote control situation.

The system has numerous features, many of which are not found on commercial systems. Foremost is ease of construction and alignment, made possible by printing the important frequency determining inductors on the PCB pattern. Equally important is the security of the system. As already mentioned, the unit has lots of codes – 4,782,969 to be exact, which should be daunting enough in itself. However, today's hi-tech criminals have been known to employ sophisticated scanners that simply

cycle through every possible key combination of a particular alarm system. Although it may take quite a few hours for such a scanner to crack the code for this system – maybe enough time to attract attention to the miscreant, that's only the first hurdle.

Incorporated in the receiver is circuitry that can be used to activate an alarm if the first correct code is not followed by the remaining code in a limited time. How's that for a tamper-proof system?

The transmitter is battery powered, as would be expected. However, the receiver also consumes a very low standby current, and can also be battery powered. The main power consumption is in the relay board, but provision for powering dual coil latching relays has been made if battery powered operation is required for the whole system. This type of relay only consumes power while changing state; otherwise it requires no power. However, for each of the relays supplied with the kit from Oatley Electronics, a current of 30mA is required.

Typically, a complete receiver/4-channel relay board combination can be powered by most types of 12V AC-DC unregulated plug-packs.

The operation of the unit can be selected to either pulsed or toggle mode. In pulse mode the selected relay operates while the transmitter pushbutton is held. Toggle mode allows a relay to be turned on with a pulse, then off with a following pulse. If desired, an audible signal from a buzzer can be used to indicate each time any one of the channels is turned on or off; a short beep for ON, a long beep for OFF. Typically, the range for reliable operation is 200 metres or more, depending on conditions.

Regular readers may also remember, or have built, the single channel UHF remote switch presented in January 1987. If you don't require the 'tamper-proof' feature, the alarm channel of the system being described here can be used as a 17th channel, (with far less code combinations) in conjunction with the January 1987 transmitter. More details on this will follow when the receiver is presented.

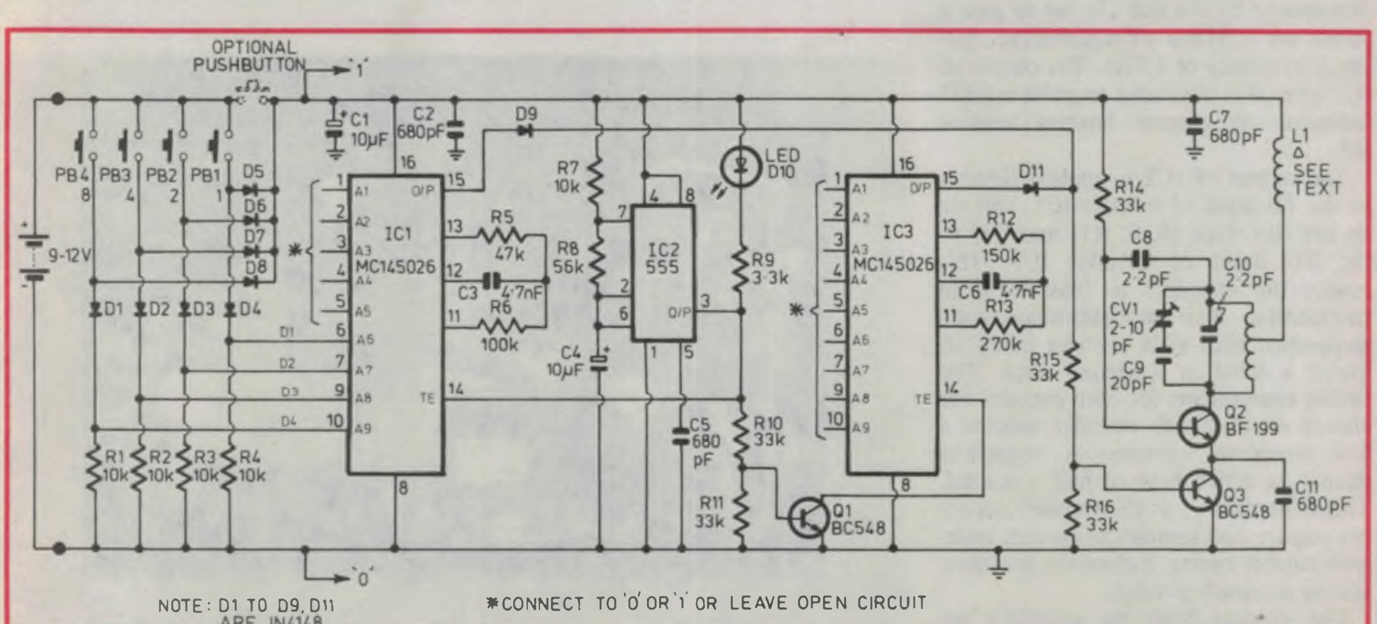
Transmitter circuit

The encoding section of the transmitter is based on the Motorola MC145026 IC. This device was used in the January 1987 UHF remote switch, where it was used to provide 13122 possible code combinations and single channel operation.

The transmitter being described here uses two of these ICs to obtain a security code which has almost 5 million combinations, transmitted in conjunction with a 4 bit data code determined by the status of the pushbuttons. The data is only passed to the output of the receiver if the correct code precedes it.

Timing components R5, C3, R6 and R12, C6, R13 determine the rate of the code sequence transmission for IC1 and IC3 respectively. The timing components used in the receiver's decoder section are chosen to match the transmission rate. If the delays are different, the receiver would not accept an otherwise valid code.

The particular codes generated by the encoders (IC1 and IC3) depend on the states of their address lines (A1-A9). These lines can be connected to the supply line ('1'), ground ('0') or left open circuit (O/C). Note however that the last four address lines (A6-A9) on IC1 are treated as data lines (D1-D4),



The transmitter circuit diagram. The unusual arrangement of the trinary encoders, ICs 1 and 3, allows nearly 5 million user selectable codes. IC2 alternately activates the encoders and drives the LED indicator when the unit is transmitting.

as the information on these lines depends on the status of the pushbuttons. With the pushbuttons pressed, the lines are connected to the supply ('1') via isolating diodes D1-D4. Otherwise, when the pushbuttons are released, they are grounded ('0') via resistors R1-R4, allowing up to 16 possible binary codes, depending on which buttons have been pressed.

Individual pushbuttons can be treated as individual channel controls; CH1 to CH4, or in a binary combination. More on all this, however, when the receiver is presented.

For the purposes of describing the circuit's operation, we will assume that pushbutton 1 (PB1) is pressed. Under these conditions, power is applied to the circuit via isolating diode D5, and address line A6 (pin 6 – IC1) is pulled to a logic 1. If IC1 was now enabled by applying a '0' to pin 14 (TE), it would continuously send out a code sequence at pin 15, dependent on the A1-A5 inputs (soldered links), followed by the data on the A9-A6 inputs as set by the pushbuttons – currently equal to the binary code 0001. Similarly, if encoder IC3 was enabled (TE = '0'), it would also send out a code sequence selectable by the soldered links at its address inputs, A1-A9.

However, these ICs are alternatively enabled by the 555 timer IC2, which is connected as an astable multivibrator. The frequency of operation is mainly determined by R8 and C4, set to give a 300ms on – 300ms off squarewave, giving a frequency of 1.7Hz. The output of IC2 (pin 3) is also used to pulse a LED indicator via current limiting resistor R9.

The output of IC2 is applied directly to the TE input of encoder IC1, and via an inverter stage (R10, R11 and Q1) to the TE input of encoder IC3. This causes the encoders to take turns in transmitting their predetermined code sequences, with each encoder being allowed a third of a second each. The timing components for each encoder are chosen so that each encoder outputs a few complete transmission sequences during its active time of half a second. This is necessary, as the receiver decoders require two samples of correct code, with correct timing, before the transmission is accepted as valid.

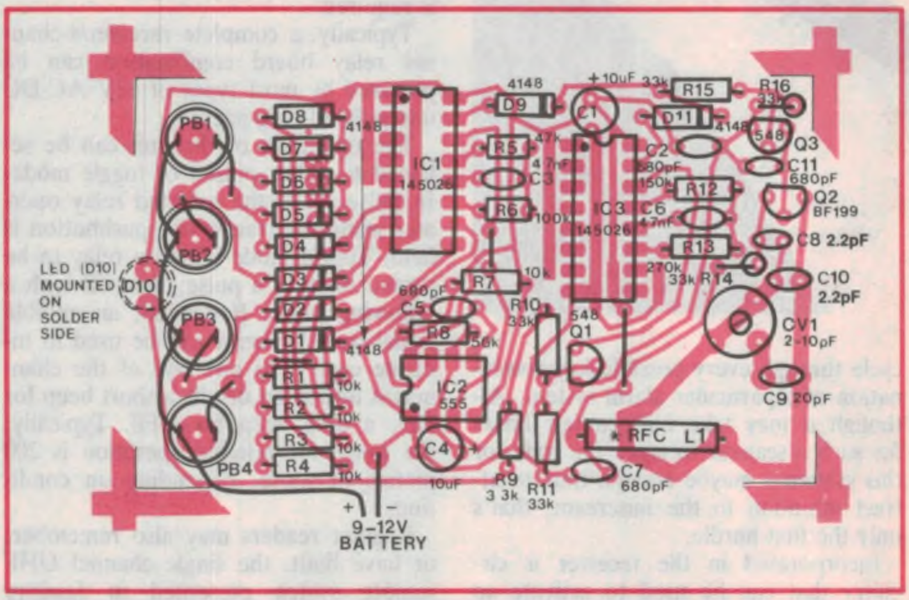
The outputs from the encoders are connected via isolating diodes D9, D11 and resistor R15 to the base of the switching transistor Q3. This transistor simply provides a ground return for the UHF oscillator, and therefore switches the oscillator on and off in synchronism with the code sequences.

Transistor Q2 and its associated components make up a Hartley oscillator whose frequency is adjusted to 304MHz by means of trimmer capacitor CV1 and C9. The total capacitance of CV1, C9 and C10 in conjunction with the printed inductor (PCB pattern) make up the resonant tank circuit, while C8 provides the necessary feedback and the RFC (L1) partially isolates the stage from the power supply.

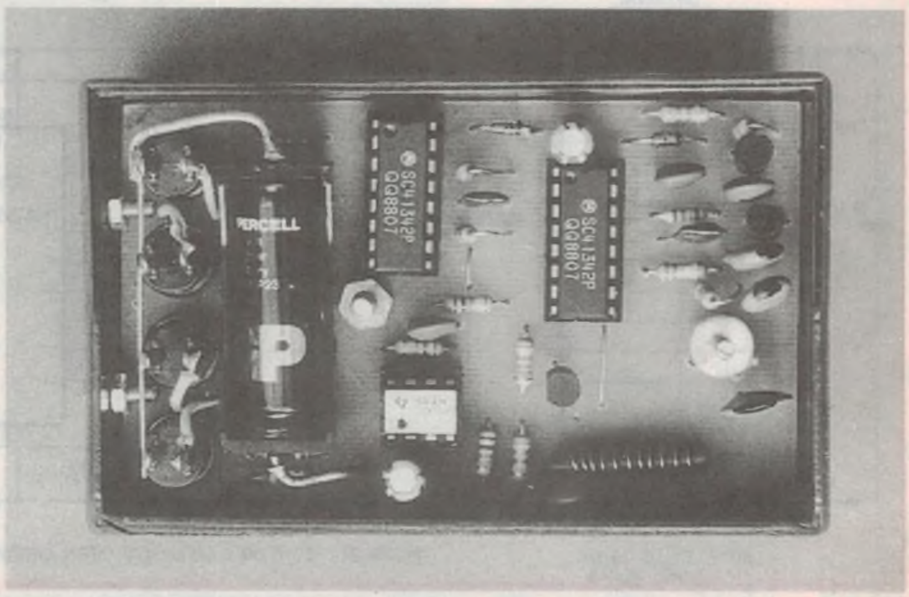
Making the transmitter

A complete kit of parts for this project is available from Oatley Electronics. The kit is complete (as per prototype photograph) and also includes the 12V battery.

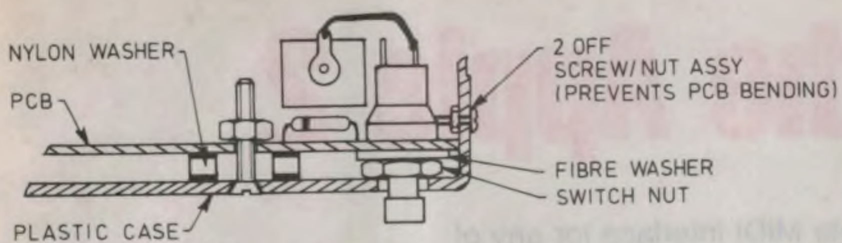
Before assembling the PCB, use the blank PCB to locate the hole positions on the plastic case for the 4 pushbuttons, the mounting screw and the LED indicator. Once located and marked, carefully drill these holes to a size that allows each pushbutton and the LED to project through the case. Countersink the hole for the mounting screw, being



The layout for the transmitter. The battery holder sits over the row of diodes D1 to D8 and is supported by its connecting wires.



The prototype, slightly larger than actual size. A piece of tape is recommended to hold the battery firmly in the holder.



To make sure the PCB doesn't flex when a pushbutton is pressed, fit two stop screws in the end of the case as shown.

careful not to drill the countersink right through the plastic!

The inductor L1 (RFC – value not critical) is made by winding 10 turns of the supplied enamelled copper wire on the small cylindrical ferrite core. The turns should be equally spaced to occupy the full length of the rod, and a dab of glue applied to prevent the core from moving within the winding. The supplied wire can be soldered without scraping off the insulation, and we recommend that the ends be tinned before the inductor is finally mounted on the PCB, as the tinning process takes a few seconds.

Next, mount and carefully solder all the components on the PCB, with the ICs last. Watch particularly for correct orientation of the diodes, transistors, ICs and electrolytic capacitors.

Finally, attach the battery holder to the PCB using solid copper wire (1mm) connected between both ends of the holder and to the PCB. The holder sits above the row of diodes, and the positive end connects to the push-buttons' common rail. It may be necessary to place a cable tie around the battery holder to ensure that the battery does not shake loose during use. Also, to prevent the PCB flexing when the push-buttons are operated, drill the case and fit two screw/nut combinations as shown in Fig.1.

Testing & adjustment

The frequency of the oscillator should already be very close to the allocated frequency of 304MHz, thanks to the use of printed inductors. However fine tuning using a frequency counter is recommended.

To enable the oscillator to run continuously for this adjustment, a wire link can be inserted between the cathode of D8 and the positive supply rail (positive battery terminal). The frequency counter should be loosely coupled to the output tank circuit, and the trimmer capacitor C9 adjusted with a non-metallic screwdriver so that the frequency counter shows 304MHz.

By 'loose coupling' here we mean fitting a small 1-turn loop of insulated hookup wire to the end of the counter's lead, and holding this loop just near enough to the tank circuit's printed inductor to produce reliable readings.

Note that a functional transmitter should cause interference when placed very close to the antenna terminals of a TV set, or when next to the ferrite antenna of an AM radio. But because the power output of the transmitter is around 9 microwatts, it will not cause interference in normal use.

For now, there is little more that can be done until the receiver is presented. It still remains to code the transmitter, which should be done in conjunction with coding the receiver, as the two have to match.

The supplied circuit boards for both the transmitter and the receiver have all the address lines left open-circuit, allowing initial testing of the transmitter-receiver combination to be undertaken prior to coding – as both codes, by default, are the same.

The final code you select, from the millions available, is achieved by setting each address line (A1-A5 for IC1, A1-A9 for IC3) to either a logic 0 (ground), a logic 1 (supply), or by leaving it open-circuit. Note that the MC145026 chips regard an open-circuit on the address lines as quite distinct from either a logic 1 or logic 0 – giving three possible input levels.

However, it is strongly recommended that the code you wish to use be applied after the receiver has been built, and correct operation has been confirmed. And that can all happen next month...

PARTS LIST - TRANSMITTER

1 PCB coded OE88T
1 plastic case - 31mm x 55mm x 90mm
4 push button switches (normally open)
1 12V lighter battery holder
1 ferrite former (for RFC)
Enamelled copper wire, screws, nuts, hook-up wire.

Resistors

All 1/4W, 5%: 1 x 3.3k, 5 x 10k, 5 x 33k, 1 x 47k, 1 x 56k, 1 x 100k, 1 x 150k, 1 x 270k

Capacitors

2 2.2pF disc ceramic
1 20pF disc ceramic
4 680pF disc ceramic
1 2-10pF trimmer
2 4.7nF metallised polyester
2 10uF 16VW low leakage electrolytic

Semiconductors

10 1N4148 signal diodes
1 red LED
2 BC548 transistors
1 BF199 transistor
1 555 timer IC
2 MC145026 trinary encoder ICs

Kits of parts for this project are available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985

Postal Address (mail orders):

PO Box 89, Oatley NSW 2223.

The prices for the kits associated with this project are:

Complete transmitter kit (battery included)...............................$34.95
Receiver/decoder PCB and components kit......................$59.95
Four relay driver/indicator PCB and components kit..................TBA
Small transmitter (EA January 1987).................................... $16.50
Post & Packing charge $3.00

NOTE: Each kit will only be available after publication in Electronics Australia.

The printed circuit artwork for this project is owned by Oatley Electronics, and may not be reproduced commercially.

Construction project:

MIDI on the Apple 2

Here's a cheap, simple but complete MIDI interface for any of the Apple 2 series computers. Plug it into a slot, and record or playback is a matter of some simple programming. Real-time MIDI music is now within any Apple 2 owner's grasp.

by PETER PHILLIPS

OK, so the IBM PC and its clones are the flavour of the month. But some of us are not ashamed to admit that we still use an Apple on the odd occasion. And there are those, particularly the more musically inclined, who are likely to have an Apple 2GS.

Readers may remember the days when third party developers were all anxious to scramble onto the Apple bandwagon. The result was a plethora of plug-in cards – including, I presume, a range of MIDI cards. But then came the IBM. Also, Apple put a stop to the clones of its machine, and before long the public realised that the best crunch per dollar was from the IBM stable. So, almost overnight, the Apple's popularity fell as the faithless public turned to the new '16-bitter' from IBM.

Fighting back, Apple has produced the 2GS, which features a 16 bit micro and an Ensoniq synthesiser IC. Also, the Apple 2e is still relatively popular, particularly in the education field, as it is a friendly machine, still well supported with software.

So the Apple isn't dead by any means, just not as popular as it once was. Unfortunately, price is often a barrier, and by the time you set yourself up with an Apple system, there's usually not much left for peripherals.

Like so many ideas, this project sprang into being as a result of an empty wallet and the need to get into MIDI. Apple sells a rather neat little MIDI interface for the 2GS, operating from the serial port. Although I've not used one (it's a bit expensive for what I want), I assume it is compatible with the current crop of 2GS software. But then, I didn't want a 2GS only device. My needs aside, such a project would probably not arouse sufficient interest with our readers to make it worthwhile.

Basically, what I wanted was a means of recording from a keyboard (real-time stuff), with playback from the recording available as required. Software could handle all the other features I might like, such as editing, graphics, sequencing, even step-time music. Any computer would do, providing it could be suitably programmed, which made an Apple 2+ ideal from my point of view.

The missing link was the hardware interface, and my research in this area convinced me it should be relatively easy. And I was proved right. The result is a very standard plug-in card; almost an anti-climax it seems.

By the way I'm assuming in this article that you're already familiar with the MIDI system. If not, a helpful introduction to the subject was given in the article 'Inside MIDI', published in the January 1988 issue of *EA* .

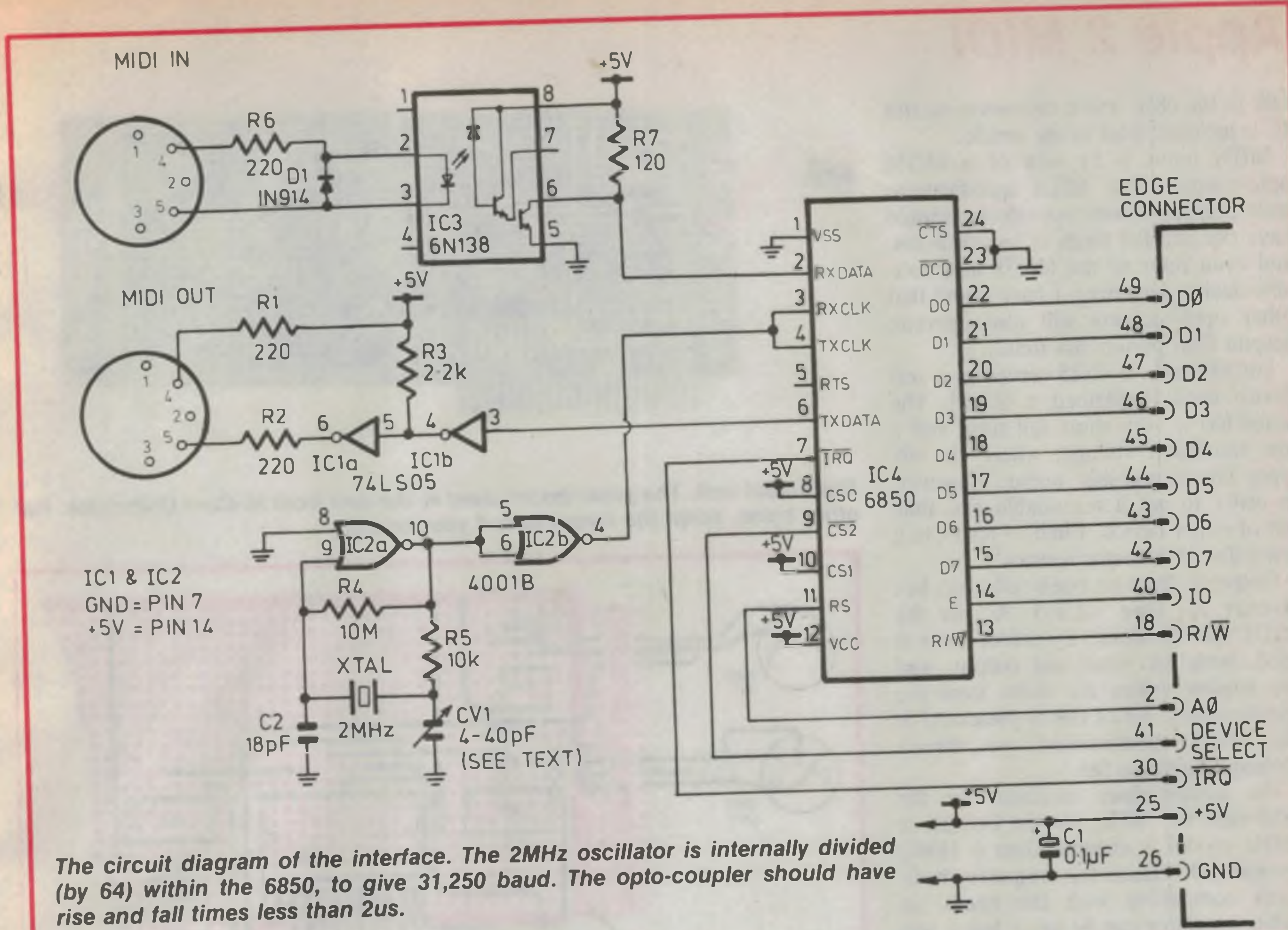
The card

Over recent years, MIDI interfaces for various computers have been presented. Readers may recall our universal version presented in *EA* for February 1988. This particular interface operates by way of a Centronics parallel printer port, and provides only a MIDI-out facility.

The advantages of this approach are the inherent universality and cheapness of the unit. However, it lacks the MIDI-in facility, as a printer port is essentially a one way device. This may not be a problem if step-time programming is all that the interface is to be used for, which was its original purpose anyway.

But in my case I wanted input as well as output. The Apple has lots of ways of achieving this, assuming you have the right card. For example, I could see it would be possible to input through a printer card, or by the venerable games port. But all these schemes would need

All you need is a MIDI keyboard, our interface and an Apple 2 computer to get into MIDI driven music.



The circuit diagram of the interface. The 2MHz oscillator is internally divided (by 64) within the 6850, to give 31,250 baud. The opto-coupler should have rise and fall times less than 2us.

some tricky software. Apple themselves use the 2GS serial port for their MIDI interface, though I'm not sure how.

Obviously the serial port must be able to receive data and pass it into the computer at a higher rate than the MIDI interface. But the serial port on the 2GS (like most computers) has a maximum baud rate of 19,200, while MIDI operates at 31,250 baud. They either have a big input buffer hidden in the small package, or manage to get the serial port to operate at or higher than the 31,250 rate. Either way, the software would need to handle all this, and allocate memory as a buffer area.

So, unless I wanted to indulge in tricky software, a plug-in card seemed the only way.

The restraint here is the cost of such a card. Like the IBM, the Apple slots are double-sided, and any PCB made for the project would fall into the $60 category. So the search was on for a way around this problem. Happily it was solved when I found a supplier of inexpensive Apple proto-boards.

We normally avoid using proto-typing boards in projects, as they impose difficulties for constructors who have limited experience in PCB work. However, because of the relative simplicity of the circuit, this option has been chosen, mainly in the interests of keeping the project costs to a minimum.

The circuit

As can be seen from the circuit diagram, the whole thing revolves around a Motorola 6850 asynchronous communications interface adapter (ACIA). For those not familiar with this chip, it's basically like a traditional UART device, but with an inbuilt baud-rate divider and software programming for both baud rate and data format.

The 6850 is a low cost IC and is commonly used in this kind of application, despite the data sheet's assertion that its maximum baud rate is 19,200. Because the software driving the card needs to

The unit will work on a 2GS or any Apple 2 series computer with slots. Software development is required, although our sample programs will get you going.

talk to the 6850, more discussion on this IC is included later in the article.

MIDI input is by way of a 6N138 opto-coupler. The MIDI specifications state that the chosen opto-device should have rise and fall times of less than 2us, and even refer to the 6N138 as a suitable device. However, I have found that other opto-couplers will also operate, despite their poorer rise times.

For example, a 4N25 served as a test device until I obtained a 6N138. The latter has a very short fall time and a low saturation voltage, where the 4N types are measurably worse. However, in order to get a reasonable rise time out of either device, I had to resort to a low value of collector resistor.

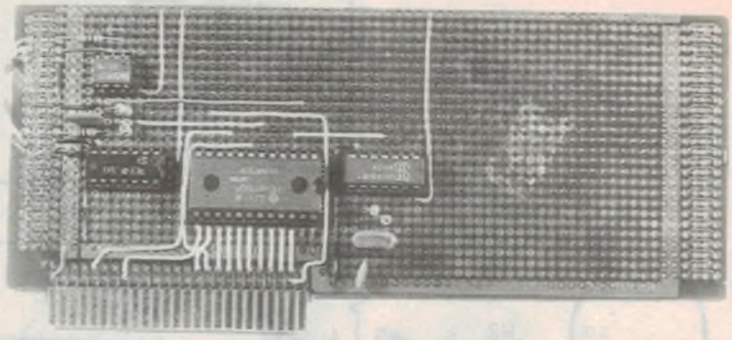
Output is from an open-collector, hex inverter IC, type 74LS05. As per the MIDI specifications, a current loop is used, both for input and output, and the resistor values are those from the specifications. All of this is presented in the MIDI specifications, so there's nothing original so far.

The master clock oscillator for the 6850 runs at 2MHz, chosen because a 2MHz crystal is cheaper than a 1MHz version and because this frequency is directly compatible with the needs. A 1MHz oscillator can be used, but it will need to be divided to give 500kHz input to the 6850.

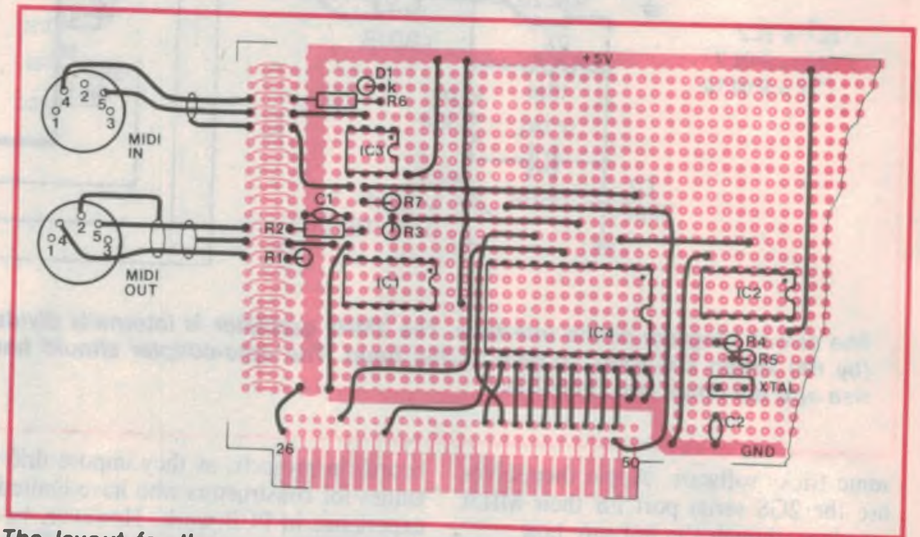
Why does a 1MHz clock need dividing down, when a 2MHz clock doesn't? I thought you might ask that. The answer is that to give the 31,250 baud rate needed, the divider chain inside the 6850 can be set to divide down by the 64 times needed from 2MHz, or the 16 times needed from 500kHz – but not the 32 times which would be needed from 1MHz.

The oscillator circuit itself is quite standard, and uses a CMOS 4001B quad NOR gate. Included in the circuit is an adjustable capacitor, labelled CV1, which may not be required. I found its adjustment fairly critical in order to avoid the crystal jumping into overtone operation, and producing a substantially higher operating frequency.

Not having the adjustable capacitor at all resulted in correct operation in my case, but because it provides adjustment on the degree of feedback, its inclusion may be necessary in your circuit. The best way is to try it and see. If the oscillator starts reliably and its frequency is correct at 2MHz, great. If not, include the capacitor, and adjust it accordingly. The output waveform should be a reasonable square wave of 5V p-p with a period of 0.5us.



The actual unit. The proto-board used is the one from Hi-Com Unitronics. For other types, adapt the layout to suit your board.



The layout for the component side of the board. The links pass though the pads as shown and connect to the required point on the 'track' side.

Construction

As can be seen, the circuit is very simple, and should present no problems to constructors, despite the proto-board approach. The layout diagrams are for the proto-board sold by Hi-Com Unitronics of Caringbah, NSW – although other types of board can be used. However, in this case, you would have to adapt the layout diagrams to suit whatever track/pad arrangement applies to your board.

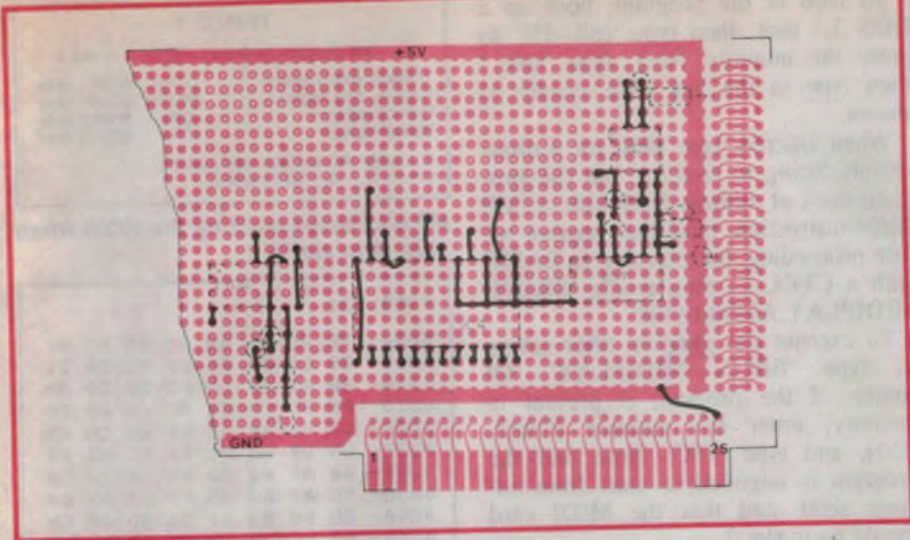
The board used in this case consists of a lot of stand alone double-sided pads, plus two rails that are intended for the power supply. The pads therefore provide only anchoring for the components, and links have to be added as required for the actual wiring. Telephone wire, or similar, is the most suitable as insulation is required in most cases.

Commence by locating the IC sockets. Although the layout diagram only represents one way of implementing the circuit, if you are going to follow it, then do so religiously. Otherwise, you are on your own. Once the sockets are located, it remains to attach the links and components.

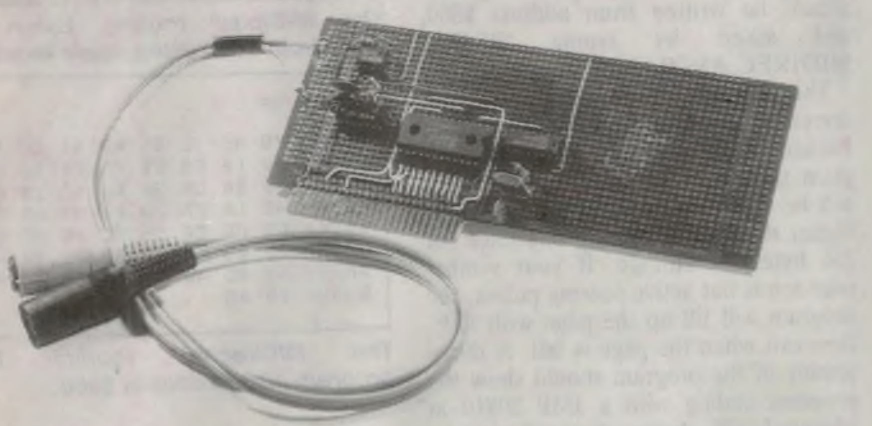
In keeping with the double-sided format of the board, links are required on both sides, as shown on the layout diagrams. Simply bare enough wire so that it can enter by one pad, and extend to the required pad on the other side.

I avoided using component leads to double up as links, as removal of the component would become difficult should this ever be necessary.

Take care when soldering, as the pads are fairly close together, making inter-pad shorts possible. It is not necessary to twist wires around the component lead or IC socket pin being connected to, as there is no mechanical strain on



The 'track' side. These links connect the top links to each required point, and also provide connections to the supply or ground lines.



A 'full-frontal', including the two leads required to connect the card to a MIDI instrument. Some type of mechanical termination of the leads to the proto-board is recommended.

the board and its components.

Once the whole circuit is built, and thoroughly examined for errors, I suggest initial testing before plugging it into the Apple. The first test is to determine that there are no short circuits between the power supply rails. Then, plug in the ICs (they all face the same way) and repeat the test. If all is well, next apply a 5V supply to the circuit and confirm that the total current taken by the board is around 150mA.

The only real test you can now perform is to ensure that the oscillator is working. Use either a CRO or a frequency counter to

determine that the oscillator is (a) functioning and (b) on frequency at 2MHz. Once all the above tests have been completed, it remains to try the big one.

I'm sure readers are aware of the need to switch off the computer before plugging in a card. The hard part here is turning it back on for the initial testing. Within the bounds of Apple's limitations, the card can be plugged into any socket. I suggest slot 2, the usual communications slot. Don't use slots 0 or 7 on the 2+, or slot 3 on the 2e or 2GS. Otherwise, it doesn't matter which slot you use, as the software is up to you.

So, gather the courage, plug in the card and switch on the Apple. If it beeps, excellent. If not, find out why.

I built two versions of the card and had no problems with either. In fact, I cannot see any real reason for things to go wrong, and for the card to destroy the computer.

Once you're this far, its a matter of turning to the software side.

The software

Writing a program for the card requires some knowledge of the 6850, as well as the Apple. It's all easy enough though, and a test program is include to help you along anyway. I am planning to develop some more elaborate software for the card, and this will be made available to readers when completed.

The 6850, like any UART, is actually two devices in the one package. Basically, the IC contains a transmitter and a receiver section, which each access the computer through a register. The *transmitter data register* (TDR) receives data from the computer and passes it on to the transmitting section. In this section, the data is serialised and transmitted to the outside world along with the specified start, stop and parity bits.

The receiver section accepts serial data from the outside world and holds it ready for the computer in the *receiver data register* (RDR) for subsequent parallel transfer to the computer.

Two other 8 bit registers are used by the 6850, referred to as the *status register* and the *control register*. The status register can be read by a program to determine if certain events have occurred, indicated by a particular bit in the register being set. The control register is used by the software to set the mode of operation of the 6850.

6850 details

As in any I/O program, the software can be either interrupt driven, or use polling to determine the status of the data transfer. The Interrupt Request (IRQ) line of the Apple's microprocesser is connected, via the slot to pin 7 of the 6850. The decision on whether to use interrupts or not is up to the user, and depends on your needs. More on this later, however.

Like any ACIA, the 6850 can be programmed to do all sorts of things, in this case using commands within the software. Other similar devices like the AY-3-1015 UART are hardware programmed with wire links. The control register is used by the 6850 for this purpose, and the function of each bit of the register needs to be understood. The following is a summary that should suffice.

Bits 1 and 0 are used for initial reset, and to set the clock divide ratio. Binary values 00, 01 and 10 give clock division ratios of 1, 16 and 64 respectively, while 11 is used for initial reset.

Bits 4, 3 and 2 determine the number of data bits, whether parity is used or not, and the number of stop bits. For MIDI, the code must be 101, giving 8 data bits, no parity and 1 stop bit.

Bits 6 and 5 deal with the RTS output (of no concern here), and enabling or disabling the transmit interrupt. Use 00

Apple 2 MIDI

for no interrupt or 01 to enable interrupt.

Bit 7 determines if receive interrupts are to be used. Set this bit to 1 if receive interrupt is to be enabled, 0 otherwise.

In the sample programs, the ACIA is first reset by writing a hex value of 03 to the control register. This sets bits 1 and 0 to a 1, causing the 6850 to reset itself – a software reset.

Next, a control byte is sent to set up the mode of operation. For the PLAY program, the byte is (hex) 36, which sets the mode to 8 data bits, no parity, divide clock by 64, receive interrupt disabled and transmit interrupt enabled. The RECORD data byte is (hex) 96, which sets up the same data format, but disables the transmit interrupt and enables the receive interrupt.

The status register is not used in the sample programs, but would be needed if polled operation was required. In this case, the status register is continually read and action taken depending on the status of the various bits. Bit 0 is set to a 1 if the incoming data has been read and is available for transfer to the computer. The action of reading the data register will reset the status bit to 0, ready for the next byte.

Bit 1 of the status register is set to a 1 if the transmit section is ready to receive new data from the computer. The remaining bits perform functions more related to a modem, and are not really important for this project. If you decide to get involved in developing software that uses polling routines, it may be a good idea to get more information on the status register, as it has a couple of little peculiarities that need attention.

Interrupt driven software is always difficult, as you never know when the interrupt is likely to happen, making polling routines much simpler. However, unless you keep track of times, software using polling routines can be very inefficient.

Test programs

The test programs included in this article are written in machine code, and can be directly entered from the Apple's monitor. The first listing is to test the MIDI out function, and will simply cause middle C on a MIDI keyboard to repeat forever. The program will stop if a key is pressed on the computer's keyboard, and return control to the monitor.

To feed in the program, boot up a DOS 3.3 disk, then type 'call -151' to enter the monitor. Next, type '800: ' then type in the hex code *exactly* as shown.

When entered, type 800L for a disassembly listing to confirm that the program ends at address $861 with a JMP $0804 instruction. Save the program before proceeding, by returning to BASIC with a CTRL C, then typing 'BSAVE MIDIPLAY,A$800,L$100'.

To execute the program after saving it, type 'BRUN MIDIPLAY'. Of course, if the program is present in memory, enter the monitor (CALL -151), and type 800G. Note that the program is intended to start from address $800, and that the MIDI card should be in slot 2.

The MIDI-in test program is shorter, as it doesn't require the timing loops used in the previous program. Again it should be written from address $800, and saved by typing 'BSAVE MIDIREC,A$800,L$100'.

This program remains in an interrupt driven loop, waiting for MIDI data. Pressing any Apple key causes the program to exit to the monitor. The data will be stored from address $1000 to no higher than $10FF, giving one page (or 256 bytes) of storage. If your synthesiser sends out active sensing pulses, the program will fill up the page with $FE, then exit when the page is full. A disassembly of the program should show the program ending with a JMP $0810 at address $0837. Again, the card must be in slot 2.

For those who would like more details of the programs, we will supply a photocopy of the full listings through our reader service. For details refer to the back of the magazine.

TABLE 1

Test program addresses for card in slot 2

Transmit data register	(TDR)	$C0A1 write
Receive data register	(RDR)	$C0A1 read
Control register	(CR)	$C0A0 write
Status register	(SR)	$C0A0 read

If another slot is used, use $C0n0.
Where N = 8 + slot number.

I/O addresses used by the ACIA when card is in slot 2.

```
*800.861

0800- 78 4C 31 08 B5 00 8D A1
0808- C0 E8 E0 05 D0 05 20 21
0810- 08 A2 00 58 AD 00 C0 30
0818- 06 8D 10 C0 4C 14 08 78
0820- 00 A0 00 AE 00 03 CA E8
0828- CA D0 FB 88 D0 F5 A2 00
0830- 60 A9 03 8D A0 C0 20 58
0838- FC A9 08 8D FF 03 A9 04
0840- 8D FE 03 A9 36 8D A0 C0
0848- A9 FF 8D 00 03 A9 90 85
0850- 00 A9 3C 85 01 85 03 A9
0858- 3F 85 02 A2 00 86 04 4C
0860- 04 08
```

The 'MIDIplay' routine. Enter hex code from $800 using Apple monitor.

```
*800.839

0800- 78 4C 1D 08 AD A1 C0 9D
0808- 00 10 E8 E0 FF F0 0C 58
0810- AD 00 C0 30 06 8D 10 C0
0818- 4C 10 08 78 00 A9 03 8D
0820- A0 C0 20 58 FC A9 08 8D
0828- FF 03 A9 04 8D FE 03 A9
0830- 96 8D A0 C0 A2 00 58 4C
0838- 10 08
```

The 'MIDIrecord' routine. This program also resides at $800.

As already mentioned, it is planned to make available software that will operate the interface to a much higher level of sophistication than these sample programs. But at least they should get you should be up and running with MIDI.

PARTS LIST

1 Apple prototyping board (see below)
2 5 pin DIN line sockets
1 2MHz crystal
2 14-pin IC sockets
1 4-pin IC socket
1 24-pin IC socket
600mm length of twin shielded wire, length of telephone wire or insulated hookup wire for links.

Resistors

All 1/4W 5%: 1 x 120, 3 x 220, 1 x 2.2k, 1 x 10k, 1 x 10M.

Capacitors

1 18pF ceramic
1 4-40pF trimmer (if needed)
1 0.1uF ceramic.

Semiconductors

1 6N138 opto-coupler
1 74LS05 hex inverter
1 4001B quad NOR gate
1 6850 ACIA
1 1N914 or similar diode

Note

The Apple Proto-board used in this project is available from Hi-Com Unitronics, of 7 President Avenue, Caringbah 2229 or phone (02) 524 7878. Proto-boards for the Apple are also available from Radiospares branches in each state.

The 6N138 opto-coupler is available from Jaycar Electronics, which is also able to supply 2MHz crystals.

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The lite Guard detects a moving person or vehicle by comparing the background temperature with a rapid change of temperature across the detection beams. So when Lite Guard detects movement across the coverage area, it will turn on the floodlight(s) for 1-20 minutes as pre-adjusted.

Specifications: Detector: Dual element pyroelectric PIR sensor • Raintight outdoor all weather operation. • Photocell to deactivate sensor during daylight • **Operating Voltage:** 240V AC. 50Hz • **Operation time:** Adjustable 1-20 minutes • **Sensitivity:** Adjustable 20'-50'. 30 beams • Aimable desired direction with 2 ball joints • switching Capability: 500W max. incandescent. • **Operation Modes:** Off, Auto, Test, Manual Ont.

Super Bargain Save $50
Fantastic Negative Ion Generator

There have been volumes written about the benefits of negative ions combating air pollution, cigarette smoke etc. can be very beneficial to Asthma sufferers. Our great little Rover generates billions of ions per second! Includes tester.

Were $79.00

A 0990

$29

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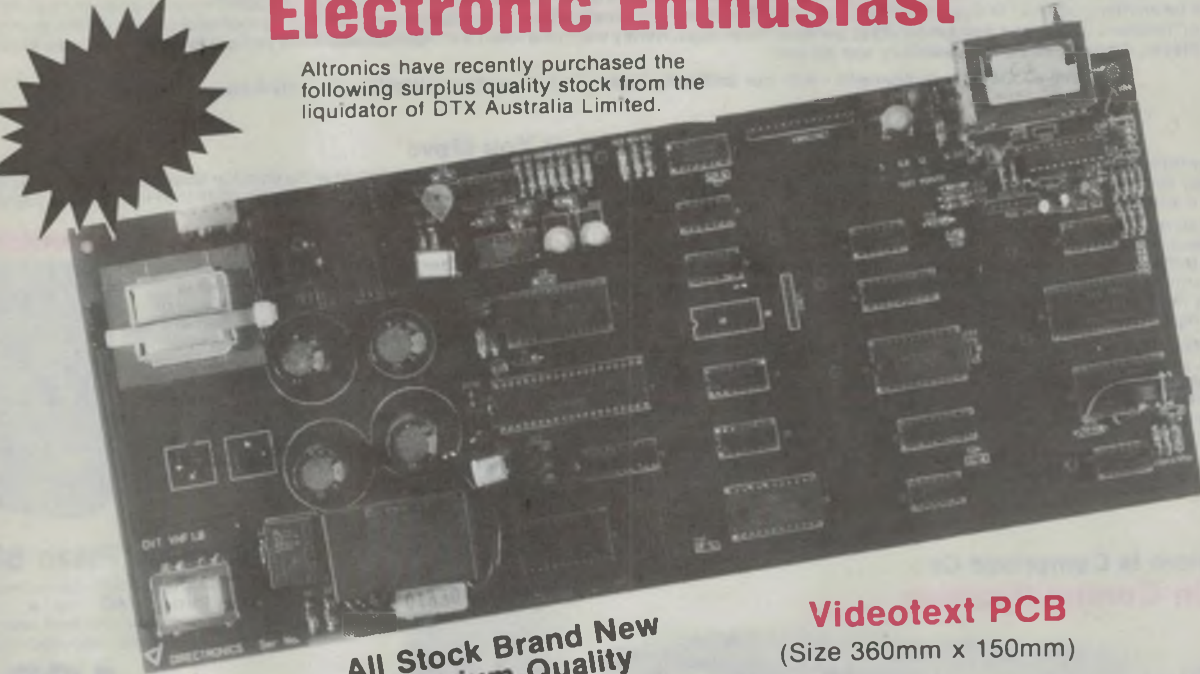
HIGH TECH Company Collapse Brings Fantastic Bargains For The Electronic Enthusiast

Altronics have recently purchased the following surplus quality stock from the liquidator of DTX Australia Limited.



All Stock Brand New Premium Quality

Videotext PCB

(Size 360mm x 150mm)

This PCB is a goldmine of quality components for the Enthusiast — the value exceeds $100, yet the cost to you is from an unbelievable **$3**

Here is Just Some Of What You Get

FEATURES:

Mains Transformer - 240-9/15/24V 300mA
Line Isolation Transformer - Telecom approved 600/600 Ohm or 600/150 Ohm impedance.
Video/RF Modulator (Channel 0)
Low profile 12V 5A SPDT Relay
Bridge rectifiers
Filter capacitors
Voltage regulators
Crystals (6MHz and 4.43MHz)
Trim pots and caps
TTL, CMOS, Linear and LSI IC's
Flatpack heat sink
Many other active and passive components.

1—9	5—9	10+
$5	**$4**	**$3**

Mains Transformer Bargain Of The Year!

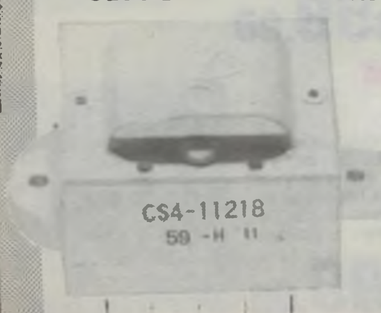
240V to 9, 15 or 24V

Quality PCBMount Type Manufactured By NMB Research Limited of Japan.

Primary: 240V Pins 2,4.
Secondary 1: 15V @ 300mA Pins 8,9
Secondary 2: 9V @ 800mA Pins 6,7.
Secondary 3: 24V @ 300mA Pins 6,9 (Join Pins 7,8)

Cat No. ZX0010

Normally $15
Now Simply Incredibly Priced!



1—9 **$3**
10—24 **$2.50**
25+ **$1.80**

Scoop Purchase Scoop Purchase

Famous Arlec Brand Type 45035

PCB Mounting Line isolating Transformers

May be used to provide isolation between Telecom Australia and mains operated equipment.
Approved to Telecom Specifications 1053 & 1054

Specifications:
Impedance: 600 Ohm line/600 Ohm equipment. **Turns Ratio:** 1:1
Max Level: 0 dbm @ 300 Hz.

Were $14
Now For The Very Quick

1—9 **$6**
10—24 **$5**
25+ **$4**

M 1000

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Just Imagine a Security/Alarm System you can install in about an hour — Uses no Wiring or Cables and Costs Less than $1 for the Mounting Hardware

UHF 305MHz Microprocessor Controlled Wireless Security System

Commercial grade, quality alarm systems are expensive - Just phone one of the "Name" security firms and get a quote for your home - our estimate is that it will be anything up to $1,000 just for the equipment - **then there is the installation** - countless holes punched through walls, miles of wiring and a day or two of installers labour and **that's around $35 per hour these days. Hardly worth the effort it it? After all what have you got to loose? - Only the Video Player CD Player, Camera, Hi Fi, TV, Jewellery and so on!!**

Well all that is now changed - with our brilliantly engineered Home Guard Wireless Security System Read On —

Take It With You If You Move

Apart from the flawless operation of the Home Guard System—One of the great features is its application with rented or leased premises—Lets face it, money spent on installing a wired system in your Home or Office, Factory etc. is irrevocably lost when you move on. With the Home Guard you simply take it with you.

This alarm system is a brand new design that features completely wireless connection to all accessories, even the reed switches. Think of how easy it is to install a "Wireless" alarm system. The benefits are endless, e.g. arming your Flat or Townhouse with an alarm you don't need to run wires through the roof or drill great holes through your walls. When moving house the alarm is simple to dismantle and re-install elsewhere.

The system divides protected areas into either perimeter zone or internal zone, programmable by dip switches in each transmitter/detector. **Pocket remote control** can simply arm or disarm your house perimeter from your bedside when retiring etc. this allows essential protection while cancelling internal zone as desired. Each transmitter/detector unit can be programmed into interior or perimeter zone. Zones can be programmed for instant or delayed trip. The system has a built-in ear piercing siren for intrusion and panic alarm signals.

Passive Infra Red Movement Detector

Ideal for the lounge room, family room or hallways e.g. anywhere where an intruder is likely to pass through. Mounts up on the wall or on top of bookshelves etc. Detects movement within an area of 9M by 9M by sensing intruder body heat movement through the protected area. Should not false trigger with the family cat or curtain movement etc. — as is the case with the cheaper Ultrasonic alarms.

S 5280 $129.00

Remote Piezo Siren

This unit is an optional line carrier receiver. Receives signal through 'AC' line i.e. it would ideally be located in, say, the roof space and plugged into mains power.

S 5290 $125.00

System Is Comprised Of :

Main Control Receiver

S 5265 $349

Features:

- Wireless reception of external or internal sensors or detectors.
- Selectable home or away modes for selecting internal and external arming or just external to allow movement inside the building.
- Built in Piezo electric siren gives different signals to indicate different functions.
- Sends signal down power line to activate one or more remote sirens.
- Programmable Arm/Disarm switch buttons.

The main control receiver runs on 240V AC with a 12V 1.2AH battery for emergency backup. All other units with the exception of the line carrier, run on a 9V battery each. The average life expectancy is approximately one year. System works around the 305MHz frequency where there is less chance of false alarm. The range of the unit is normally 80 metres in open space.

Alarm and Indication Sounds

Intrusion Alarm — Panic Alarm — Arm Tone — Disarm Tone — Exit Click Tone — Monitor Tone — Tampering Alarm.

Complete System Special Package Price

One	S 5265	Main Controller
One	S 5270	Reed Switch
One	S 5280	Passive I/R Detector
One	S 5285	Wall control unit.

This Month $499

S 5260 Normally $570

Accessories

Note: For larger installations your system may well require several Reed switches, movement detectors and 2 or more sirens. Also the remote door controller and or pocket remote controls could be very worth while accessories. The fantastic thing about the Altronic system is you simply add more detectors as you discover the need — no wiring, no expensive technicians, no modifications to equipment.

Hand Held Control Transmitter Unit

A real joy to use — keep it at the bedside table — allows you to, say, arm the house perimeters when retiring or you can take it with you when you go out, arming your system after you lock the door. Unit is a function control transmitter — to send 4 different signals.

Off — To disarm the system before entering **Home** — To instantly arm the system with 'Perimeter' detection only. **Away** — To arm complete system after a given exit delay time of about 40 seconds. **Panic** — To start an emergency signal whenever needed, in any mode.

S 5275 $59.00

Detector/Transmitter Unit (Reed Switch)

Suitable For Windows and Doors

This consists of an enclosed reed switch and compact UHF transmitter and a removable enclosed magnet. The unit is at rest when magnet and reed are side by side (within 25mm or 1 inch). When the magnet is moved away more than approximately 1 inch the alarm signals to the Main Control Receiver and the alarm is sounded. In practise the Reed/Transmitter is mounted on the door or window frame with the magnet on the moving door or window.

S 5270 $55.00

Front Door Keypad Control Unit

This handy accessory virtually duplicates the function of the Master Controller unit but at a more convenient location i.e. just inside your entry door etc. System can thus be armed or disarmed without the need to go to Master unit. Especially handy for larger homes or offices.

S 5285 $99.00

PHONEORDER TOLL FREE ALTRONICS 008 999 007

'Sixty-Sixty' Integrated Amplifier Kit

(EA May,June,July '86)

Features:
• 60 watts per channel into 8 ohm loads • Very low noise on all inputs - better than CD performance • Very low distortion • Excellent headroom • Tape monitor loop • Tone controls with centre detent and defeat switch • Mono/stereo switch • Toroidal power transformer • Easy-to-build construction • Very little wiring.

Performance Specification

Power Output — 8 ohms 62W **Distortion** - Less than .0% at 1kHz. **Frequency Response** - Phono Inputs - RIAA/IEC equalisation within + - 0.5db from 40Hz to 20kHz Line Level Inputs — -0.5db at 20Hz and -1db at 20kHz **Input Sensitivity** - Phono 1kHz -4.3mV • Line Level - 270mV. **Hum & Noise** - Phono - 89db • High Level Inputs - 103db. **Tone Control** - **Bass** - + -12db at 50Hz **Treble** - +-12db at 10kHz. **Damping factor** - At 1kHz and 30Hz - greater than 80 **Stability** — Unconditional.

K 5060 **$299**

Beginner Constructors Can Build this Amplifier Kit — It looks terrific and will last you a lifetime. **Save $200 or More on comparable performance commercial units.**

"This New Amplifier offers a standard of performance far ahead of anything we have previously published and ahead of most commercial Integrated Stereo Amplifiers".

"It is half to one third of the cost of an Imported Amplifier with equivalent power output and performance". *Says Leo Simpson Managing Editor Electronics Australia Magazine.*

The reproductive purity of these speakers simply amazed us. The secret, of course is the DANISH VIFA Drivers. VIFA drivers are used in many top selling imported systems such as Bang & Olufsen, Rogers, Mission, Jamo, DCM Timewindow etc.

Build These Fantastic New Playmaster HiFi Loudspeakers

See Electronics Australia Sept '86

$449 full kit K 5090

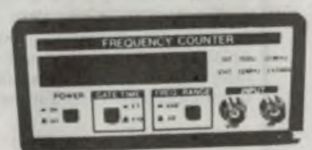
If your budget won't run to the $600 to $800 needed for a fully imported pair of equivalent speakers, these are the ones to go for.

RF Signal Generator

With provision for both internal and external modulation, this generator is a winner.

SPECIFICATIONS:
Frequency Range: 100k - 150MHz in 6 ranges **RF output level** 100mV RMS **Accuracy** +/-3% **Modulation:** Internal (30% depth) - 1KHz • External - 50Hz - 20KHz • Crystal Locked Oscillator

Q 1550 **NOW $199**



Frequency Counter Sensation

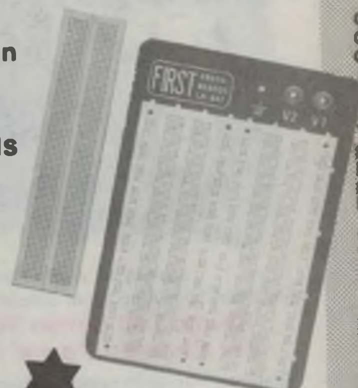
150MHz Frequency Counter

A frequency counter is invaluable for the accurate alignment and testing of many modern electronic circuits.

SPECIFICATIONS:
Freq.Range: 10Kz - 150MHz **Gate Time** 1 sec. 6sec. **Accuracy** +/-1 count **Max.Input** 20V P-P **Sensitivity:**
• 10Hz - 30MHz - 25mv-100mV
• 10MHz - 150MHz - 100mV - 300
• Power requirement-9V DC at 100mA

Q 1520 **$180.00**

Great Saving On Quality Solderless Breadboards



640 Holes
P 1005 **$12.50**

640 + 100 Holes
P 1007 **$14.50**

640 + 200 Holes
P 1009 **$16.95**

400 + 1280 Holes
Accepts up to 16 x 16 pin DIL IC's Terminals for PS Connections.
P 1012 **$43.50**

500 +1920 Holes
Accepts up to 24 x 16 pin DIL IC's Metal Backing Plate for Shielding of sensitive circuitry.
P 1015 **$65.00**

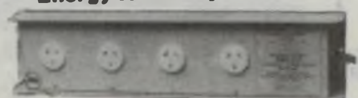
Stop Data Crashes And Corrupted Software

"Squeeky Clean" Mains Filters

An investment in one of our fantastic 'Squeeky Clean' Mains Filters could save you a small fortune with your computer system. **Protects Hardware and Software** from mains voltage spikes caused by lighting, transmitters, electric motors, welding, machinery etc. Anyone who has to re-build 3 weeks of software programming will cherish the aquisition of one of these fine mains filters.

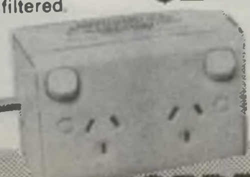
Energy Authority Approved.

P 8160 4 Outlets
Each individually filtered. A must for 'serious' computer installations e.g. for Schools, Business etc. • **Loading Rating:** Continuous 10 amps, with circuit breaker at 240V AC. • **Outlets:** 4 GPO's individually filtered.



P 8160 **$269**

P 8150 Single Filtered Double Outlet Model
Just the shot for home computer or for individually located peripherals e.g. remote printer, computer terminal etc. **Loading Rating:** 10 Amps Max. load at 240V AC • **Outlets:** 2 GPO's single filtered.



P 8150 **$99**

High Definition Computer Monitor

Superb "Goldstar Pro" Non glare naturally, & screen character resolution well worthy of mating up with top end personal or professional computers.
• Compatable with IBM, Apple, Commodore Computers
• Excellent for small business applications • Exceptionally clear & stable display • 80 characters x 25 lines display. CDT Non glare phosphor P31 **Input** composite video 1V P-P **Input Conn.** RCA Jack **Input Imped.** 75 Ohms or high imped. (switchable) **Video Bandwidth** 18MHz **Horiz. Resolution** 900 lines at centre **external controls** brightness contrast

Save An Incredible $100

Now $129.00

D 1116 Amber Screen

Jack O'Donnell
M/Director

Great Kit Projects To Build Many Just Released

Brilliant Performance Stereo Pre Amp

Studio 200 Stereo Control Unit

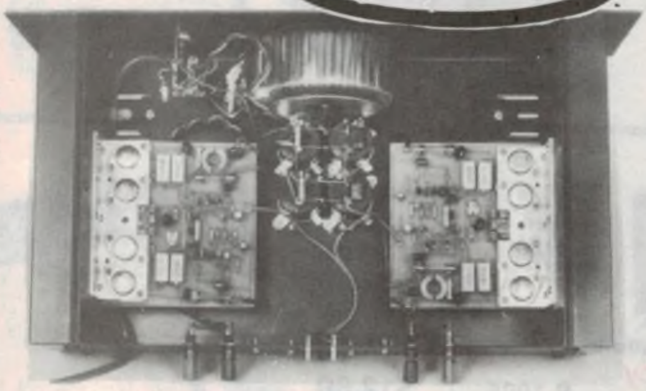
(Silicon Chip June/July'88)

Out-Performs Commercial Units Costing $600 Plus

The Studio 200 Stereo Control Unit is companion to the studio 200 stereo power amplifier (or other power amps). It features slim single unit rackmount profile, treble, bass, balance, input selector, tape monitor switch, stereo/mono switch and volume control. Inputs include phono, tuner, CD, VCR and tape loop.

K 5015 $229

Simple PCB Construction Virtually No Wiring



Calling All Audio Purists
This Great New Amp From Silicon Chip Is For You

Studio 200 Series 100 Watts Per Channel Power Amplifier

K 5010 $399

Features: • In-Built speaker protection • Toroidal Transformer (low hum) • Black Satin Finish • Low leakage power supply capacitors • Housed in Rugged Custom Chassis.

Specifications: • **Output Power** 100W into 8 Ohms **Freq. Res.(at 1W) 20Hz-50KHz** + or - 1db **Input Sensitivity** 870mV **Harmonic Distortion (20Hz-20KHz)** 0.1% **Signal To Noise Ratio** 100db or Better **Protection** 5A fuses plus RDE245A Polyswitch **Damping Factor** (without Polyswitches) 100 (with Polyswitches) 100. **Stability** Unconditional.

Go anywhere 240V Mains Power from your car or truck battery with these fantastic DC to AC Inverters

Power House 600W Inverter

(See EA Dec'87)

A must for farming, camping, mining, boating, remote settlements and wherever else 240V power isn't available.

Features: Strong custom steel chassis • Industrial grade power coat finish • Can be configured to operate off either 12V and 24V DC • Very little internal wiring • Manual or Auto start facilities • Low battery cut out • Compact Toroid transformer.

Fully Built & Tested

K 6770 KIT VERSION	K 6774 12V INPUT	K 6775 24V INPUT
$425	$525	$525

300 Watt Inverter With Auto Start

Operates From 12V Car Battery

Features: Auto start draws power from your battery only when appliance is plugged in and "turned on" i.e. battery can be left permanently connected if required. • **Voltage regulated** • **Current Regulated** • **Current Overload** unit self limits — Single PC Board construction — easy to build as there is very little internal wiring.

Complete Kit
K 6750 $279.00

Fully Built & Tested
K 6755 $379.00

Discolite

(See Silicon Chip July/Aug'88)

Add Some Colour To Your Next Party

K 5805 $159.50

The Discolite Flashes party lights on and off in beat with music from your amplifier.

• 4 light channels controlled by 4 separate audio channels • Forward, reverse and auto-reversing chaser patterns • Simultaneous strobe on all four channels • Alternating light patterns • Music modulation available on chaser, strobe & alternate patterns • Inbuilt microphone for beat triggering or audio modulation of lights • Direct inputs for beat triggering or audio modulation of lights • Sensitivity control • pre-settable sensitivity levels for each channel • Front panel LEDs mimic light display.

Great For Parties. Shop displays and special lighting effects.

Transistor FET Zener Tester

$49.95 K 2527

(See EA Feb/Mar'88)

New updated circuit incorporates facilities for testing transistor FETs and Zeners etc.

Features: • Gain • Leakage • Breakdown Voltages • Zener Voltage • Polarity — NPN/PNP

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Low-Cost Unit
Checks Values from 1pF - 100uF

Upgraded Digital Capacitance Meter

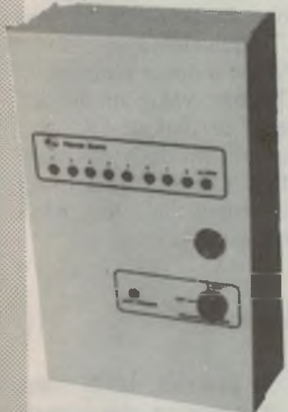
The readout consists of a bright 4-digit LED display and the full scale readings for each range are 9999.9nF and 99.99uF. No adjustments are necessary when taking a reading. You simply connect the capacitor to the test terminals and select the appropriate range. The circuit can accurately measure capacitance down to one picofarad (1pF). This is made possible by the internal nulling circuit which cancels any stray capacitance between the test terminals or test leads. So when you measure a 5pF capacitor, the unit will display 5pF.

$79.00 K 2522

Save $$$ on the cost of commercial equivalents

Super Low Price on Famous EA 8 Sector Alarm System Kit

(See EA Mag.Jan '85)



Features:

- Alarm has 8 separate input circuits - 8 sectors can be monitored independently.
- Each input circuit is provided with an indicator LED and a sector On/Off switch.
- Individual sector isolation allows the user to have some areas of the premises habited while others remain protected e.g. Inside Off/Outside On.
- Inputs accept both normally closed and normally open sensors.
- Two inputs provided with an entry delay between 10-75 seconds).
  Internal trip warning buzzer—alerts owner/occupant of pending alarm operation—great for the "forgetful" amoungst us. This buzzer is pre-settable between 5 and 55 seconds prior to Alarm.
- Unique circuit detects automatically when any N/O or N/C loops are either open circuit or dead short. **e.g. someone trying to bridge reed switches etc.**
- Switched output can be used to send a silent alarm through an auto-dialler circuit or similar.

K 1900 (without Back Up Battery) KIT **$149.50**

S 5065 (12V 1.2AH Backup Battery) **Now Only $15.00**

24V To 12V DC Converter

(Silicon Chip Dec'87)

Enables 12V appliances like stereos, 2 way radios, CB's etc. to operate from a 24V battery.

- Operates from 18V-30V. Output is 13.6V at 5 amps.

KIT **K 3255 $59.00**

Bench Top Power Supply

3-30V to 1 amp Max.with variable current limit

FEATURES:
- Output 3 to 30V at 1A • Short circuit protected • Load switching • Current limiting. Dual scale meter • Housed in our Deluxe "ABS" instrument case.

SPECIFICATIONS:
- Output Voltage - 3 to 30V • Output Current - 0 to 1 amp (fully variable) • Load Regulation - Better than 0.2% from 0 to full load • Output Ripple-Less than 2mV RMS.

KIT **K 3210 $79.00**

KIT **K 3300 $195**

Laboratory Power Supply

3-5 Volts at up to 5 Amps

Designed by Electronics Australia, this supply has been one of our most popular kits. Our version incorporates refinements and is now housed in an attractive, tough "ABS" instrument case. This all new compact version has been made possible by the use of a highefficiency Toroid Power Transformer. So you win four ways - less heat, less weight - Greatly enhanced appearance and easier to build - **Remember the Altronics Kit is fully drilled and punched.**

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Don't forget our Express Mail and Phone Order Service - for the cost of a local call, Bankcard, Visa or Mastercard holders can phone order for same day despatch.

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Using new low-cost RMS converter chips

The latest generation of monolithic RMS converter chips offers true RMS measurement capability, at op-amp prices. This article discusses the operation and applications of the new Analog Devices AD736 and AD737 chips, which are laser trimmed for high accuracy.

Precision rectifiers, or average responding circuits, have long been popular for RMS measurement in low-cost portable meters. Their inherent disadvantages have been tolerated because of their simplicity and very low cost.

As its name implies, an average responding circuit directly follows the *average* value of an AC voltage or current. First, the circuit rectifies the signal and then low pass filters it. In the precision rectifier shown in Fig.1 amplifier A1 half-wave rectifies the input signal. Amplifier A2, operating as a summing amplifier, supplies a gain of 2 for the half-wave rectified signal, but only a gain of 1 for the raw input signal. Since the 2X amplitude half-wave rectified output of A1 is 180° out of phase with the raw input waveform, A2 subtracts the negative half cycle, resulting in a full-wave rectified output voltage.

The 2.2uF capacitor between A2's output and the summing junction averages the rectified signal. The resulting DC voltage is then scaled by adding gain; the chosen scale factor converts the DC average reading to an RMS equivalent value for a sine wave form. For example, if the average absolute value of a sinewave voltage is 0.636 that of Vpeak, then the corresponding RMS value is 0.707 times Vpeak. Therefore, for sinewave voltages, the required scale factor (or gain) is 1.11 (0.707 divided by 0.636).

There are several obvious problems with the average rectified approach to AC measurement. First, the circuit requires several trims: symmetry and scale factor, plus an offset adjustment for each amplifier. Second, precision rectifiers also exhibit low typical bandwidths while measuring low-amplitude input signals. Last, and perhaps the least obvious, are the inherent difficulties in trying to measure signals that differ from the pre-calibrated waveform. Errors can easily exceed 30%, for waveforms other than that used for calibration.

In contrast to the "average" value of an AC signal, true RMS is a "universal language" among waveforms. RMS-to-DC conversion permits the magnitudes of all types of waveforms to be compared among one another and to their respective "DC" equivalents.

In reality, RMS is a direct measure of the power or heating value of an AC voltage, compared to that of DC; a 1 volt RMS signal will produce the same amount of heat in a resistor as a 1 volt DC signal. Mathematically, the RMS value of a voltage is defined as:

$$V_{rms} = \sqrt{Avg\,(V^2)}$$

In actual circuit practice, RMS computation involves squaring the signal, taking the average, and then obtaining the square root. Computation techniques based on the logarithmic Vbe relationship of a transistor calculate the square and square root. A capacitor or low-pass filter performs the averaging. So, true RMS converters are "smart rectifiers," since they provide an accurate RMS reading regardless of the type of waveform being measured.

Table 1 compares the performance of true RMS to that of average responding methods. As shown, if an average responding circuit is calibrated to determine the RMS value of sinewave voltages, and then used to measure either symmetrical square waves (or DC volt-

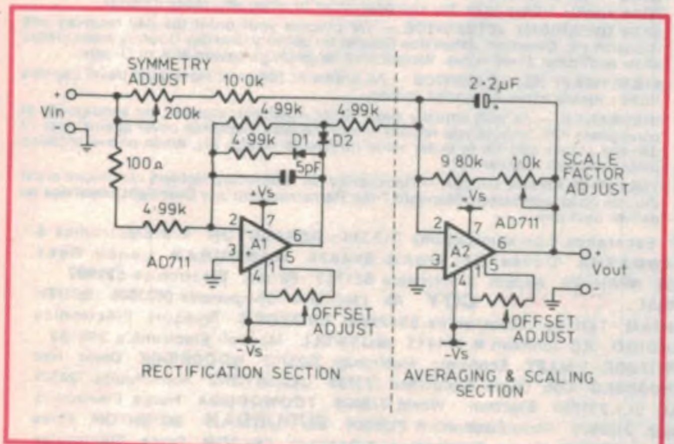
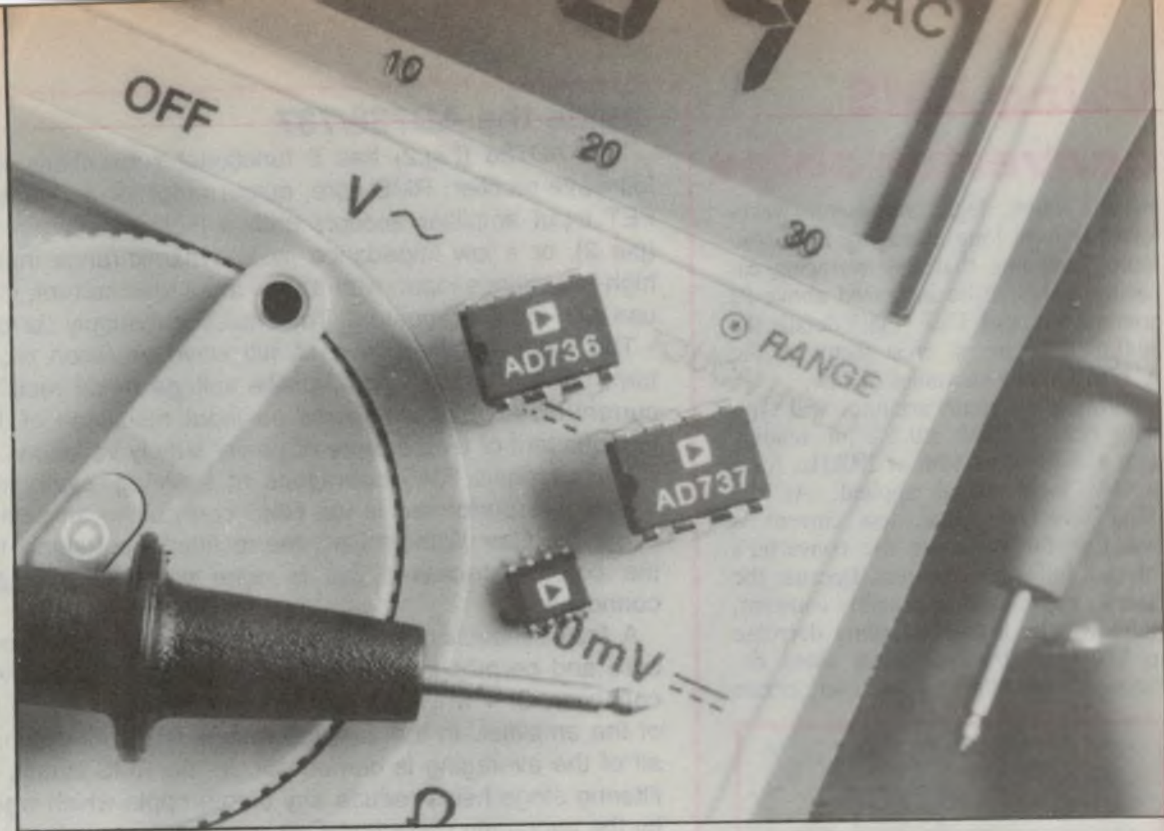


Fig.1: A standard average-reading precision rectifier circuit, as discussed in the text.

Table 1 (right): Average and true RMS measurements compared for different waveforms.

Waveform Type 1 Volt Peak Amplitude	Crest Factor (Vpeak/Vrms)	True rms Value	Average Responding Circuit Calibrated to Read rms Value of Sinewaves will Read	% of Reading Error* Average Responding
Undistorted Sinewave	1.414	0.707 V	0.707V	0%
Symmetrical Squarewave	1.00	1.00V	1.11V	+11.0%
Undistorted Trianglewave	1.73	0.580V	0.555V	-2.1%
Gaussian Noise (98% of Peaks < 1 V)	3	0.333	0.266	-20.2%
Rectangular Pulse Train	2 10	0.5V 0.1V	0.25V 0.01V	-50% -99%
SCR Waveforms 50% Duty Cycle 25% Duty Cycle	2 4.7	0.495V 0.212V	0.354V 0.150V	-28% -30%

$$\text{*\% of Reading Error} = \frac{\text{Aver Resp. Value} - \text{True rms Value}}{\text{True rms Value}} \times 100\%$$



Analog Devices' new AD736 and AD737 laser trimmed RMS converter chips are well suited for use in digital multimeters.

ages), then the circuit will exhibit a 11% computational error.

As is the case with many things in the real world, there is no all round "best measurement" technique. Rather, each method has its own virtues. Average responding detectors are simple, quick to respond to changes in amplitude, and exhibit low errors when measuring a pre-calibrated waveform. RMS devices will measure a wide variety of waveforms, but are slow to respond (or settle) when input amplitudes vary.

The circuit shown in Fig.2 improves low-level RMS measurement by accepting a differential input voltage. This differential connection breaks up ground loops typically found in the unbalanced input signals. The user may connect the differential input voltage to pins 1 and 2, or use input coupling capacitors to eliminate the typical 2mV input offset of the AD736.

Most RMS circuits employing the AD736 or AD737 require only two external components: an averaging capacitor, Cav and an input-coupling capacitor. Cc. An optional filtering capacitor, Cf, can reduce output ripple. With single-ended input signals, the designer can reduce the required parts count by omitting input AC coupling capacitor Cc and connecting pin 1 directly to the common terminal at pin 8.

Since the averaging capacitor, Cav, "holds" the rectified input signal during RMS computation, its value directly effects the accuracy of the RMS measurement, especially at low frequencies. Furthermore, because Cav appears across a diode in the RMS core circuit of the AD736, the averaging time constant will increase exponentially as the input signal decreases. As a result, as the input level decreases, errors due to non-ideal averaging will *decline*, while the time it takes for the circuit to settle to the new RMS level will *increase*. Therefore, lower input levels allow the circuit to perform better (due to increased averaging) but increase the waiting time between measurements. Obviously, users must accept a trade-off between computational accuracy and settling time.

The differential circuit may be set to respond to the average value of a differential waveform by simply omitting Cav. Because the average responding connection does not use an averaging capacitor, its settling time does not vary with input signal level; it is determined solely by the RC time constant of Cf and the internal 8kΩ resistor in the output amplifier's feedback path.

The *crest factor* of the input waveform should be considered when designing a low-error RMS circuit. Crest factor is the ratio of the peak signal amplitude to the RMS amplitude (CF = Vpeak / Vrms). Many common waveforms, such as sine and triangle waves, have crest factors less then two. Other waveforms – low duty cycle pulse trains or SCR waveforms – have high crest

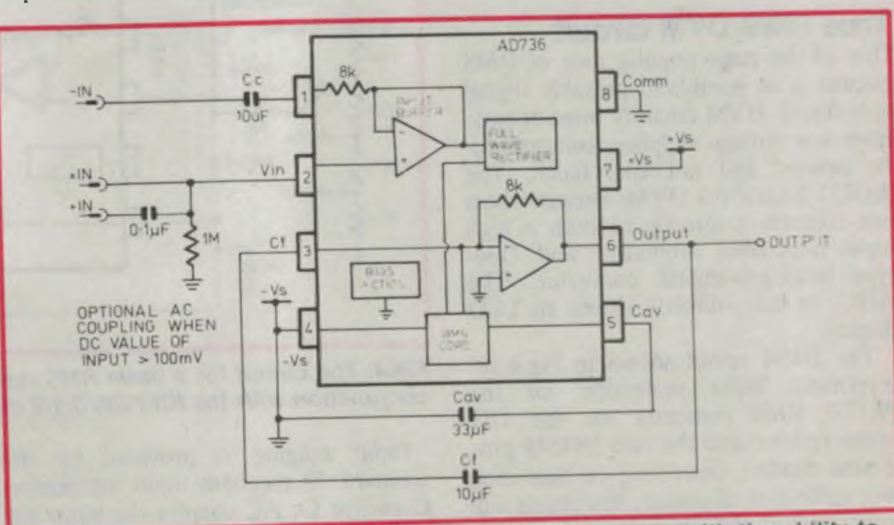


Fig.2: A true-RMS measuring circuit using the AD736 chip, with the ability to accept differential input voltages.

Using RMS converter chips

factors. These high crest-factor waveforms require long averaging time constants, meaning that the averaging capacitor needs to be increased above its nominal value of 33uF. Fig.3 details the additional error vs. crest factor of the AD736 for various values of Cav.

Differential circuit accuracy will typically be ±0.2mV ±0.2% of reading with a -3dB bandwidth of 200kHz, for a 100mV input signal applied. As the input levels decrease, less current is available for switching the converter's internal full wave rectifiers. Because the circuit capacitances remain constant, there will be a corresponding decrease in low level bandwidth for these devices. At the 10mV input level, circuit

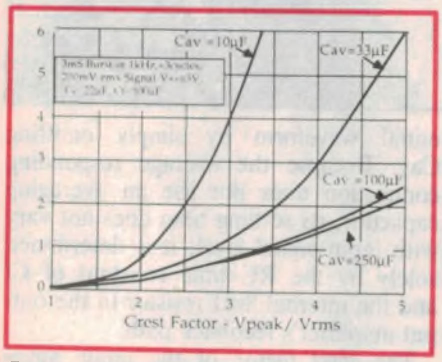


Fig.3: The additional error vs crest factor for the AD736, for various values of Cav.

bandwidth is approximately 50kHz; at 1mV it drops to 5kHz. The circuit will handle input voltages as low as 10uV (with ac coupled inputs). However, the device's bandwidth will not exceed 100Hz.

True RMS DVM circuit

One of the most popular uses of RMS circuits is in hand-held portable digital voltmeters. DVM circuitry must operate from low voltage supplies, consume little power, and not cost much. The AD737 is ideal for DVMs because users can connect it directly to both a high input impedance attenuator and 7136-type analog-to-digital converter. The ADC, in turn, directly drives an LCD display.

The DVM circuit shown in Fig.4 incorporates input protection for the AD737 RMS converter via the 47Ω series resistor and the two 1N4148 protection diodes. Operating on less than four milliwatts of power, this circuit will work even if the 9V battery decays to six volts.

Inside the AD736/737

The AD736 (Fig.2) has 5 functional subsections: input amplifier, full-wave rectifier, RMS core, output amplifier and bias sections. The FET input amplifier accepts both a high impedance, buffered input (pin 2), or a low impedance, wide-dynamic-range input (pin 1). The high-impedance input, with its low input bias current, is well suited for use with input attenuators. Total quiescent supply current is 180uA.

The input amplifier drives a full wave precision rectifier, which in turn, drives the RMS core. Unlike voltage mode rectifier circuits, the current-mode rectifier insures an input resolution of 100uV or less, independent of temperature or power supply variations.

The essential RMS operations of squaring, averaging and square rooting are performed in the RMS core, using an external averaging capacitor, Cav. Without Cav, the rectified input signal travels through the core unprocessed (as is done with the average responding connection).

A final subsection, an output amplifier, buffers the output from the core and permits low pass filtering to be performed via an external capacitor, Cf – which should be connected across the feedback path of the amplifier. In the average responding connection, this is where all of the averaging is carried out. In the RMS circuit, this additional filtering stage helps reduce any output ripple which was not removed by the averaging capacitor, Cav.

The AD737 (Fig.4) differs somewhat from that of the AD736. Since it omits an output buffer amplifier, it has 4 functional subsections rather than 5. This significantly reduces DC offset errors at the device's output, allowing the device to be highly compatible with high input impedance A/D converters.

Requiring only 160uA of power supply current, the AD737 is optimized for portable multimeters and other battery powered applications. The converter also offers a "power down" feature, reducing the power supply standby current from 160uA down to a mere 30uA. The power-down is turned on by tying pin 3 to the +Vs terminal.

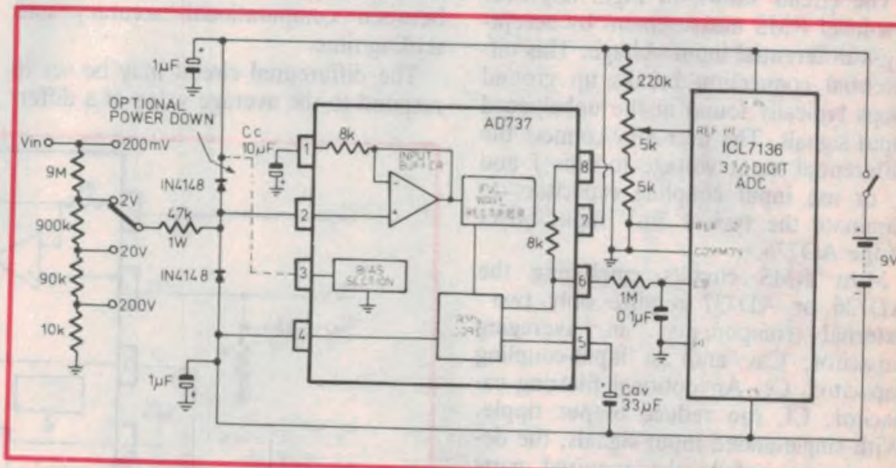


Fig.4: The circuit for a basic RMS reading digital voltmeter using the AD737 in conjunction with the ICL7136 3-1/2 digit ADC chip.

Input ranging is provided by the standard 10 megohm input attenuator. Capacitor Cc AC couples the input signal to the AD737. A large value capacitor connected between pins 6 and 8 of the AD737 delivers post filtering. Because the A/D has a high input impedance, a user can employ an RC network using a large value resistor and a 0.1uF capacitor to save valuable board space.

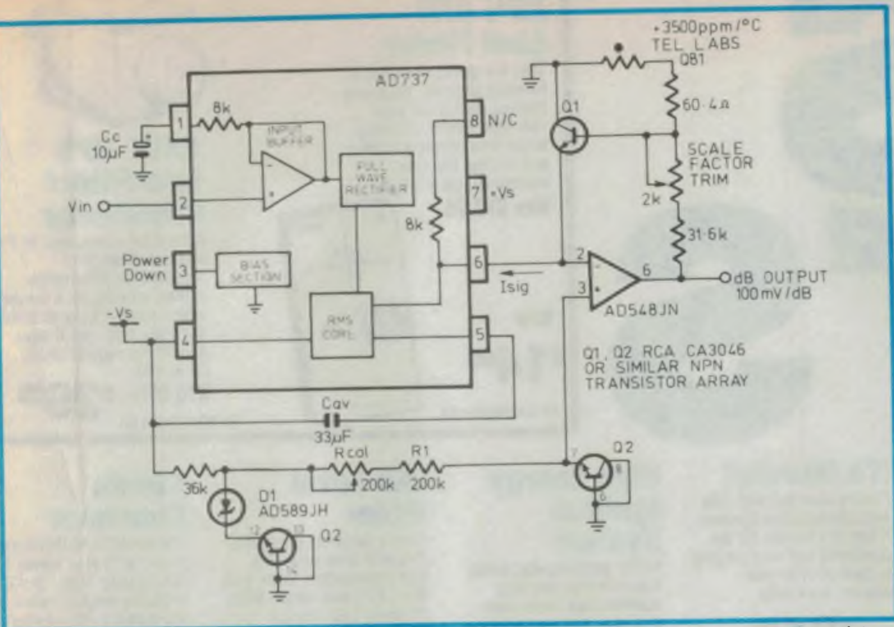


Fig.5: A circuit using the AD737 which produces a DC output proportional to dB, over a +/-30dB range.

Wide range dB circuit

With the help of a few external components, an AD737 can determine the RMS level of an input voltage over a ±30dB range (relative to a preset 0dB level of 30mV). Typical accuracy for the circuit in Fig.5 is ±0.5dB from 1mV to 300mV, and ±1dB from 300mV to 1V. The current Iref, which flows through resistors Rcal and R1 to transistor Q2 sets the zero dB reference level. Band-gap reference D1 and transistor Q3 establish a reference voltage that minimizes effects of negative supply and temperature variations. The current output at pin 6 of the AD 737 drives one input of a log ratio circuit. Iref drives the other input, which is set by resistors Rcal and R1.

The +3500ppm/°C thermistor, together with a 60.4Ω metal film resistor, compensate for the gain temperature coefficient (TC), and set the amplifier's gain to 33.3 at room temperature. This scales the output voltage to a more convienent 100mV/dB level from the approximately 3mV/dB value of Q1's emitter/base voltage.

The calibration procedure for this circuit is:

1) Apply a 30mV RMS, 1kHz, sinewave voltage to Vin.
2) Adjust Rcal for Vout = OV
3) Reduce the input sinewave voltage to 3mV. Adjust scale factor trim for -2.00 volts Vout.

Editor's Note: Analog Devices' AD736 and AD737 RMS converter chips are available in Australia from Parameters, the local distributor, with offices in Melbourne (03) 575 0222, Sydney (02) 888 8777 and Perth (09) 242 2000. The price for both chips (JN package) in one-off quantities is $7.45 plus 20% sales tax, if applicable.

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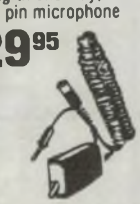

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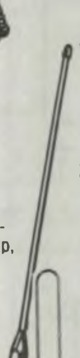

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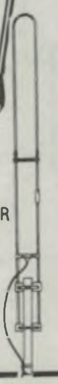

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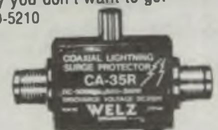

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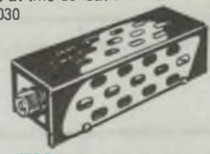

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Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible, the circuits have not been built or tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide construction details.

Capacitance meter

I have used the 'direct reading capacitance meter' (EA Jan. '79) for many years, but the need was often there for a meter that would measure larger values of capacitance. After much experimenting, the accompanying circuit was developed and expanded to cover the range from 2pF to 10,000uF.

An eight pole 17 position switch was obtained from a disposal store, which allowed X3 and X10 ranges to be used. A 12 position switch would cover the X10 ranges only. The 0-1mA meter was scaled 0 to 3 and 0 to 10.

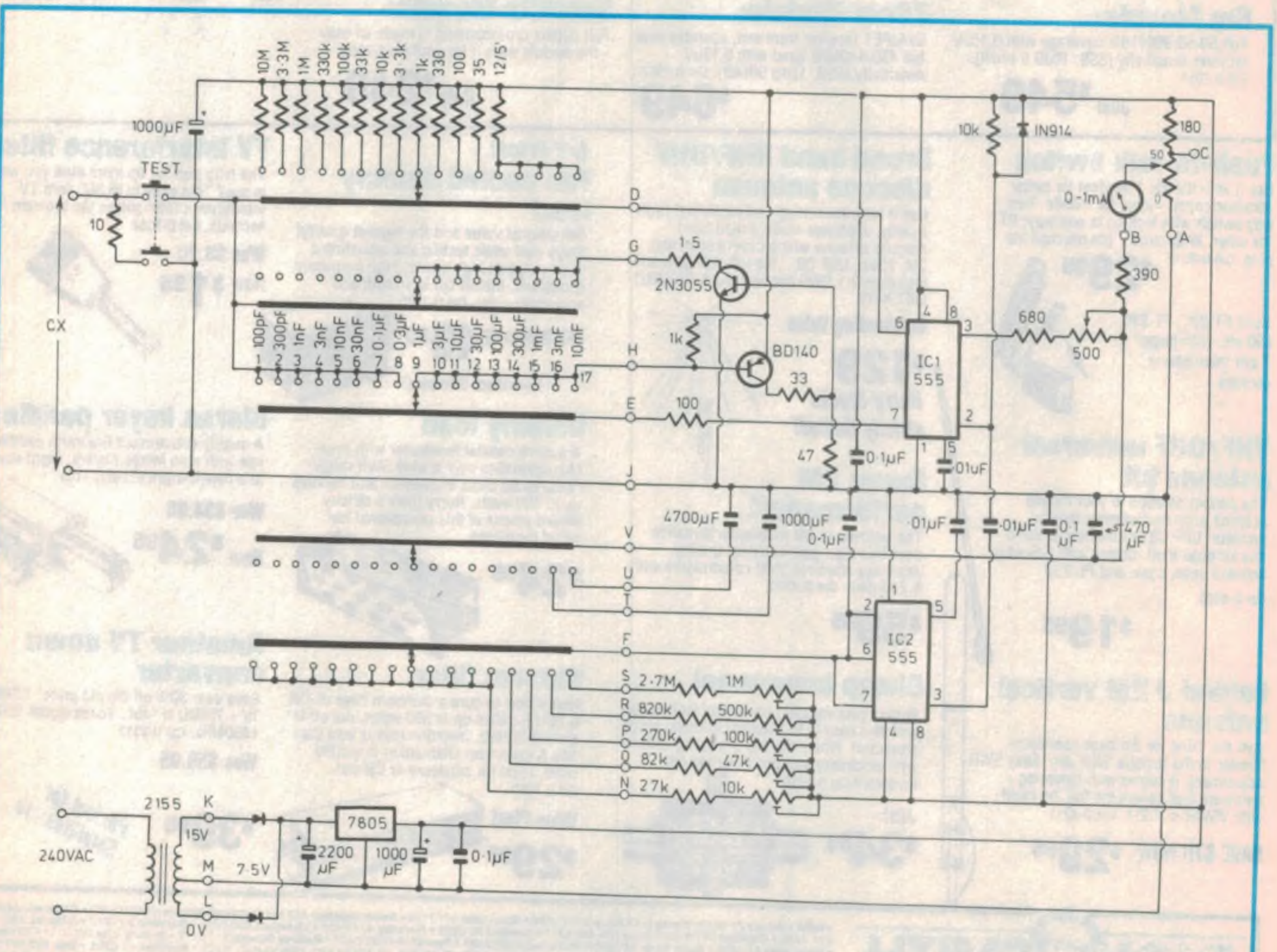
The unknown capacitance "CX" is determined by measuring the charging time in relation to a time interval. CX is charged through the range resistor, sensed by pin 6 and discharged by pin 7 in IC 1. IC 2 pulses IC 1 to repeat the process. The mA meter then reads the average of the pulsed waveform at pin 3 on IC 1, which is filtered to reduce the meter oscillations. On the 10,000uF range, the frequency is only 3.2Hz rising to 360Hz on the lower ranges. Ordinary 555 timers are used in both positions. CMOS 555's were tried without any improvement.

Power supply requirements are 5 volts at up to 0.5 amps, so battery operation is not really practicable. A 2155 transformer, two diodes, a 2200uF filter capacitor and a 7805 regulator with heatsink makes a suitable power supply.

Calibration is easy provided a range of capacitors, which have been tested on a known accurate capacitance meter, is available. Electrolytics can vary by 50%. First, set all 6 presets to mid position. Select the 1uF range, press the 'test button' and zero the meter. This nulls out the effects of stray capacitance, which is very noticable on the low capacitance ranges. Connect a known 1uF capacitor, press the test button and adjust the 10K preset to read correct value on the meter. This will set the ranges from 100uF to 100pF.

Switch to the 300uF range, zero the meter as before, and connect a known 220uF capacitor. Press the test button and adjust the 47k preset for correct meter reading.

Repeat this procedure for the 100uF, 3000uF and 10,000uF ranges using suitable known capacitors and adjusting the appropriate preset. If the limit of adjustment is reached on any range, adjust the 500 ohm meter preset to give



the correct value and then repeat the previous calibration on the other ranges. Accuracy should be within +/-1% on the 300uF to 10,000uF ranges, and +/-5% on the 100uF to 100pF ranges depending on the accuracy of the range resistors which should be 1%

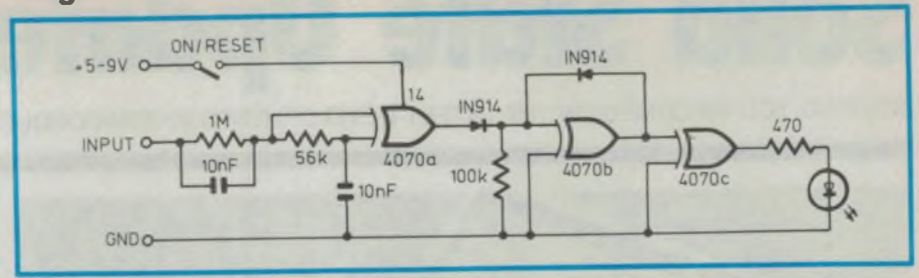
A 12 ohm resistor is used for the high capacitance ranges because of the voltage divider effect of the 2N3055 and the 1.5 ohm resister. For the same reason, 35 ohms was used instead of 33 ohms on the 30uF range.

The test button is provided to ensure that the capacitor to be tested is discharged before it is connected to the 555, which could otherwise be damaged.

Keith Vieritz,
Kallangur, Qld

$60

Logic level change detector



Here is a simple little circuit which may be of interest. Similar to the Mem position of a logic probe, it will latch a LED 'on' when any voltage variations on the input are encountered. It was designed initially to go in an RS232 patch cable/analyser box to check for short handshaking pulses. Hence it is capable of responding to positive or negative voltage transitions, and pulses down to 2-3 microseconds in duration.

The first exclusive-OR gate monitors the fast changing input with one input leg and monitors a slow changing input with the other. (Set by 56k and 10nF to ground).

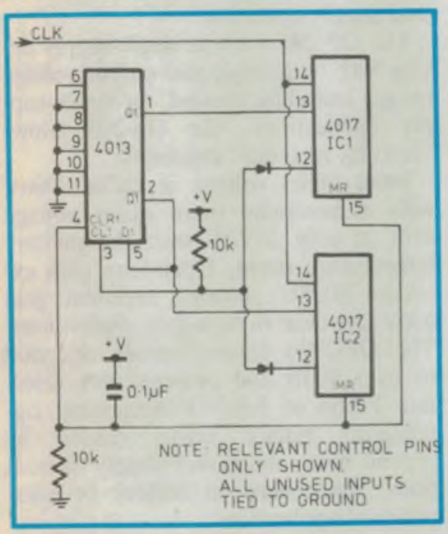
The output of this gate produces a pulse when the input voltage level shifts, even slightly.

The second gate acts as a buffer and latch stage, and the third gate is the LED driver. Interrupt Vcc to reset the LED.

Ian Jackson,
Frankston, Vic.

$30

Cascading 4017 counters



A recent project required 4017/22 Counter/Decoders to operate in sequence. I could not find any helpful hints in available literature, so developed the following.

If only two 4017/22 counters are to be sequenced, one half of a 4013 flipflop will do the job.

Both counter carryout pins (12) are OR'd to the 4013 clock pin (3) which is held high with a pullup resistor. Q(pin1) controls the clock enable of counter 1 (pin13) and Q-bar (pin2) the C3 of counter 2. Having reset all devices to get the system in sync either by a reset on power up arrangement as shown, or some other way, consider what happens at the 9/7 count of counter 1.

The next clock pulse will make counter 1 return to 1 and its carry out pin (12) will go high. This position edge will clock the 4013 which will toggle. Q will go high and Q-bar low, clamping counter 1 at 0 and enabling counter 2.

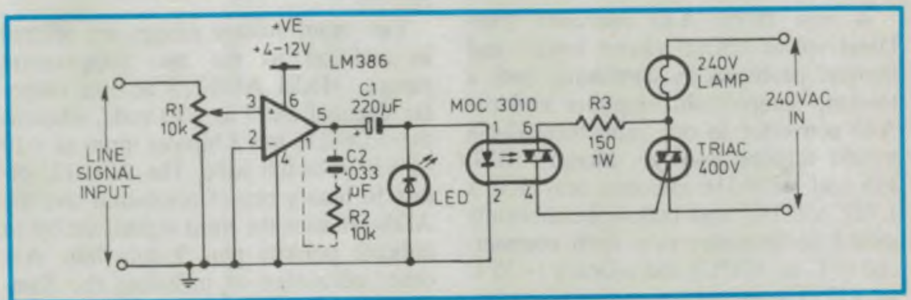
Counter 2 will have ignored the clock pulse as it was disabled with Q-bar high, but with the clock line high, the negative edge of Q-bar going low acts as both enable and clock signals, so advancing counter 2 to 1. The cycle repeats when the carryout of counter 2 in turn goes high.

If more than two counters are to be sequenced this may be done with another counter decoder, the outputs being inverted and used to enable the main counters in turn. All the main counter carryout pins are OR'd to the control clock input as before and the sequence terminated by connecting the net output to the reset line.

W.A. Jolly,
Nambucca Heads, NSW

$40

Beat triggered strobe light



This circuit was designed as a cheap and easy way of having a 'disco strobe' light, which flashes in time with the beat of a hi-fi stereo. The circuit uses the triggering threshold of an optically coupled triac driver (MOC3010), to strobe a 240V lamp.

The first stage of this design is the amplifier stage consisting of a power amp IC (LM386) and a sensitivity control R1, which can be a trim pot or rotary pot, depending on your application.

For the input of the amp, I decided on using the RCA line output, at the rear of the stereo, because this is a constant source.

C2 and R2 form a bass gain network, so the light will operate more towards the drum beat frequency region. This is optional and circuit will work without it.

The MOC3010 acts as a AC mains isolator, which triggers the gate of the 400V triac, (SC141D or SC151D). The triac can operate a 100W globe quite comfortably, although anything over may require a small heatsink, if any heat is produced.

For safety precautions, do not touch any parts while system is on or earth triac to metal body, as the triac is actively terminated.

I've build three of these circuits and each works well, with a cost of about $15 each.

Paul Nolan,
Greenwood, WA

$40

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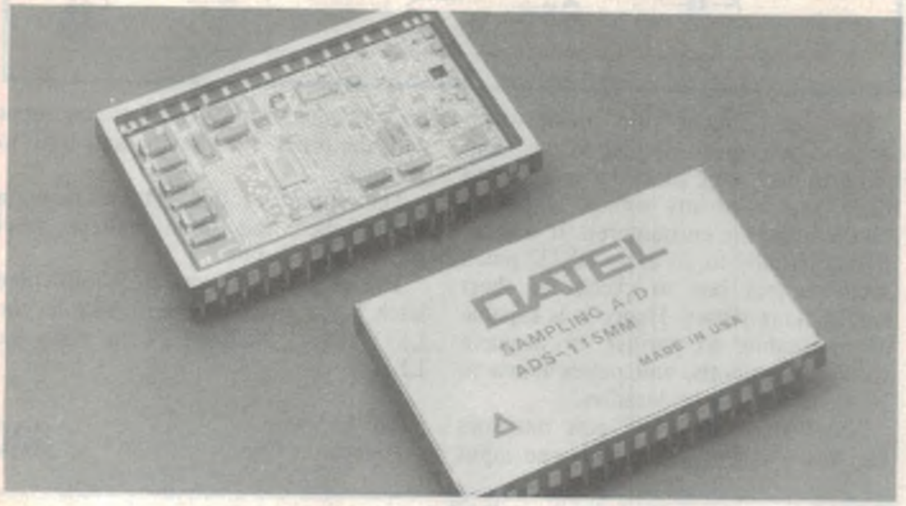

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A new 10-bit A/D converter from Datel solves critical circuit layout and thermal problems by combining both a tracking sample/hold amplifier and the A/D converter in one miniature 32-pin hybrid ceramic package. Models ADS-115 and ADS-116 measure only 1.1" x 1.712" x 0.190" and feature hermetically sealed performance over both commercial (0°C to +70°C) and military (−55°C to +125°C) temperature ranges with optional high reliability screening. These devices offer true 10-bit A/D performance with conversion rates up to one million samples per second.

The products are very suitable for single or multi-channel applications needing data points from a rich spectral content signal. Larger-array FFT sizes of 1024 points or beyond are suggested. Typical usage would include high speed data acquisition and process control systems, DSP applications, imaging, transient analysis, communications signal processors, medical scanning, acoustic, seismic, vibration and resonance analyzers.

Two input voltage ranges are offered in addition to the two temperature ranges. Model ADS-115 accepts unipolar signals from 0 to +10 volts, whereas the ADS-116 has a bipolar input of −10 to +10 volts full scale. The ADS-115 offers 10 binary bits of resolution and the ADS-116 uses the most significant bit to indicate polarity plus 9 data bits. Another advantage of including the Sample/Hold with the A/D converter is that the input impedance is 15 megohms, unlike many non-sampling A/D's. This avoids loading errors in sensitive circuits.

Both models are fabricated using a proprietary gate array which handles all internal timing. TTL/CMOS-compatible data and overrange outputs may be three-state gated for shared computer data busses in both byte-wide and full word widths.

For further information contact Elmeasco Instruments, 12 Maroondah Highway, Ringwood 3134.

Switcher IC for low RFI

Switched mode power supplies are widely used for many reasons, including small size and high efficiency, but they generally need particular attention to reduce noise injected into the supply source. The circuit of Siemens SMPS IC TDA4814 may be configured in mains driven supplies so that the loading on the mains is sinusoidal, minimising RF interference and other problems

The device is therefore useful in applications where the load on the mains is normally non-sinusoidal or undesirably reactive, for example its use in electronic ballast circuitry for fluorescent lamps.

The TDA4841 is available from Australian stock.

Further information is available from Electronic Components Dept. Siemens Ltd, 544 Church Street, Richmond 3121 or phone (03) 420 7314.

Micropower dual op amp

Precision Monolithics has introduced the fourth member of its "next generation" dual operation amplifiers, the OP-290 precision low voltage micropower dual op amp.

The OP-290 draws less than 20uA of supply current per amplifier, which is 200 times less than the industry standard OP-07, but is able to drive over 5mA per amplifier into a load. Power supply voltage for the OP-290 ranges from +1.6V to +36V in single-supply operation and from ±0.8V to ±18V in dual supply operation.

The OP-290 is a true single-supply device with both input and output voltage ranges including ground. In single-supply applications, the Op-290 allows "zero-in, zero-out" capability.

Input offset voltage is under 200uV with a maximum input offset voltage drift of only 2uV/°C over the military temperature range. Open-loop gain exceeds 700,000 ensuring excellent gain accuracy, even in high-gain applications. The OP-290's common-mode rejection of over 90dB and power-supply rejection ration of 5.6uV/V maximum, significantly reduce errors caused by ground noise and power supply fluctuations experienced in battery or solar powered applications.

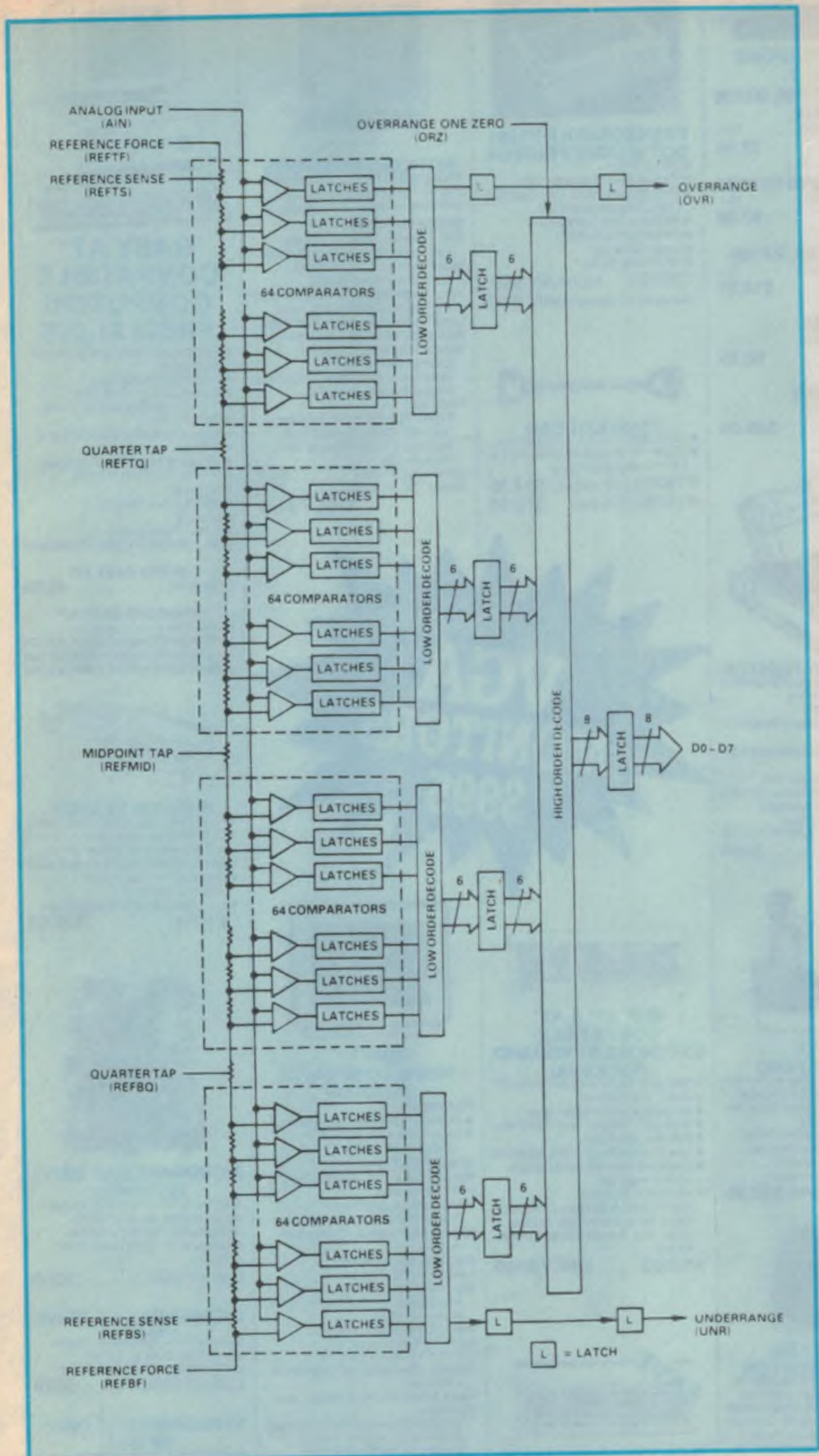
The OP-290 conforms to the industry standard 8-pin dual op amp pinout and can be used to upgrade systems using the LM158A/258A/358A and ICL7621.

For further information contact VSI Electronics (Australia), 16 Dickson Avenue, Artarmon 2064 or phone (02) 439 4655.

200Ms/sec flash ADC

Waveform digitizers, radar, communications systems, digital radio, microwave telecommunications, and test instruments should benefit from the extremely wide bandwidth of Analog Devices AD770 analog-to-digital converter (ADC). Using a "flash" architecture, the monolithic AD770 provides an 8 bit output at 200megasample/second, with 250MHz full-power and 400MHz small-signal bandwidths.

Unlike existing limited-bandwidth units, the bandwidth of this converter allows low distortion sampling of



Block diagram of Analog Devices' new AD770 flash ADC, which provides 8-bit conversion at 200 megasamples per second.

100MHz Nyquist-frequency signals. Additional benefits include accurate sampling of high-frequency signals without an external sample/hold, fast settling when a high-speed external sample/hold is used, and sampling of signals beyond the Nyquist frequency (undersampling/decimation).

The analog input range can be unipolar or bipolar – especially useful in RF applications where the signal is AC-coupled – and set to any span within a ±V range by the two reference inputs. To allow accurate endpoint adjustment, force and sense taps are available for these reference voltages. The reference resistor ladder also provides taps at mid – and quarter-points, for improved RF decoupling; sophisticated designs can also use these taps to curve the ADC transfer function when a specific nonlinear shape is needed.

A proprietary error-correcting scheme within the converter greatly reduces erroneous output "sparkle codes" that are typical of flash converters. All digital outputs are ECL-compatible.

Using standard −5.2V and +5V supplies, power consumption is 1.7W maximum. The AD770 is available in a 40-pin ceramic DIP.

Further information from Parameters, Centrecourt, 25-27 paul Street Nth., North Ryde 2113 or phone: (02) 888 8777.

60V ultra high efficiency switcher

The New Era SH1605ATSC positive adjustable pulse width modulated voltage regulator building block is designed for buck, fly-back and forward type switchers.

Capable of continuous load currents in excess of 5 amperes, the SH1605A-TSC has an output range of 3 to 55 volts. Its control circuits provide true PWM output regulation in conjunction with a high current/high voltage switch and ultra soft recovery free wheeling diode.

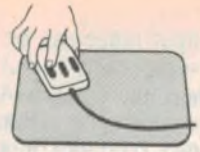
Output voltage and switching frequency are adjustable for optimum circuit performance in your application. Internal compensation insures stable operation over a wide range of circuit and ambient conditions.

Other features include:

- 60 volt input
- Fixed frequency PWM control.
- Adjustable operating frequency to 150kHz
- Ultra fast soft recovery free wheeling diode.
- High efficiency, typically greater than 80%.

For further information contact your local George Brown Group office or George Brown Group Marketing Division, 456 Spencer Street, West Melbourne 3003. Phone (03) 329 7500.

ROD IRVING ELECTRONICS



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BARGAIN!

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CP80, SX80, DP80, BX100 MB100 (C22036)
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1-9 **$8.95** — 10+ **$7.95**

MX100, FX100, RX100 (C22002)
1-9 **$19.95** — 10+ **$18.95**

LX80 (C22003)
1-9 **$9.95** — 10+ **$8.95**

LQ1000 (C22012)
1-9 **$27.60** — 10+ **$25.00**

STAR NX1000 PRINTER
- 144 c.p.s. high speed draft printing
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- Proportional printing available in all font styles
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C22049 .... $495

DELUXE PRINTER STAND
- Restores order to your work area without occupying extra space
- Feeds and refolds paper under the printer automatically
- Adjustable paper deflectors to ensure smooth flow of paper
- Made of moulded plastic
- Suitable for most printers

C21058 80 column **$89.95**

THE BUTTON SPIKE PROTECTOR
Surges and spikes are caused not only by lightning strikes and load switching but also by other equipment being switched on and off, such as fluorescent lights, electric motors, fridge freezers, air conditioners, etc.

For effective protection such spikes must be stopped before they reach your equipment. Simply plug The Button into an outlet and it will protect all equipment plugged into adjacent outlets on the same branch circuit. The Button employs unique metal oxide varister technology and will dissipate 150 joules of electrical energy. (nearly twice that of comparable surge arresters.)

SPECIFICATIONS:
Voltage: 240V Nominal
Total Energy Rating: 150 joules
Response Time: 10ns
Protection Level: 350V peak

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- 120 C.P.S.
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- Print Modes: NLQ, Dot Graphics, Draft, Proportional Font
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- Logic Seeking
- 1K Printer Buffer

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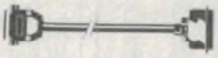

PRINTER LEAD
- Suits IBM* PC/XT, compatibles
- 25 pin "D" plug (computer end) to Centronics 36 pin plug

P19029 (1.8 metres) **$14.95**
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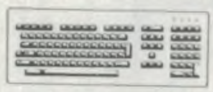
PRICE BREAKTHROUGH!
VGA MONITORS
$995



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These new keyboards are both XT* and AT* compatible!
- 20 Dedicated function keys
- Enlarged "Return" and "Shift" key
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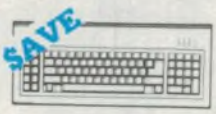
- Low Profile Design, DIN standard
- Separate Numeric and Cursor control keypads
- Additional Functions: Key-in-lock, Audio Beep, Previous Word, Next Work, Fast Repeat, Line Feed, Pause, Clear Screen, Reset

X12022 ...... **ONLY $109**



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IBM* XT* COMPATIBLE KEYBOARD
- 100% IBM* PC*, XT* compatible
- Low profile keyboard design
- Proper placement of shift keys with large key tops to suit professional typists
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- Cherry brand TS-M00001 19mm low profile switches, meet 30mm ergonomic requirement and provides high performance and maximum reliability
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- 3 Status displays

Just like the "Real McCoy" only at a fraction of the price!

Cat.X12020 .... **only $89**

RITRON 2 MONITORS
Stylish 20MHz monitors available in green or amber displays and with built-in swivel and tilt base

SPECIFICATIONS:
CRT Display Size: 12 inches non-glare 90 degree deflection
Input Signal: 1.0 - 2.5V p-p composite video signal
Input Impedance: Normal 75 ohm, high approximately 50K ohm
Input Terminals: RCA phone jack
Rise and Fall Time: Less than 25 us
Video Bandwidth: 20MHz
Corner: 800 lines
Geometric distortion: 2% or less
Linearity: less than 2%
Controls:
Front: Power On/Off, brightness, contrast. **Rear:** Vertical hold, Horizontal hold, Vertical line, Vertical size

Green Cat X14506 .... $179
Amber Cat X14508 .... $179
ONLY $149

ZDIN 12" 20MHz COMPOSITE MONITOR
FEATURES....
- High contrast, non-glare screen
- High resolution, 80 or 40 character display

SPECIFICATIONS....
Picture tube: 12" diagonal and 90° deflection
Phosphor: Available in Green or Amber
Video input signal: Composite Signal
Polarity: Negative Sync
Level: 0.5V-2.0Vp-p
Scanning frequency:
Horizontal: 15.734KHz + - 0.1%
Vertical: 60Hz
Video bandwidth: 20MHz
Active display area: 216(H) x 160(V)mm
Display character: 80 characters x 25 rows
Input terminal: RCA Phono Jack
Controls:
Outside: Power Switch, Contrast, Brightness, H-Shift, V-Size
Inside: H-Width, H/V hold, H/V linearity, Focus
Power supply: 110/120V 60Hz, 220/240V 50Hz
Dimensions: 308(W) x 307(H) x 297(L)mm
Weight: 7.3 Kg
Shipping weight: 8.3 Kg

CAT.No	DESCRIPTION	PRICE
X14514	(GREEN)	$129
X14516	(AMBER)	$129

SPECIAL, ONLY $119
(10 OR MORE $109 EACH!)

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- Final assembling and testing in Australia!
- 1 M/Byte Main Board
- Switchable 8/10/12 MHz
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- 80286 CPU
- Colour Graphics Display Card
- 8 Slots
- Floppy & Hard Disk Controller
- Printer Card and RS232
- Keyboard
- 200W Power Supply
- Manual
- 6 Months Warranty
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SHORT BABY AT*
512K RAM **$1,895**

STANDARD BABY AT*
640K RAM, hard disk drive....
& 20 M/BYTE HARD DISK $2,195
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- Restores order to your work area.
- Conveniently stacks paper printout in document tray automatically
- Made of black plastic coated steel
- Suitable for most printers (80/132 column)
- Excellent value at these prices!

C21054 .... **$26.95**

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Slimline 5 1/4" disk drive, double sided, double density. 500K unformatted, 360K formatted 40 track/side. Steel band drive system

Cat. C11901 .... **$239**

MITSUBISHI 5 1/4" DRIVE 4854/MF504
Slimline 5 1/4" disk drive, double sided, high density. 1.6MB unformatted, 1.2MB formatted

Cat. C11904 .... **$279**

MITSUBISHI 3 1/2" DRIVE MF353C
Double sided, double density, 1MB unformatted, 720K formatted

C11908 .... **$239**
C11909 Incl 5 1/4" mount bracket **$269**

MITSUBISHI 3 1/2" DRIVE MF355
1.6 M unformatted, 1.44M formatted

C11910 .... **$269**
C11911 Incl 5 1/4" mount bracket **$299**

5 1/4" MOUNTING BRACKET KIT FOR 3 1/2" DRIVE
X11050 .... **$29**

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20 M/BYTE HARD DISK
Tandon drive with controller card. IBM* compatible. 12 month warranty
X20010 ...... **ONLY $495**

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With controller **$695**

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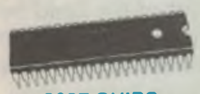
X20030 ... **ONLY $2,490**



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& single 360K Disk Drive $3,895
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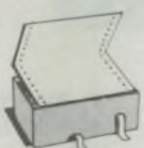
COPY HOLDER (YU-H33)
- Copy area 9½" x 11"
- Sliding line guide
- Flat metal base

C21060 .... **$39.95**



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Quality paper at a low price! 2,000 sheets of 70 gsm bond paper
C21003 11 x 9½" **$39.95**
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THOMSON EGA MONITOR
Top quality high resolution EGA monitors with a space-age design

SPECIFICATIONS:
CRT: 14 inch (360mm) diagonal, 90 degree deflection
Display Size: 245(H) x 180(V)mm
Phosphor: P22, non glare, tinted screen
Dot Pitch: 0.38mm
Video Bandwidth: 18 MHz
Resolution: 15.75KHz - 640 x 200; 21.85KHz 640 x 350
Input Signals:
1. RGBI - positive, H(+), V(+)
2. RrGgBbI - positive, H(+), V(−)

Input Impedance: 330 ohms
Dual Scanning Frequency:
Horizontal: 15.75 KHz or 21.85 KHz +- 10Hz
Vertical: 50 - 60 Hz
Connector: 9 pin, D-type
Size: 312(H) x 363(L) x 380(W)mm
Weight: 10.8 Kg (Net)

X14525 .... **$695**
EGA CARD **$195**

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3½" DISK STORAGE (DD80-L)
- Holds up to 80 x 3½" diskettes
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base
- Contemporary design

C16038 ..... **only $19.95**

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- Holds up to 40 x 3½" diskettes
- Lockable (2 keys supplied)
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C16035 ..... **only $14.95**

COPY HOLDER (YU-H32)
- Adjustable arms allows easy positioning
- Copy area 9½" x 11"
- Sliding line guide
- Clamp mounting

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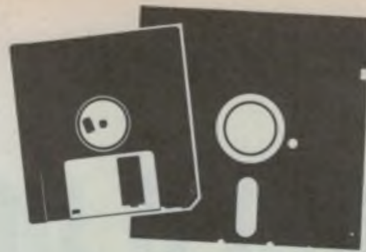
JUMBO 5¼" DISK STORAGE (DD120-L)
If you have lots of disks, you'll appreciate the extra capacity of this disk storage unit when it comes to locating a particular disk.
Features...
- 120 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact plastic base

C16028 ..... **only $19.95**

5¼" DISK STORAGE (DD50-L)
Efficient and practical. Protect your disks from being damaged or lost!
Features...
- 50 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- Contemporary Design

C16025 ..... **only $14.95**



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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).

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10+DISKS	100+DISKS	1,000+DISKS
$6.75ea	$6.50ea	$6.25ea

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5¼" HIGH DENSITY DISKS
(DOUBLE SIDED)

10+DISKS	100+DISKS	1,000+DISKS
$23.95ea	$22.95ea	$21.95ea

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3½" 2S/2D "NO BRAND" DISKS

10+DISKS	100+DISKS	1,000+DISKS
$23	$22	$21

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MICRODOT DISKS!
FREE PLASTIC LIBRARY CASE WITH EVERY 10 DISKS!

DESCRIPTION	1-9 BOXES	10+ BOXES
3½" 2S/2D	$32.95	$30.95
5¼" 1S/2D	$ 9.95	$ 9.50
5¼" 2S/2D	$11.95	$10.95
5¼" 2S/HD	$23.95	$22.95

5¼" DISK STORAGE (DD100-L)
Efficient and practical. Protect your disks from being damaged or lost!
Features...
- 100 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)
- High impact ABS plastic base
- Contemporary design

C16020 .... **only $15.95**

DATA TRANSFER SWITCHES
If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 WAY RS232	X19120	$49
4 WAY RS232	X19125	$59
2 WAY Centronics	X19130	$49
4 WAY Centronics	X19135	$59

Product Review:

Icom's new IC-A20 air band handheld

The new Icom IC-20A looks much the same as other hand-held transceivers, but inside there's a hidden bonus for glider pilots, balloonists and other flyers: a VOR navigation receiver, capable of displaying your bearing and course heading. It covers all 720 COM channels and 200 NAV channels in the VHF aircraft band.

Icom communications gear has a very good reputation for performance and reliability, and the company's new IC-A20 hand-held VHF air band transceiver looks to be no exception.

Although it's physically much the same size and weight as say a 2-metre amateur radio handheld – 65 x 198 x 35mm, and 675 grams – the IC-A20 provides not just a 720-channel communications or 'COM' transceiver, but a 200-channel air navigation (NAV) receiver as well. This uses the VOR (VHF Omnidirectional Ranging) system, which is capable of indicating both an aircraft's bearing with relation to a selected VOR transmitter, and its deviation from a designated course heading.

With this combination of features, the IC-A20 looks like being very suitable for glider pilots and balloonists, as a low-cost and self-contained COM/NAV set. Even though it has only just been approved by the Department of Transport and Communications, I gather sailplane pilots and hang-gliders in particular are showing great interest already.

This is hardly surprising, because it's not only very compact but costs less than half the price of a typical instrument-panel type COM/NAV setup. I gather it's also either the first dual-function aviation handheld to be approved in Australia, or at least the first to come from an organisation the size of Icom and able to provide full-scale service and support.

It should also be of great value to pilots of light aircraft, as an emergency backup – although it's apparently not as yet approved for this purpose.

I imagine another important use for it will be as a readily portable and convenient ground station, for communicating with a glider, balloonist or light aircraft pilot while they're aloft.

Small wonder that Icom has been selling around 2000 units per month overseas already, and expects the IC-A20 to have a similar market here.

But enough preamble. Now let's look at the details. As a communications transceiver the IC-A20 tunes from 118.000MHz to 135.975MHz, the 'COM' section of the aircraft band. This section is divided into 720 channels, spaced 25kHz apart, and the IC-A20 will both transmit and receive on each and every one. It will also scan through them, using its scanning facility.

It actually has *three* scanning modes, one of which is the 'Full Scan' across all COM channels. The second main mode is 'Memory Scan', which scans through up to 16 selected channels stored in the IC-A20 memory. And the third mode is 'Lockout Scan', which again scans through the memory channels, but skips past those you have flagged as "locked out" (i.e., not to be scanned).

All three modes of scanning can be arranged to operate in either direction – upwards or downwards, in terms of frequency channels or memory channels.

For NAV/VOR receiver operation the IC-A20 tunes over the full 10MHz range from 108.000MHz to 117.975MHz, in 25kHz steps as before. Although this corresponds to a total of 400 possible channels, I gather that this part of the band is currently only divided into 200 NAV channels, spaced on 50kHz multiples.

In fact in Australia, almost all of the VOR stations in use are apparently on *even* 100kHz multiples, and in the part of the band between 112MHz and 117.90MHz. The part of the band below 112MHz is reserved for ILS (instrument landing system) transmissions, such as the 'Localiser' transmissions used to guide pilots in lateral approach to airstrips.

So the rather higher resolution of the IC-A20 will be a bit redundant, at least for the time being. Not that this is a problem, of course.

Incidentally the IC-A20 will actually detect a localiser station, and show a 'LOC' message on its display. But it can't make further use of the localiser signals, in the same way that it calculates bearings using VOR signals.

The VOR system

How does the VOR system of navigation work? If you don't know, there's no need to be embarrassed. Most people in electronics probably don't know much about it either, unless perhaps they've had experience of flying and aircraft avionics.

I have to confess that before the IC-A20 turned up for review, I had barely heard of it myself. All I knew was that it used VHF radio transmissions from special stations dotted all over the country, and that most small aircraft at least had a receiver in the instrument panel which used the transmissions to work out and indicate either the plane's bearing with respect to a station, or its deviation from a planned course heading.

But as soon as the IC-A20 turned up, I realised that I'd need to find out somewhat more about the system – and fast. So I tried contacting one of the local avionics firms, and struck immediate pay dirt in the form of Mr Brad Granger, of Dasyl Avionics at Bankstown airport.

Mr Granger was very helpful, both explaining the basics to me over the phone and sending me some training literature on the subject. So after his help and some quick boning up on the sub-

ject, I think I can give you at least a basic idea of how the VOR system works. Here goes, anyway:

Each VOR station transmits effectively two different 30Hz signals, on a continuous basis. One signal has exactly the same phase in all compass directions, while the phase of the other signal varies according to the compass direction from the station. The phase of the two signals coincides only in the 'radial' direction of due North from the station.

By demodulating and separating the two signals, and then comparing their phase, a VOR receiver can therefore work out on which compass 'radial' from the station it is located. In other words, it can indicate the current *bearing* of the receiver (and the aircraft carrying it) with respect to the VOR station concerned.

If desired, the position along that bearing or radial can be determined by tuning to a second VOR station, and repeating the procedure. This will give another bearing, and by plotting the intersection of the two on a map you can therefore work out the actual position – the technique known as 'triangulation'.

So that's the basic idea of VOR. Now for a little more detail.

There are two RF signals radiated by a VOR station, both at the same frequency in the 108-118MHz band. One is from a fixed omnidirectional antenna, radiating equally in all horizontal directions. This signal is *amplitude modulated* by a 9960Hz subcarrier, which is in turn *frequency modulated* by one of our two 30Hz signals. After demodulation this signal forms the VOR receiver's reference phase signal.

The second RF signal radiated by the VOR station is electrically unmodulated, but fed to a horizontal dipole antenna which is rotated mechanically at the rate of 30 revolutions per second.

Being a dipole, this second antenna produces a 'figure-8' shaped RF field, with the radiation in one lobe exactly in phase with the radiation from the fixed antenna, and the other exactly out of phase. So as the antenna and its field rotate, the radiation from the 'in-phase' lobe will add to the radiation of the first antenna, while that from the other lobe will subtract from it.

The nett result of this addition and subtraction is to produce a heart-shaped or *cardioid* radiation, rotating at 30 times per second. And this in turn causes the signal received in any direction from the VOR transmitter to be amplitude modulated at a frequency of 30Hz, with a phase depending on its bearing from the station.

Only along the 'due North' radial from the station will the phase of this 30Hz amplitude modulation coincide with that of the 30Hz signal transmitted via frequency modulation of the station's 9960Hz subcarrier. In all other directions it will lag behind in phase, by the same number of degrees as the compass bearing.

For example due East of the station, it will be lagging by 90°; due South from the station, it will be opposite in phase, or lagging by 180°; and due West, it will lag by 270°. Similarly for all points in between these main bearings, its phase will correspond to the exact bearing.

In the VOR receiver, the output from the main demodulator consists of the variable-phase 30Hz amplitude modulation, together with the frequency-modulated 9960Hz subcarrier. The variable phase signal is separated by passing it through a low-pass filter, while the subcarrier is 'cleaned up' by passing it through a limiter. It is then fed to an FM detector, which recovers the original 30Hz reference phase signal.

By comparing the reference-phase and variable-phase signals in a phase comparator, the VOR receiver can then indicate the bearing angle to the station. In conventional instrument-panel VOR receivers this may be done using either a servo-driven rotary dial, or in more recent models via a digital readout.

As an alternative to reading out the bearing itself, the receiver may allow you to feed in the desired course bearing with respect to the station concerned, and it will then indicate your deviation from that course via a *course deviation indicator* or 'CDI'.

This is done by using the desired course information to program a phase shifter, which shifts the 30Hz reference phase signal by the appropriate number of degrees. The CDI will then indicate 'on course' only when the variable-phase 30Hz signal corresponds to this phase.

Generally with conventional instrument-panel VOR displays the CDI takes the form of a vertical needle, which moves from side to side to indicate course deviations. Only when the needle is in the centre of the dial are you proceeding along the desired bearing radial, either towards or away from the VOR station concerned.

With the IC-A20, all indication is via a small LCD display panel. This indicates station frequency and channel memory number in the centre, with mode indicators at the top and VOR indications below. The bearing is indicated digitally, while the CDI display is via a small horizontal 'dial' with dots indicating 2° deviation increments. 'On course' is indicated by a small diamond in the centre, while deviations to either side are indicated via a variable number of small triangular 'arrow heads'.

Other features

Other features of the IC-A20 include a backlight for the LCD display, built-in AGC and ANL to reduce fading and impulse noise, adjustable squelch, one-touch access to the air band emergency frequency of 121.500MHz and switchable transmitter output power to conserve battery power.

Air band handheld

Transmitter power output in the 'High' position is 1.5W (5W PEP), and in the 'Low' position 500mW (1.6W PEP). Receiver sensitivity on the COM section of the band is 1.0uV for 6dB S/N ratio with a 1kHz signal and 30% modulation, with a corresponding figure of 2.0uV for the NAV section of the band. Audio power output from the receiver is 500mW at 10% THD into the internal speaker or an external 8-ohm load.

By the way, the IC-A20 is capable of duplex operation, being able to switch back and forth between designated NAV and COM channels.

The IC-A20 is very solidly made, and is fitted with a belt clip attached to the back of the case. It comes complete with rechargeable battery pack, which clips to the bottom of the transceiver itself. Also included is a carrying case, plug-pack charger, cigarette-lighter cable, earphone, user manual and of course the appropriate 'rubber ducky' flexible whip antenna (where did that name come from?).

User reactions

This was one of those products where it wasn't easy to carry out really thorough tests. Not having a licensed pilot on our staff, we couldn't really put the IC-A20 through all of its paces 'in the field'. All we could do was try out the receiver in a number of typical locations on the ground, and check the transmitter output working into a dummy load.

Needless to say, the transmitter section checked out fine – as you'd expect from any product coming from a firm like Icom, and particularly one that has been approved for air-band use by the Department of Transport and Communications.

On the receiver side it had plenty of sensitivity, and we could easily 'eavesdrop' on all sorts of conversations between aircraft and traffic controllers at the nearby Sydney and Bankstown airports. Picking up VOR stations wasn't so easy, but then we were on terra firma, after all...

Overall we were quite impressed by the IC-A20, which seems to us a very nicely made little unit. The combination of a 720-channel COM transceiver with scanning, plus a VOR/NAV receiver seems likely to give it a lot of appeal for people associated with aviation.

But how is it likely to be greeted by those for whom it's designed? Not being a pilot or glider myself, I rang Mr Terry Neumann, radio officer for the Gliding Federation of Australia, for some background and expert reactions to the advent of the IC-A20.

A close-up of the IC-A20's display and keyboard, with the other controls visible at the top. The VOR indications appear on the LCD panel below the frequency indication.

Like Brad Granger, Terry was also very helpful. He said that the release of the IC-A20 would be greeted with great interest by sailplane enthusiasts and balloonists alike. Apart from anything else, this is because until now there really hasn't been an aviation 'handheld' available in Australia from a firm like Icom, able to provide really good backup and support.

There *have been* other hand-held transceivers, but only in relatively small numbers and lacking the same kind of support. And although the IC-A20 is a little more expensive than some of the existing units, it does provide the VOR facility. Some earlier units did apparently provide this facility, but according to Terry these were 'very rare'.

He said he thought the IC-A20 would become very popular for communication between ground support people and glider pilots, because of its compactness and light weight. The VOR facility would probably make it popular for use in gliders/sailplanes also, bearing in mind that its price of around $1100 ($970 plus tax) is less than half that of typical instrument-panel COM/NAV sets.

However Terry did make two qualifications. One was that hand-held gear like the IC-A20 could be a mixed blessing in a sailplane. Not being fastened down, it could fly around inside the cabin if the craft encountered turbulence and air pockets, and damage either itself or other things – including the pilot!

He would therefore recommend that it be fixed inside the cabin in a suitable mounting bracket or fitting. (I notice that Icom does list what is called an optional 'Mobile Bracket', the IC-MB16, and also a 'Wall Bracket', the IC-MB16D.)

Terry's other qualification was that the IC-A20's VOR facility might turn out to be of limited appeal to glider pilots, as many gliding clubs operate from airfields which don't have this facility. The use of such navigation aids is apparently also prohibited in some gliding contests.

Still, he did agree that the VOR would probably make a great 'bragging feature', and add significantly to the IC-A20's marketing appeal...

All in all then, even an expert like Terry Neumann seems to be quite impressed with Icom's new offering for the aviation band. The IC-A20 therefore looks set to become a very popular unit, and a worthy addition to the Icom range.

Further details on the IC-A20 transceiver are available from Icom Australia at 7 Duke Street, Windsor 3181 or phone (03) 529 7582.

In closing, my grateful thanks to Brad Granger of Dasyl Avionics, and Terry Neumann of the Gliding Federation of Australia, for their kind help in preparing this article. (J.R.)

Broadcast band loop antennas – 1

Here is the first of three articles taking a critical look at the performance of different types of antenna for broadcast band radio reception, based on extended research by the author. Later articles will describe improved antenna designs.

by NOEL S. ERBS

Over the last two years I have devoted a considerable amount of time and effort investigating different types of antennas for broadcast band reception. While my observations generally support previously published work, some claims made for loop antennas could not be duplicated.

At the risk of trying to reinvent the wheel, I have summarised in these articles my recent experience with antennas in a quest for good quality broadcast band reception in Wagga Wagga during daylight hours.

The initial spur to tinkering with antennas was aimed at pulling in Sydney station 2KY for a friend, who valued their weekend sporting coverage. While the following comments make reference to 2KY, they apply equally to many other distant stations and are intended simply as statements of fact. No criticism of 2KY is intended or implied.

Table 1 lists commercial (C) and ABC (N) stations received in Wagga Wagga, together with rated power and line-of-sight distances. Note that several ABC repeaters have been omitted from this list because they offer no program or signal strength advantages over, say 2CY or 2CO. Callsigns, locations, and transmitter rated power information are taken from the AM station listing which was published in the March 1986 issue of *Electronics Australia*. Distances were mainly scaled from a Shell road map, although that for 2WG was determined by direct road measurement.

The only station close enough to my location to be immune to fading and distortion in the early morning and at night is 2WG.

Receiver used

The principal receiver used to evaluate comparative antenna performance was a Sony ICF2001 PLL Scanner. This receiver has a 5-LED signal level indicator and an antenna attenuator switch with DX, NORMAL and LOCAL positions. It is also fitted with an ANTENNA TUNE thumbwheel, which was adjusted for a peak in each case.

Observations have established the following overlap between LED ranges:

DX	1	2	3	4	5						
NORMAL				1	2	3	4	5			
LOCAL							1	2	3	4	5
LEDs	1	2	3	4	5	6	7	8	9	10	11

The antenna used for signal strength comparisons was a 20m wire, basically an inverted "L", running E-W and approximately 5m above the ground. With this antenna, 2WG and 2CO clearly exceeded a 5-LED reading on LOCAL.

A resistive divider (Antenna-470R-antenna in-100R-ground) was found to reduce the 2WG signal to exactly 5 LEDs on LOCAL. Attenuation for six reference stations is plotted against frequency in Fig.1.

While the attenuation of the stations used in Fig.1 shows some frequency dependence, it is close to 4 LEDs. Extrapolated LED rankings for 2CO of (9+4) = 13 and 2WG of (11+4) = 15 are therefore reasonably accurate.

Signal comparisons

Using this antenna, the Sony gives typical relative signal strengths during mid-afternoon as in Fig.2. Note that the figures shown were averaged from readings taken within 30 minutes between 1pm and 4pm on four different days. The Antenna Tune thumbwheel was peaked, but no separate antenna tuner was used. Stations 2XX, 2KY and 3DB are included for comparison only as selected examples of weak stations.

It would be nice to predict subjective sound quality on the basis of observed signal strength, but this is not always so. In general, a LED ranking above about 9 gives "no fuss" reception, and six stations fall into this category.

Six more stations have a LED ranking between 9 and 7 and their reception is more susceptible to interference. Stations ranking below 7 usually contain an unacceptable level of background hiss for relaxed listening. However, there are some anomalies.

For example, recovered audio from 3AR and 3LO is disappointing compared to 2CR, considering their 50kW output and ranking, and 2CA reception

Table 1: Commercial (C) and national (N) stations received in Wagga Wagga, showing transmitter power and distance away. These were the signals used for the author's investigations.

Location	Callsign	Power kW	Distance km
Wagga Wagga	2WG(C)	5	12
Albury	2AY(C)	2	115
Young	2LF(C)	5	120
Corowa	2CO(N)	5	130
Griffith	2RG(C)	5	150
Canberra	2CA(C)	5	160
Canberra	2CY(N)	10	160
Wangaratta	3NE(C)	5	170
Deniliquin	2QN(C)	2	215
Shepparton	3SR(C)	2	220
Cumnock	2CR(N)	50	275
Swan Hill	3SH(C)	2	340
Sydney	various		350
Melbourne	various		350
Horsham	3WV(N)	50	490
Renmark	5RM(C)	2	590

is usually better than the signal level suggests. Another interesting comparison is between 3NE and 3SR. The latter, at only 2kW and 220km ranks 8 LEDs, easily out-performing 3NE at 5kW and only 170km, ranking 4 LEDs. Figure that one out!

In the long distance stakes, 3WV at 490km is nearly as strong as 2CR, and 5RM at 590km falls not far short of 2FC in Sydney.

Comparing with theory

A theoretical treatment of propagation from a vertical dipole on a resistive plane is given in that well-known classic work, *Radiotron Designer's Handbook* by F. Langford-Smith. In essence, transmitted field strength diminishes as a function of the number of wavelengths from transmitter to receiver, but the effective capture area of a given receiving antenna is also a function of wavelength, and the two relationships combine to express the signal recoverable from an antenna as:

Signal = constant x Pt/D ....(1)
where Pt = transmitted power (kW), and D = distance (km).

As a matter of interest, the signal strengths established as LED rankings and plotted in Fig.2 were plotted against power/distance in Fig.3. The broad scatter of points makes the assumptions about a plane surface and soil conductivity look rather suspect.

Note that no account is taken here of the effect of directional antenna installations which may be in use at some transmitter sites, and the 20m wire is assumed to be non-directional.

Daylight reception

The usual DX problems exist for weak signal reception during daylight hours. These are listed below in two groups, over which a listener has:

(a) No control:

1 A weak signal buried in background atmospheric noise;
2 Occasional periods of appallingly noisy propagation conditions;
3 Ride-through at night of remote stations on the same frequency;
4 Static from regional thunderstorm activity.

(b) Some control:

5 Local electrical interference;
6 The likelihood of receiver front-end noise intruding;
7 Adjacent station breakthrough.

We will not consider the first group. With weak signals (less than 7 LEDs), near field interference from colour TV line scan whistle, mains switching tran-

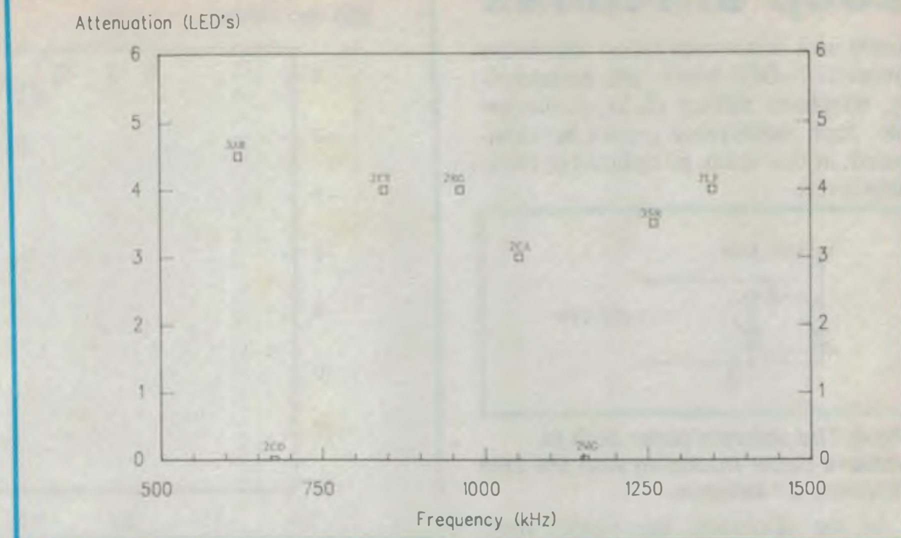

Fig.1: Signal strengths with a 470/100 ohm antenna voltage divider.

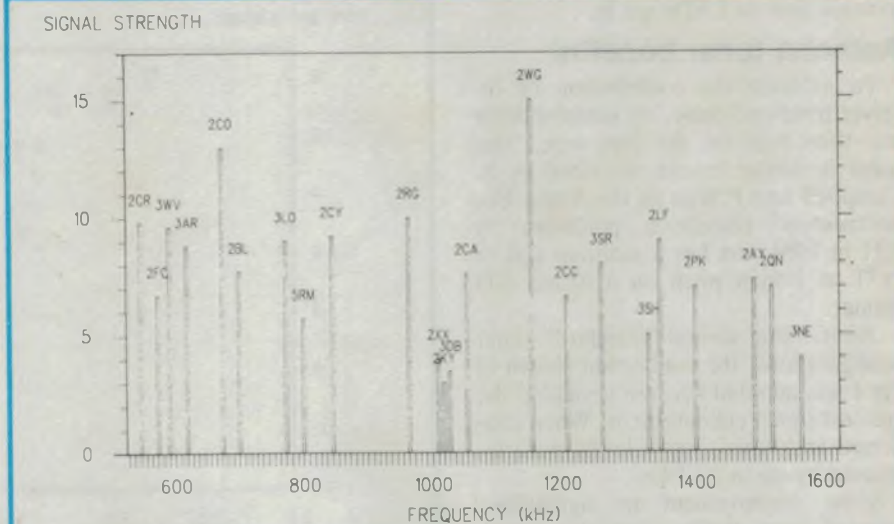

Fig.2: Relative field strengths plotted during mid-afternoon.

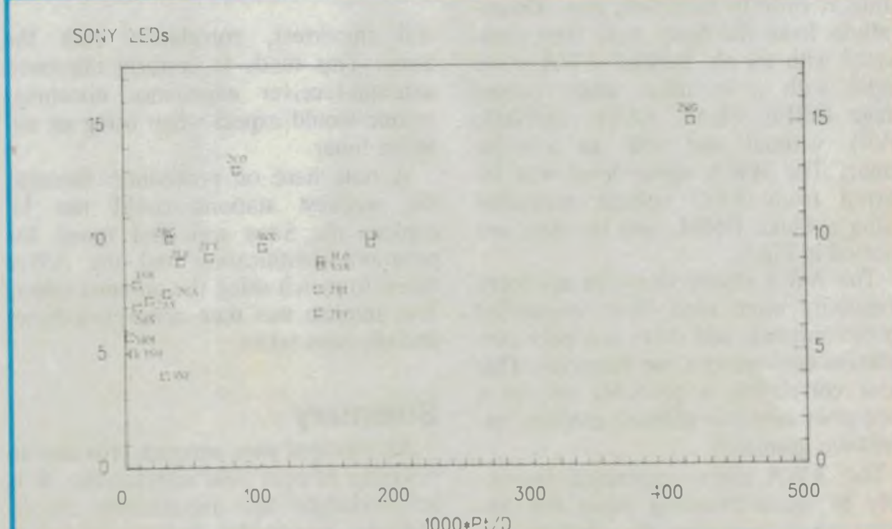

Fig.3: The same results plotted against power/distance.

sients, sick fluorescent tubes, microwave ovens (ON-OFF hum), and occasionally, telephone dialling clicks, is inevitable. Such interference cannot be eliminated; at best it can be reduced to tolerable levels.

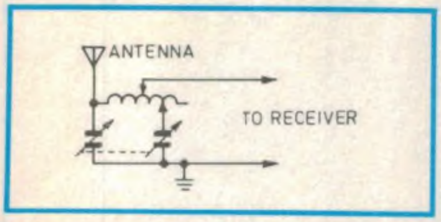

Fig.4: The antenna tuner built to achieve better matching with the 20m "inverted L" antenna.

In the afternoon, the signals from 2KY and other distant stations are often almost buried in background noise and so weak that no LEDs are lit.

Antenna tuner benefits

To evaluate the contribution of receiver front-end noise, an antenna tuner was then built for the 20m wire. This tuner is similar to one described by S. Campbell and P.Wait in the *Radio Experimenters' Handbook* published by ETI in 1984, but has a multitap coil of 117T at 1.4mm pitch on a 67mm OD former.

After trying several "standard" tuner configurations, the connection shown in Fig.4 was adopted because it yielded the greatest signal enhancement. When connected and tuned, signal levels were increased by up to 2 LEDs.

Some improvement in signal/noise ratio of weak stations was also noted. This is hardly surprising, as one would expect some receiver noise when operating at close to maximum gain. Observations from the Sony were then compared with an old faithful AWA valve radio with a modified audio output stage (6BE6, 6BA6, 6AV6, 2x6BM8, 6V4), without and with an antenna tuner. The AWA signal level was inferred from AVC voltage measured using a Fluke DMM, and the data are plotted in Fig.5.

The AWA clearly shows its mediocre sensitivity when used direct connected to the antenna, and there is a poor correlation between the two receivers. This poor correlation is probably due to a frequency sensitive antenna-receiver impedance mismatch.

The AWA radio responded favourably to signal boosting using the antenna tuner, and even the weakest stations from Table 1 could be reliably copied. Fig.6 shows a much better, but still imperfect, correlation with the Sony. This tends to confirm improved antenna-receiver impedance matching, as one would expect when using an antenna tuner.

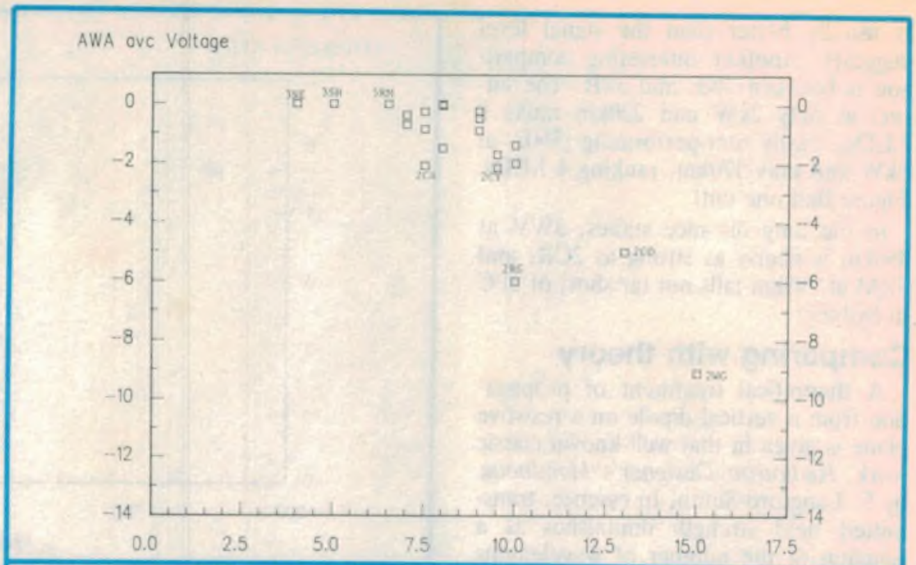

Fig.5: Comparison between the Sony results and those with an AWA.

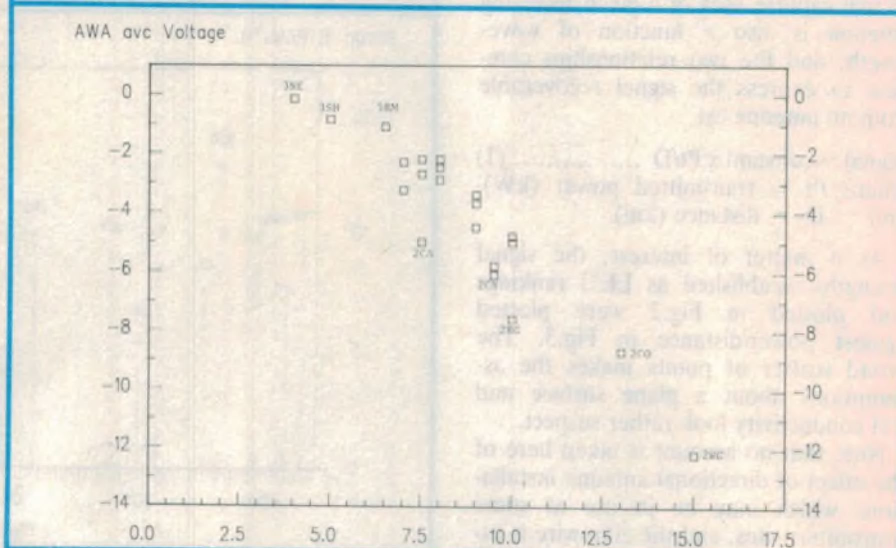

Fig.6: The antenna tuner gave improved results with the AWA set.

A note here on procedure: Because the weakest stations could not be copied, the Sony was first tuned for program identification and the AWA tuned to match using the antenna tuner. The antenna was then connected direct and readings taken.

Summary

An elevated wire antenna provides no rejection of near field interference. It is acknowledged that information on directional transmitter antenna arrays is incomplete. However, 2KY is known to be omnidirectional (personal communication), as is 2WG, while 2RG has a directional array favouring approximately 30° E of N.

Despite this, the data presented in Fig.3 has so much scatter that prediction of received signal strength on the basis of transmitter power and distance figures appears unreliable.

Using an antenna tuner with a receiver as sensitive as the Sony ICF2001 gives some improvement in signal/noise ratio on weak stations. However, as would be expected, using an antenna tuner with less sensitive receivers can bring in stations normally not available during daylight hours.

The second and third articles in this series will summarise my experience with a passive loop antenna and look at the performance of several different tuned loops.

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Opto-Electronics Feature:

Fibre optic links for the Australia Telescope

One of the challenges with the newly-opened 'Compact Array' section of the Australia Telescope was to link the array's five moveable and one fixed 22-metre antennas – spaced over 6km – with the central computer. The solution adopted was a network of fibre optic cables.

by JIM ROWE

The Compact Array section of the Australia Telescope is located at Culgoora, about 20km west of Narrabri in northern NSW. It consists of six fully steerable 22-metre radiotelescope receiving dishes, spaced over a distance of 6km in a straight line running East-West.

The array is designed to make use of a technique known as *earth rotation synthesis*, in which signals from the individual dishes are combined to produce the effect of a single much larger 'synthetic' dish – with greatly improved angular resolution.

To achieve the effect of a complete synthetic dish, the spacings between the dishes must be varied over a period of time. This means that the dishes must be moveable along the common East-West axis. In the Compact Array five of the dishes are mounted on large bases fitted with bogies, and are moved along a 3km length of special wide-gauge railway track. The sixth dish moves along a 75m length of similar track located a further 3km to the west.

For signal reception all dishes are stationary, and accurately located at selected track positions known as 'stations'. There are 37 different stations in the array, 35 used by the five dishes deployed along the 3km track and the remaining two used by the sixth dish on its short track. This gives a very large number of inter-dish spacing combinations.

A view along the side of the track at Culgoora, showing four of the dishes and a number of the station terminal boxes.

Regardless of the stations at which the dishes are located, the signals from each of them must be conveyed to a central computer building for processing and analysis.

Up to four receivers can be operating simultaneously in each dish, at frequencies between 1.5 and 10GHz. The incoming RF signals (essentially 'noise') are converted down to a common intermediate frequency (IF), which is then digitised for transmission to the control building.

Each of these digitised IF signals involves data transmission at a rate of 512 megabits per second, so that for each dish over 2 gigabits of data must be transmitted each second. This calls for a wideband data communications network, linking all 37 stations of the array with the control building.

In previous radiotelescope arrays the IF links have been implemented using either coaxial cable or waveguides. However coaxial cable has severe bandwidth and loss problems for distances more than a few hundred metres, and the average distance for the AT Compact Array is around 1km. The Very Large Array built in New Mexico in 1980 used low-loss waveguides, but this was very expensive and difficult to use. In any case it is no longer available.

You can get an idea of the size of the dishes from this shot, looking up from trackside on the day the AT was officially opened.

In the development of the AT Compact Array it was therefore decided to take advantage of the relatively low cost glass optical fibres now readily available, and offering wide bandwidth combined with low losses.

For the widest bandwidth and lowest losses the ideal optical transmission medium would be single-mode fibre. This has a central light-conducting core only 10um or less in diameter, which forces the light to propagate along the fibre in a single transmission mode. As a result, 'modal noise' is a minimum.

Modal noise is a type of noise caused by fluctuations in transmitted power level at (inevitably imperfect) splices and connectors, as a result of changing interference patterns at these transitions. These are produced by changes in transmission mode, as a result of minor fluctuations in laser wavelength, bending of the fibre and changes in temperature.

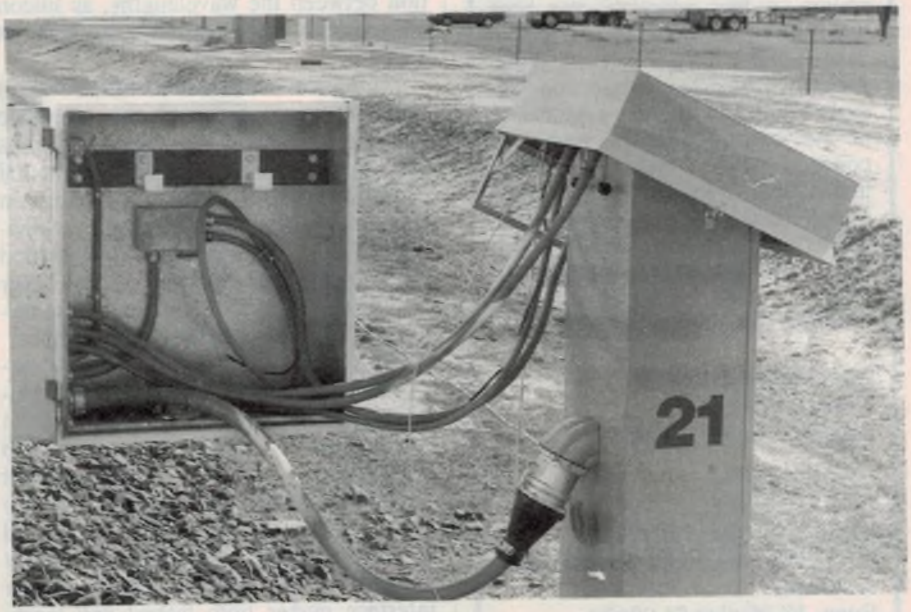
However with the Compact Array, the fact that the dishes must be moved frequently between stations means that the fibre-optic links cannot be made permanently. Instead they must be made via connectors at each station – in dusty, open-air conditions which are a long way from the controlled environment normally required for joining optical fibres.

Normal butt-joint type fibre-optic connectors require cleaning and care each time they are reconnected, or they have a very short lifetime even in air-conditioned equipment rooms. It was therefore necessary to use much more rugged, military style lensed connectors.

The only problem with this type of connector is that as yet, they are only available to suit multi-mode fibre. As a result, all of the Compact Array's optical cabling has had to be implemented using multi-mode fibre. This forced the system's designers to find ways of overcoming the inherently greater difficulty of transmitting data at high bit rates on a multi-mode system.

Each receiving station along the Compact Array is linked to the control building by a cable containing four graded-index, wide bandwidth fibres. The cables are gel-filled with slotted cores, and are mounted in PVC ducting. To achieve the required bandwidth, the stations furthest from the control building are linked using cable with fibres having a 2GHz.km bandwidth-distance product.

The cabling inside the antenna structures includes some long vertical drops to allow for azimuth and vertical rota-



When a dish is at a 'station', its signal and power connections are made to that station's terminal box. The power cable is at bottom.

FO links for AT

The Stratos 900 series military grade expanded beam connectors, as used for the dish connections on the AT antenna digitised IF links. (Courtesy Fibernet)

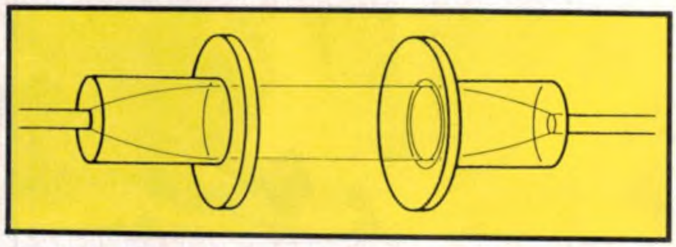


Fig.1: Basic idea of the lensed type of expanded beam optical connector. (Courtesy Fibernet)

tion of the dishes. To avoid the problems of fibres sagging within the cables, tight-buffer cord cables are used.

The digitised IF signals are transmitted on the fibres at a wavelength of 1300nm, with the same fibres also used to convey timing, control and monitoring signals by means of multiplexing at a wavelength of 850nm. Four-mode semiconductor laser diodes with multimode output pigtails are used to generate the 1300nm wavelength signals, whereas LEDs are used to produce the 850nm signals.

Detection of the 1300nm signals is via germanium avalanche photodiodes, with silicon photodiodes used for the 850nm signals. This helps in maintaining isolation between the wavelengths, as silicon photodiodes are completely invisible at 1300nm.

The optical cable connections between each receiving dish and the trackside stations are made via 'Stratos' Series 900 rugged military grade expanded beam connectors. These are made in England by the Stratos Group, a division of ICI, and assembled and aligned in Australia by Fibernet of 24 Laser Drive, Rowville 3178. A single connector performs all four fibre connections.

This type of connector uses a lens system to overcome the difficulties of accurately butt-jointing fibres whose active cross-section is only in the order of 50 micrometres. A pair of graded-index rod lenses at the ends of each fibre are used to expand the beam to around 1mm in diameter – see Fig.1. The larger diameter of the beam at the connector interface makes both lateral and longitudinal alignment much less critical, and also reduces the effect of dust and other contaminants.

Angular alignment of the two lenses is still quite critical, but this is taken care of by the design of the connectors. Also quite critical is alignment of the fibre ends relative to the lenses, within the connectors. With the Stratos connectors this is achieved by means of a special fibre termination insert, which mates very precisely with a 'location cone' inside the connector.

The fibre end is accurately centred within the termination insert by means of three precision steel balls. These allow centering to within 1.25 microns with respect to the insert's conical mating surface, for all fibre diameters between 108 and 600 microns.

When the connector is assembled, the fibre is located axially to within 5 microns of the lens focal point. This gives a maximum attenuation of 2dB per connector pair at either 1300nm or 850nm, with 50/125 micron graded-index fibre.

At each station of the AT Compact Array the fibre-optic connections are made via a trackside 'junction box'. Mains power is also supplied to the dishes via heavy-duty connectors at the same boxes.

As may be seen, the Compact Array's data and control network provides an interesting example of the application of fibre-optic technology in a relatively hostile environment. Its success is a tribute to the development work carried out by scientists in the CSIRO's Division of Radiophysics.

My thanks to Dr Alan Young, leader of the Australia Telescope Signal Distribution Group, for his help in preparing this article.

New applications for fibre optics

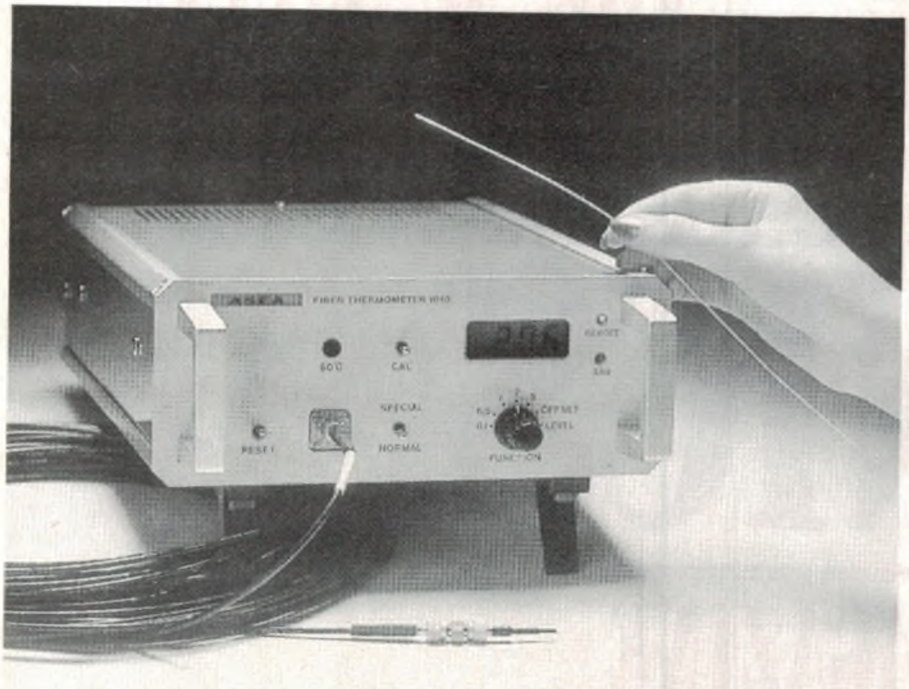
Fibre optic cables are now finding use in a surprisingly wide variety of applications, from remote sensing and measurement in industry to decorative and specialised lighting. Each application takes advantage of one or more different features of guided light transmission via optical fibres.

by ANDREW PALMER

A rapidly growing application of fibre optics is in sensing and measurement. Frequently this takes advantage of two important properties of fibre-optic cables: they are electrical insulators, and the information is conveyed along them in a form which is not affected by normal electrical interference.

The first of these properties allows them to be used in situations where there are very high voltages present – such as monitoring the operating temperature of large power transformers, alternators and switching gear. The freedom from susceptibility to EMI makes them also very suitable for operation in industrial applications where there is a very high level of electrical noise.

As an example of the use of fibre-optics for measurements in a high voltage environment, the Swedish firm ASEA has developed a range of instruments designed to measure and monitor the winding temperatures inside large power transformers and alternators, and operating temperatures for high voltage surge arrestors. Thermocouple type probes are very difficult to use in this type of application, because of the very high voltage gradients present – typically from 300V/mm to 10kV/mm. By their very nature, thermocouples are metallic and low in impedance.



ASEA's model 1010 fibre-optic thermometer, which measures from 0 to 200 degrees C to within 1 degree.

Similarly pyrometric measurement can also be either impractical (in the case of windings inside an oil-cooled transformer) or very difficult due to the effects of pollution on the surfaces of the materials.

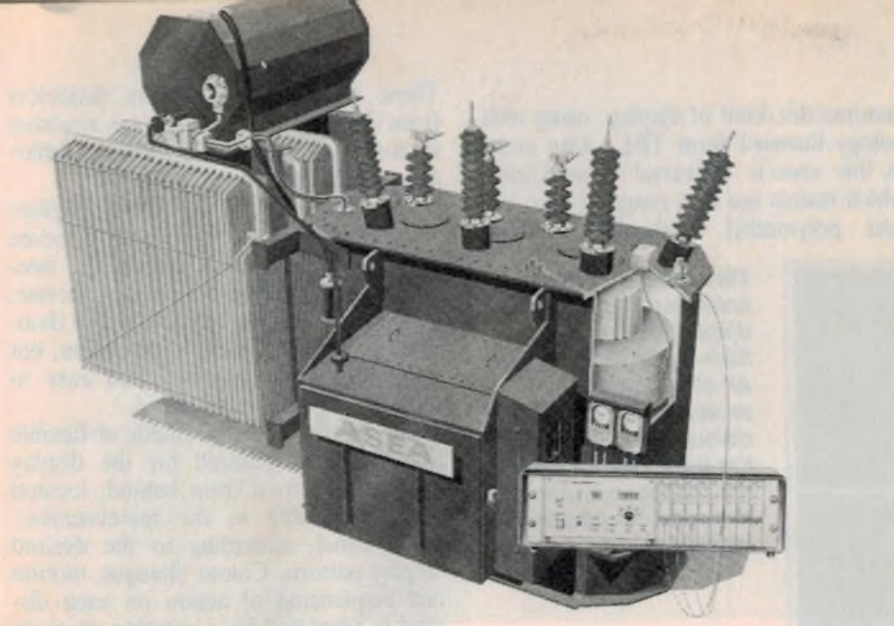
The ASEA fibre-optic temperature probes use a special sensor of gallium arsenide crystal. Light of a fixed wavelength is transmitted up the fibre-optic cable to the crystal, which performs internal frequency conversion according to its temperature. The spectrum of the light reflected and returned down the cable is then analysed to give a measure of the probe temperature.

This technique allows the probe to be very small – typically 1mm or less in diameter – and apart from the crystal itself, made from fully non-conducting materials such as glass, silicone and epoxy acrylate.

Other uses for the ASEA fibre-optic thermometers include measurements inside commercial and industrial microwave ovens and RF heaters, and measurements of body temperatures in medicine – especially during RF/microwave hyperthermia, NMR imaging or surgery involving RF cutting and cauterising.

Needless to say they are also very suitable for measurements involving radioactive materials, explosive or highly flammable materials, and in highly corrosive environments.

An example of the latter is in the electrolytic decomposition of common salt (NaCl), to produce chlorine. This involves very high direct currents, flowing in electrolytic cells whose temperature must be maintained accurately at 72-78°C. Measuring the temperature



Fibre-optic thermometers are ideally suited for measuring winding temperatures in high-voltage transformers, as they automatically provide excellent electrical isolation.

with traditional iron-constantan thermocouples is very difficult, as these not only corrode away but must be insulated from the heavy currents flowing. Fibre-optic thermometer probes have proved just as accurate and stable as thermocouples, yet are insensitive to corrosion and unaffected by the high current levels.

ASEA has also developed fibre-optic transducers for the measurement of acceleration and vibration, and also for gas detection.

Another innovative approach to the use of fibre-optics for temperature measurement has been developed by researchers at Southampton University in England, and is available in practical form from York VSOP (represented in Australia by Fibernet). Known as *distributed temperature sensing* or 'DTS', it relies on the Raman Scattering effect – wherein light is scattered randomly within an optical fibre, to an extent which is dependent upon the temperature.

Since some of the light will be scattered back in the direction of incidence (i.e., back along the fibre), analysis of the returned light can be used to determine the temperature profile along the fibre. And this is exactly what is done with DTS, allowing a single optical fibre up to 2km long to be used to measure and monitor the temperatures at many different points along its length. DTS is therefore an adaptation of the concept of *optical time-domain reflectometry* (OTDR).

With DTS as with OTDR, the signals injected into the fibre consist of a series of light pulses. The power level/intensity of the pulses is within 'eye safe' levels. The width of individual pulses (75ns) determines the spacial resolution of the system, which is 7.5m. For closer resolution the fibre is formed into a 'point probe', in which a length of fibre is coiled on a small former and used to monitor the temperature of a probe casing. this gives a localised spacial resolution of 40mm.

The fibre used in the DTS system is made of a silica matrix with various dopants which make it well-behaved over the temperature range from -100°C to approximately 600°C. The limits to this range are determined not by the DTS technique or the fibre itself, but by the non-glass coatings required for mechanical strength.

The currently available York DTS II system consists of a 'black box' opto-electronic interface and measuring unit coupled to a desktop computer. The interface can be connected to as many as four multimode optical fibres, each up to 2km long. System parameters achieved are temperature accuracy of +/- 1°C and measurement time of 12 seconds per fibre loop. Display, alarm and logic functions are handled by the system software.

Another interesting and innovative application of fibre optics to measurement is the Fibre-Optic Meat Probe, developed in the UK by TBL Fibre Optics in conjunction with that country's Meat Research Institute. It is available in Australia from Fibre Optic Lighting Australia, a subsidiary of BWD Industries.

The probe is used to measure muscle opacity, which can be used as an alternative to pH measurement in the detection of stress-related deterioration such as PSE (pale soft excutative) and DFD (dark firm and dry) conditions. It measures the opacity/light scattering characteristics of the meat in a manner similar to an endoscope.

Light is transmitted into the meat by a fibre-optic cable contained within a sharp pointed probe, and is emitted from a 3mm diameter window on the side of the probe. Back scattered light is returned to the detector via the same window and cable. The light source and photodetector used have peak response at 900nm, chosen because at that point in the spectrum absorption by haemoglobin pigment is minimal.

The instrument is calibrated by inserting the probe in translucent blocks of white opalescent plastic, whose scattering properties are within the limits of fresh and healthy meat.

Fibre Optic Lighting Australia is now locally manufacturing (under licence from TBL) a new low-attenuation and high effective area optical fibre with special cladding which makes it capable of being steam autoclaved. These properties make it very suitable for use in illuminator light guides for medical imaging instruments used by surgeons and diagnosticians.

Specialised lighting

Another area where fibre optics is becoming very widely used is in specialised lighting applications.

Fibre-optic cables allow great flexibility in the direction of light into difficult areas, for illumination of displays, etc. The light so directed can also be easily filtered to remove UV (ultra violet) and infra-red wavelengths, which may cause damage to delicate objects. For example FO lighting systems developed by TBL are installed at London's Victoria & Albert Museum, to illuminate the Medieval Treasure exhibit, and at Lloyds of London for the Exhibition of Historical Documents.

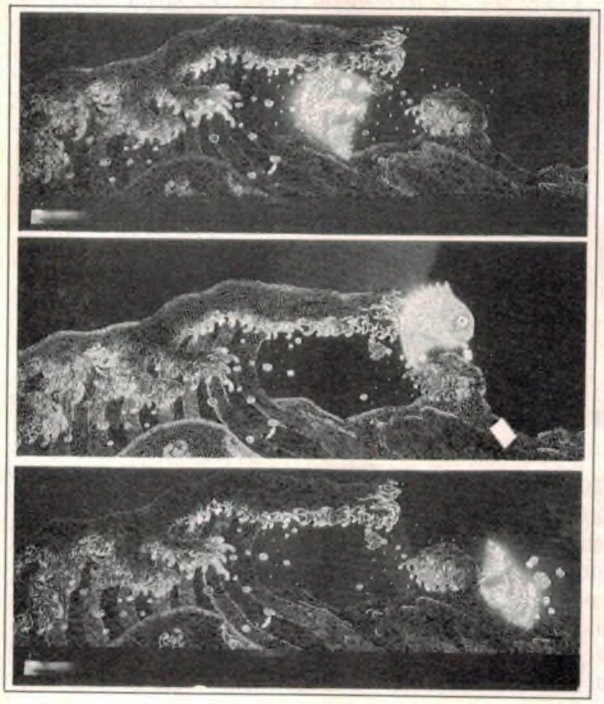
The other advantage of FO cables is that they can be used to change the spacial relationships between light sources and destinations. This makes them very suitable for animated lighting displays, allowing not only the use of a smaller number of lighting sources than would otherwise be needed, but the creation of effects which otherwise may not be practical at all.

The provision of animation can also be simplified, and performed by means of rotating 'programmed' optical cutoff/-filter wheels rather than on/off electrical switching of many separate lamps. Effects such as 'starbursts', 'crashing waves' and 'filling glasses' are therefore

New FO applications

much easier to achieve than with previous technology.

Fibre Optic Lighting Australia manufactures this kind of display, using technology licensed from TBL. Also active in this area is Universal Fibre Optics, which makes use of a range of new low-cost polymethyl methacrylate fibres. These are produced in core diameters from 0.25mm to 3mm, and are available in both clad and unclad form for different applications.



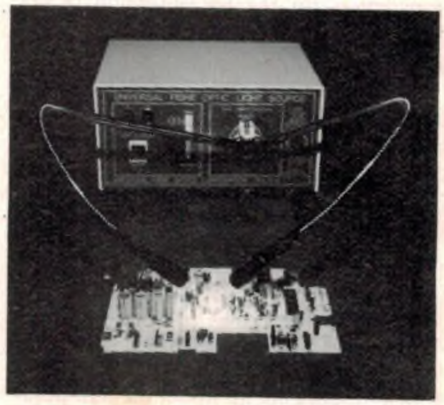
Three shots of an animated lighting display using fibre-optic technology. All effects are produced by cutoff and colour filter wheels at the light source end of the cables, obviating the need for electrical switching.

The light source for UFO displays consists of one or more quartz iodine lamps, fully sealed to protect the integral computer-designed mirror reflector. The lamps are rated to give many thousands of hours of reliable operation, but are relatively inexpensive and easy to replace when this is required.

The hundreds or thousands of flexible optical fibres required for the display are attached to it from behind, located in holes drilled in the metal/acrylic/-wood panel, according to the desired display pattern. Colour changes, motion and sequencing of action on each display is regulated by a rotating program disc, mounted between the light source and the fibres.

As the disc rotates, the intensely bright light being transmitted to the fibres changes the pattern and colours continuously. Both light sources and motor require very little maintenance.

UFO claims that fibre-optic signs and displays are also much lighter in weight than other illuminated signs such as neon tubes. They are also more rugged, and have a very low power requirement.



A light source unit for FO lighting, made in Australia by Universal Fibre Optics in Melbourne.

Further information on the products described in this article are available from the following firms:

ASEA Brown Boveri, PO Box 126, Lilydale 3140 or phone (03) 735 7222.

Fibernet, 24 Laser Drive, Rowville 3178 or phone (03) 764 2111.

Fibre Optic Lighting Australia, 5 Dunlop Road, Mulgrave 3170 or phone (03) 561 2888.

Universal Fibre Optics, 564 Glenhuntly Road, Elsternwick 3185 or phone (03) 523 5535.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Opto-Electronics Feature:

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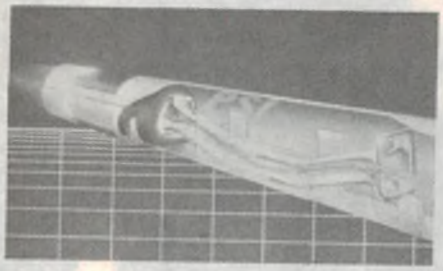


Fibre optic splice

Joining optical fibres without introducing loss into the system has always been a limitation. The new Lightlinker Splicing System overcomes many of the problems, using a four-rod glass array element, integrally fused with slight bends at both ends.

The bore of this multi-rod array with its bent geometry, permits entering fibres to meet in the centre of the alignment element common to one of the vee-shaped interstices. This inherent self-aligning characteristic permits close lateral and angular matching, and provides excellent shock and vibration immunity.

Insertion losses are typically less than 0.2dB for both multi-mode and single mode fibre depending on the quality of the fibre being used. The system is inexpensive, and a splice can be performed in 7 minutes, with minimal instruction required. The coupling element is 70mm long by 3mm diameter (approx).

Further information from Krone (Australia), 2 Hereford Street, Berkeley Vale 2259 or phone (043) 88 4422.

Optical fibre link

Optical fibre cable is being used to link the closed circuit television cameras of two buildings belonging to the Victorian Arts Centre Trust.

When the system becomes operational later this year, administration areas in the Theatre Building and the Melbourne Concert Hall will receive off-air programmes and closed circuit television from the four main venues at the centre.

Austral Standard Cables (ASC), supplied about 300 metres of cable, which contains six multi-mode graded index optical fibres, for the project.

ASC can be contacted at Moorebank Avenue, Liverpool 2170 or phone (02) 821 9777.

Laser stabiliser

The EOD Stabiliser series is a complete high bandwidth laser stabilisation and modulation system. Many lasers are inherently 'noisy' and this noise is typically +/− 4% in stable lasers but can be as high as +/− 10%. In applications where precise control of the laser amplitude is required laser stabilisers are essential.

The stabiliser series provide noise reduction from DC to 1MHz and can be used as an optical switch or analog modulator over this bandwidth. They comprise a high voltage linear amplifier, an electro-optic modulator and optical detector and high speed optical feedback circuit.

For further details contact Rofin Australia, 36a Cedric Street, Mordialloc 3195 or phone (03) 580 0802.

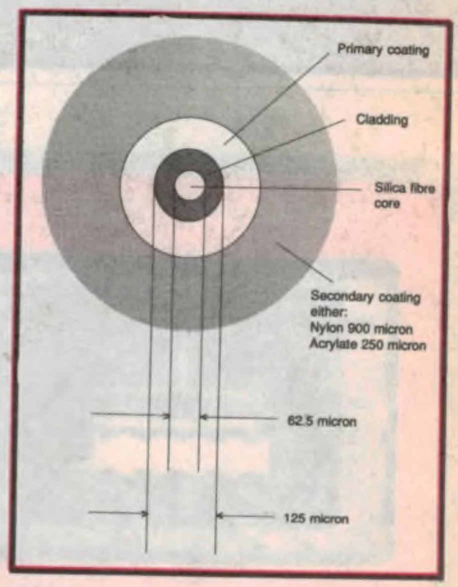
High flux LEDs

High luminous flux hyper-red LEDs with luminous intensities of up to 200 mcd at a wavelength of 650 nm using drive currents of 10ma are now available from Philips.

The new range is aimed at two broad market segments, namely standard display panels, information boards, moving advertisements, electronic games and so forth, and the expanding number of low-power applications, for example batery warning lights or indicators in portable equipment. An extra feature is the extended lifetime of the LEDs.

A new wallchart of Philips' latest range of GaA1As hyper-red light-emitting diodes (LEDs) is now available.

Further information from Philips Components, 11 Waltham Street, Artarmon 2064 or phone (02) 439 3322.

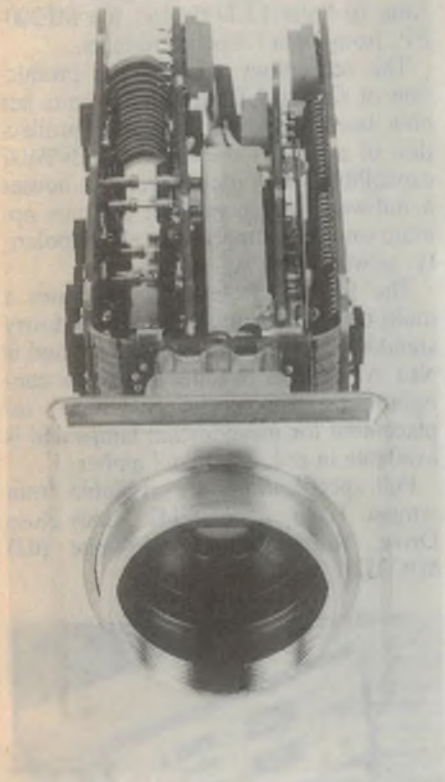


New optical fibre computer cable

A new type of optical fibre cable for local area networks is available ex-stock from Austral Standard Cables (ASC). The 62.5/125 micron graded index dual fibre (figure eight) cable recently began production at the company's Clayton factory in Victoria.

All computer installations specifying Fibre Distributed Data Interface (FDDI) standards will require 62.5/125 fibre cable in future, according to ASC. A major benefit of the new cable type is easier connection because of larger core diameter.

Further information from ASC, Moorebank Avenue, Liverpool 2170 or phone (02) 821 9777.



Solid-state imaging

A complete sub-assembly, now available from Philips, needs only a chassis and lens to form a complete black-and-white video camera for machine vision and surveillance applications. The first video camera sub-assembly incorporating a solid-state image sensor (SSIS) to reach the market, it is based on Philips own proprietary SSI sensors. Manufacturers without video equipment design experience, or without equipment assembly facilities, can fit the sub-assembly quickly and easily into their vision systems.

The unit consists of solid-state image sensor (SSIS), and all the necessary drive, pre-processing, video-processing, and power-supply circuits. There are two basic versions for 525-line or 625-line TV systems, meeting EIA or CCIR standards.

By simply adding housing and cabling, and connecting the unit to a computer, a user has the basic hardware for a machine vision or industrial inspection and control system.

Further information from Philips Components, 11 Waltham Street, Artarmon 2064 or phone (02) 439 3322.

Light chopper

Monolight Instruments announce the introduction of the Model 9000, a new generation of light chopper. Using techniques for the blade manufacture from the semi-conductor industry, the new system features extremely low jitter.

The precision oscillator coupled with digital push-button selection, ensures a very high accuracy and stability. A new ultra-smooth, high-torque ironless motor provides fast frequency lock and good performance over the chopping frequency range of 15-3000Hz. No blade changing is necessary as the full frequency is achieved with one dual aperture blade system.

For further information contact Rofin Australia, 36a Cedric Street, Mordialloc 3195 or phone (03) 580 0802.

Flat LCD display

Capable of replacing a CRT, the latest LCD display from Optrex measures 283 × 183 × 13mm, has a resolution of 640 × 400 dots and is back-lit by a cold cathode tube.

The new twisted nematic (NTN) technique used by the DMF 666NB-FW provides a higher contrast ratio for its alpha/numeric and graphics characters. These characters are displayed as blue on a white background, although other colour combinations are available. The NTN technique also considerably widens the viewing angle making the DMF 666NB-FW particularly suitable for a wide range of applications, including medical, scientific instrumentation as well as being a very useful component for instrument builders and OEMs.

Further information from Antex Elecronics, 13 Avon Road, North Ryde 2113 or phone (02) 805 0844.

Bigger 2 × 16 LCD

Handocks HDM 16216H-4 is the latest addition to their already broad range of alphanumeric and graphic liquid crystal displays.

The HDM 16216H-4 is a 2 line × 16 character LCD with a character height a very viewable 8.09mm. This display is ideal for applications where the normal 4 or 5mm character height is not sufficient. The option of electroluminescent backlighting adds futher versatility to this new display. Driving the display is via the 8 bit parallel interface, power supply is single +5V rail.

Further information contact M.B. & K.J. Davidson, 17 Roberna Street, Moorabbin 3189 or phone (03) 555 7277.

Analog FO transmission system

The LeCroy analog fibre-optic transmission system has a frequency response of DC to 1MHz and features a remote controlled transmitter. The Models 5612 transmitter and 5613 dual receiver, together with a pair of optical fibres, form a complete analog fibre-optic transmission system.

The system provides a practical means by which analog signals from transducers in noisy environments at high electric potentials or at great distances can be monitored. The receiver enclosure is designed to operate in a high EMI environment and the remote control feature allows the transmitter to be located in hazardous situations.

For further information contact ETP-Oxford, 31 Hope Street, Ermington 2115 or phone (02) 858 5122.

Opto Products

Electroluminescent display module

Just released from Deeco (Digital Electronics Corporation) of Hayward, California, is the M3 module, a 512 × 256 pixel electroluminescent display panel, power conversion circuitry and a graphics drawing controller with VT text terminal emulation.

The built-in C3 controller provides flat panel high-level graphics and terminal text applications using simple ASCII handler commands. It is capable of drawing lines, vectors, fast vectors, polygons, area fills, inside and outside paint and levels of character zoom, 45-degree angle text several line styles, normal and slanted fonts, inverse video, flashing and screen clipping.

Further information from Amtex Elecronics, 13 Avon Road, North Ryde 2113 or phone (02) 805 0844.

Optical waveform analyser

Photodyne has released a new optical waveform analyser, Model 1600XP, for use in longwave fibre optic diagnostics. It will be particularly useful for waveform analysis in optical fibres, measuring LED rise and fall times, peak power in pulsed laser diodes, dispersion in fibres and BER testing.

In use, the output BNC connector of the Model 1600XP can be plugged in directly, or via a 50-ohm cable, to an oscilloscope, spectrum analyser, or BER receiver port. The incoming optical signal is converted by the waveform analyser into electrical output signals. Voltage waveforms displayed are then referenced to the input optical power. Frequency response is flat from DC to 150MHz with minimum rise and fall times of 3 nanoseconds.

For further information contact Elmeasco Instruments, 18 Hilly Street, Mortlake 2137 or phone (02) 736 2888.

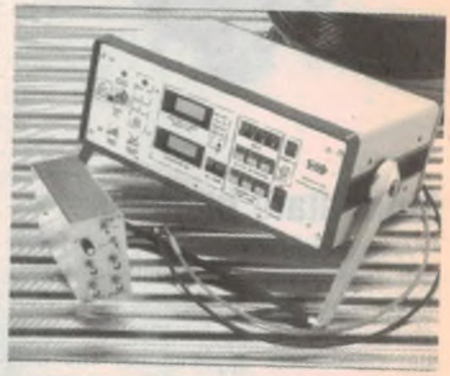
Bi-Polar LED

Ampec Technologies announces an advancement in incandescent replacement techonology with their newest 5mm Bi-Polar LED device, the MF200-BP, from Data Display Products.

The technology used in the production of standard Data Display units has now been improved to enable production of a smaller package with Bi-Polar capabilities. This unique product houses a full-wave bridge rectifier and can operate on a DC supply with either polarity, as well as on AC supply.

The MF200-BP series incorporates a multi-chip LED mounted in an industry standard 5mm midget flange base and is also available in bayonet and screw configurations. This device is a direct replacement for incandescant lamps and is available in red, green and amber.

Full specifications are available from Ampec Technologies 8/142 James Ruse Drive, Rosehill 2142 or phone (02) 689 3522.



Telemetry link

The FOL 1000-4 and 500-4 fibre optic communication links from Electro Optic Developments, provide interference free acquisition and transmission of wide band analog signals in the presence of high electromagnetic fields.

This product has been designed specially to provide accurate performance testing of electronic instrumentation controls under adverse conditions, such as electro-magnetic pulses associated with lightning strikes. The FOL series reliably record specific results from a single piece of equipment, uncorrupted by electro-magnetic pulses in the test environment.

For further details contact Rofin Australia, 36a Cedric Street, Mordialloc 3195 or phone (03) 580 0802.

TRF Reception and AM demodulation

This month we look into details of the simplest type radio receiver, the TRF or tuned radio frequency receiver. Also we see the easiest method of demodulation, i.e., recovering the audio signal from the amplitude modulated carrier transmitted by the radio station.

by BRYAN MAHER

Having learned how speech and music is transmitted on an amplitude-modulated radio carrier, of course we would like to receive it at our home. How shall we do that?

We have seen in previous episodes of this series that the tuned circuit (inductance and capacitance) can sift out for us just the radio station we want to hear, rejecting all others.

Unless we live under the shadow of the radio station transmitting antenna mast, the amplitude modulated radio frequency signal arriving at our location will probably be quite low in intensity. If you live further out, say 100km from the station, the signal strength in your first tuned circuit, Fig.1, may be as low as 5, 10 or 20 microvolts. The only thing we can possibly do with that is to immediately amplify it up to a larger signal.

Probably we will need to amplify the received signal a number of times, through multiple stages, as Fig.2 suggests. Fig.2 is representative of the simplest type of radio receiver for amplitude modulation (AM) weak radio signals. This type is called the *tuned radio frequency* or 'TRF' radio receiver.

The antenna labeled A in Fig.2 picks up all radio transmissions at our location. The first tuned circuit, B, responds to the frequency to which we have tuned the radio, attempting to reject all others. Alternately, in many portable radios without an external antenna the first tuned circuit is a ferrite rod core, like that in Fig.1, which picks up the magnetic field of the radio transmission directly within the tuned circuit itself. Either way the desired radio transmission frequency circulates between the inductance and capacitance of tuned circuit B.

Unfortunately there are inevitably some resistive losses associated with that tuned circuit, so its *quality factor* or 'Q' is not infinite. This results in imperfect rejection of unwanted other frequencies, so to sufficiently reject the myriad other transmissions on the air we usually pass the signal through two, three or more tuned circuits.

Passing through each such tuned circuit, shown in Fig.2 as B, D and F, our wanted signal becomes more dominant while all the unwanted frequencies weaken, until (hopefully) only the strong wanted signal remains.

Tuned RF amplifiers

Tuned circuits can select a frequency, but do not make the desired signal any larger. For that we need amplifier stages. As we are dealing with radio frequencies (RF), we need RF amplifier stages designed to respond to those high frequencies. RF amplifier stages are quite different from the audio frequency (AF) amplifiers you may have met in hifi record players etc.

Audio amplifiers are not tuned; quite the contrary. They are deliberately made to amplify *all* frequencies equally over the whole audible frequency range, as Fig.3(a). RF amplifiers are different in that they are only wanted to amplify a narrow band of frequencies, as Fig.3(b) suggests.

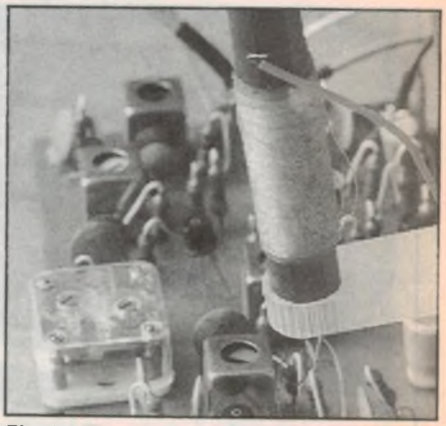


Fig.1: The first tuned circuit of this radio consists of the ferrite cored coil in the centre and the miniature tuning capacitor at lower left.

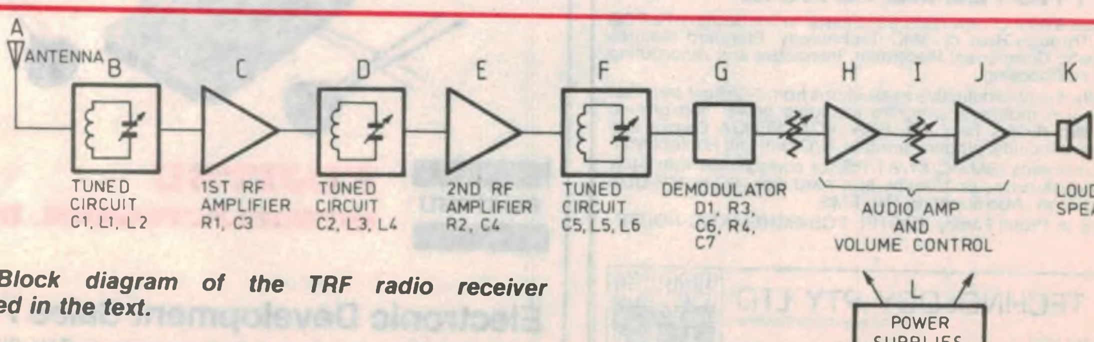


Fig.2: Block diagram of the TRF radio receiver discussed in the text.

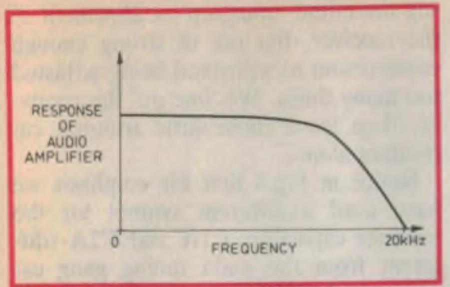


Fig.3(a): Because a direct-coupled audio amplifier is not tuned, its response is flat over a wide range.

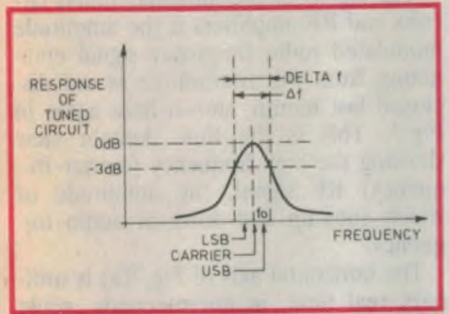


Fig.3(b): The response of a tuned RF amplifier – much narrower.

The second tuned circuit, D in Fig.2, is an intimate part of the first RF amplifier stage. Also the third tuned circuit, F, is part of E, the second RF amplifier.

Although there are many tuned RF amplifier circuit designs in use, details of one possible circuit configuration suitable for the first and second tuned circuits and first RF amplifier are shown in Fig.4.

Here L1-C1 forms the first tuned circuit fed from the antenna. L2 is a secondary winding magnetically coupling signal from C1-L1 to the first RF amplifier. This is possibly a 2N4416, 2N5245 or similar N-channel junction field effect transistor (JFET).

These transistors have three terminals, drain (D), gate (G), and source (S), and are designed to have small gate leakage current to avoid loading the Q of the preceding tuned circuit. Also these types of transistor work well at radio frequencies, up to 400MHz.

The purpose of R1 is to generate a small bias voltage drop, positive at the source S. The RF currents flowing in R1 are smoothed by the bypass capacitor C3 so that only a DC voltage remains across R1. The gate G is returned via L2 to the bottom or negative end of R1 and to ground. In this way the equivalent of a negative bias is applied to the gate G, i.e., the gate is more negative (less positive) than the source.

This bias controls the drain-source current flowing in the transistor. (If we did not have this DC negative bias voltage applied to the gate, the drain-source current would be too large and uncontrollable).

The drain-source RF currents flowing in the transistor are also controlled by the RF voltage applied by L2 to the gate.

Each time the RF voltage on the gate goes up and down on the positive half of the RF cycle, this causes the transistor drain current to rise and fall accordingly. This changes the RF magnetic field in the coil L3, the fall of this magnetic field then setting up a back voltage which charges up C2 in the coil-capacitor energy interchange – as we discovered in past articles of this series.

As before this action occurs only over a narrow band of frequencies and because of the gain of the transistor, the voltage to which C2 charges is much greater than the RF drive voltage applied to the transistor gate terminal. By this means the first tuned RF amplifier has considerable voltage gain for frequencies in a narrow band centred on *fo*, the centre frequency to which the coil and capacitor are tuned, as depicted in Fig.3(b).

The whole tuned-gain process is repeated in the second tuned RF amplifier (E in Fig.2), with its tuned load F, the signal fed to it by tuned circuit D in like manner.

Because every tuned stage in this receiver is tuned to the same frequency *fo*, this radio receiver qualifies for the name 'TRF' or *tuned radio frequency* receiver. This simple, obvious scheme was the first type of radio receiver used from the origin of radio frequency amplification, which followed from the invention by Lee de Forest of the triode vacuum tube in 1907.

Tuning capacitors

The arrows through the tuning capacitors C1 and C2 in Fig.4 indicate that those tuning capacitors can be varied by hand. Sometimes this means only a knob on the shaft of a variable capacitor, but generally a geared-down dial is used to make the adjustment process less critical.

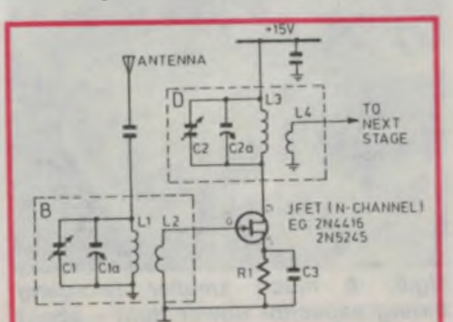


Fig.4: One possible circuit for a tuned RF amplifier stage, using a FET.

This 'tuning' is used to set the centre frequency, *fo*, equal to the carrier frequency of the station you want to hear. If you don't like the program on that station, manually adjusting C1 and C2 (Fig.4) and also the corresponding tuning capacitors in tuned circuit F, will shift *fo* for all of the tuned circuits to the carrier frequency of some other station you prefer.

For this scheme to succeed, with the receiver convenient to tune, all three tuned circuits (B, D and F of Fig.2) must be changed together so that they are always tuned to the same chosen frequency.

In ancient radio receivers, before about 1920, all three tuning capacitors would be separately adjusted to the wanted station. As that was a woefully difficult procedure, someone around 1923 thought it would be the obvious thing to build all three tuning capacitors 'ganged together' on a common shaft, so one knob or geared dial could tune all three simultaneously as shown in Fig.5.

Ganged tuning & tracking

Naturally we want the turning of that shaft to tune all three tuned circuits to exactly the same frequency, all the way across the frequency range covered. This exactness is called the *tracking ability* of the design. To achieve accurate tracking all three tuning coils would have identical inductance value and all three sections of the tuning 'gang' would have identical capacitance value at any one setting.

For tuning across the broadcast band each capacitor section may typically have a capacitance range from 60pF to 160pF (picofarads). Other larger tuning capacitors, such as the one shown in Fig.5, have higher values from 50pF to 350pF.

With these larger tuning capacitors the tuning coils would have a correspondingly smaller inductance value, because the frequency *fo* to which any tuned circuit is tuned is given by:

$$fo = 1.0/(2\ Pi\ \sqrt{[LC]})$$

where *fo* = desired centre frequency
Pi = 3.1416
C = capacitance of tuning capacitor
L = inductance of tuning inductance.

Here we see the frequency *fo* is decided by (the square root of) the product [capacitance x inductance], so for a given *fo*, larger values of C require a smaller inductance L.

TRF Reception

Quality Q

How well the tuned circuit rejects unwanted other stations is indicated by the width of the 'skirt' of the tuning curve – see Fig.3(b). The higher the quality factor Q, of any tuned circuit, the narrower is the skirt of the tuning curve, giving better rejection of unwanted adjacent transmitters.

We measure the width at the points each side of centre frequency where the response has fallen to half power, known as the '-3dB points', and we call this width *delta f*.

Previously we defined Q as the ratio:

$$Q = \frac{\text{(Energy in coil and capacitor)}}{\text{(Energy lost each cycle)}}$$

But it can be shown that this is equivalent to

$$Q = \frac{(2\ \text{Pi f L})}{R}$$

and also that

$$Q = \frac{f}{(\text{delta f})}$$

where R = resistance of coil and leads
L = inductance of the coil
f = the frequency tuned
Pi = 3.1416
(delta f) = width of response curve at -3dB points.

Choices of C and L

In many coil-capacitor designs using a larger capacitor and smaller coil of correspondingly less inductance, it is found that although the value of L is reduced, the coil resistance R is reduced much more, giving a higher value of Q. For this reason some electronics designers of high class radios opt for a *high L-C ratio*. Of course the product of L and C is the same, so that the chosen tuned frequency *fo* is not changed.

But large values of C result in large physical dimensions, therefore other designers might choose smaller C and achieve a larger L even with a little coil by winding the coil on a ferrite (iron dust-ceramic) core. This way remarkably small miniature tuning circuits can be manufactured, such as the coils and capacitor shown in the photo of Fig.6.

Note that the miniature tuning capacitor and ferrite cored coil in Fig.6 tunes over the same range of frequencies as does the large capacitor of Fig.5 when combined with shielded air-cored coils of smaller inductance.

Trimmers

Most manufacturers of coils find it impossible to wind sets of three coils all having precisely the same value of inductance. Similarly it is too much to ask variable capacitor manufacturers to produce sets of ganged capacitors of exactly equal capacitance value.

To accommodate these small discrepancies, very small adjustable capacitors are usually mounted on the three-gang capacitors, each connected in parallel with one capacitance section. The idea is that when the radio receiver is built and in operation, it is tuned to a station and these little adjustable 'trimming capacitors' or *trimmers* are adjusted (usually with an insulated screwdriver) until the volume received from the station is maximum.

We say that these trimmers are 'adjustable' rather than 'variable'. 'Variable' means designed with robust shaft bearings (sometimes ball races) so that the capacitor can be varied thousands of times over years of use, as you change stations.

But 'adjustable' means that such a capacitor is designed more flimsily, good enough to be adjusted a few times during the initial 'lining-up' or *alignment* of the receiver, but not of strong enough construction to withstand being adjusted too many times. We 'line up' the receiver, then leave those little trimmer capacitors alone.

Notice in Fig.4 that for emphasis we have used a different symbol for the trimmer capacitors C1A and C2A (different from the main tuning gang capacitors C1 and C2).

Modulated RF envelope

The signal in the antenna, tuned circuits and RF amplifiers is the amplitude modulated radio frequency signal emanating from the transmitter as we discussed last month, shown here again in Fig.7. This is the time domain view showing the high frequency (carrier frequency) RF signal, the amplitude of which goes up and down at audio frequency.

The horizontal axis of Fig.7(a) is ordinary real time, in microseconds, while the vertical axis is signal strength. We depict here how it would look when modulated by an audio frequency sine wave. It is a picture of a varying radio frequency signal, but the audio signal 'carried by it' is not to be seen directly. It implied in Fig.7(a) as the imaginary envelope we can see in our mind's eye, which would enclose either the top or bottom of the waveform shown.

Fig.7(b) is a visualization of the same thing, but drawn with frequency as the horizontal axis. Recall from last month that, for modulation by an audio frequency sine wave, the frequency domain picture Fig.7(b) shows a signal composed of three frequencies:

1. the carrier,
2. the lower sideband (LSB), and
3. the upper sideband (USB).

The carrier is the nominal station radio frequency, to which the transmit-

Fig.5: Close-up of a fairly large three gang tuning capacitor for tuning the broadcast band. All three variable 50 – 350pF sections are on a common shaft.

Fig.6: A much smaller two-gang tuning capacitor (lower right – about actual size), which uses plastic dielectric between the plates instead of air.

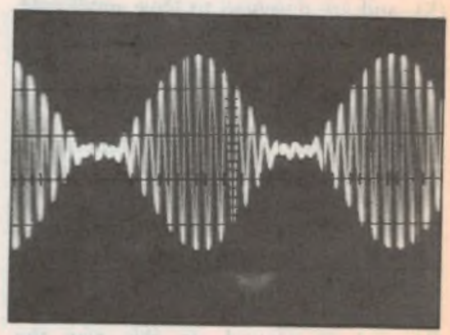


Fig.7(a): The waveform of an amplitude-modulated RF signal (slightly over modulated). The signal itself is of a high frequency, but its amplitude is varying at a lower rate – that of the modulating signal.

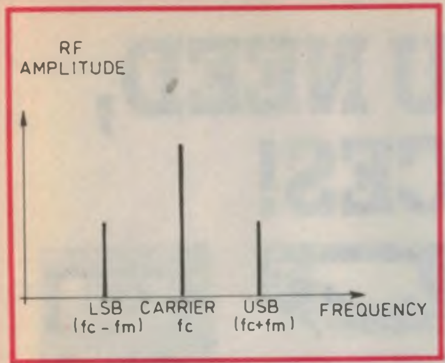


Fig.7(b): The carrier, upper and lower sidebands for the case of a carrier modulated by a sinewave audio frequency.

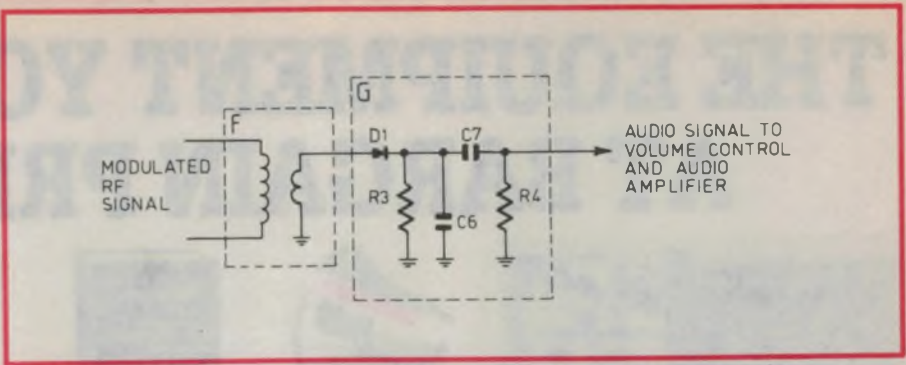


Fig.8: A basic diode demodulator for AM signals, as discussed in the text. This type of demodulator is also called a 'diode detector'.

ter and our receiver tuned circuits are tuned. In the tuned circuits this frequency is often called the centre frequency. The upper sideband (USB) is a second radio frequency signal whose frequency is equal to the sum of the carrier frequency and the audio frequency, while the lower sideband (LSB) is a third radio frequency signal whose frequency is equal to the carrier frequency minus the audio frequency.

Thus our tuned circuits must be made so that their response, shown in Fig.3(b), is wide enough to admit both upper and lower sidebands as well as the carrier.

Demodulation

So far so good. We have captured in our receiver the desired amplitude-modulated (AM) radio frequency signal, and made it big and strong. But so far, at position F in the block diagram Fig.2, we do not have a signal to which we can listen. We now must somehow extract the audio information, the audio signal, out of that mixture of three RF signals.

The process for doing just that is called *demodulation*, and (lucky for us) for an AM signal as in Fig.7 that is not a difficult task.

Let us now look into the details of section G and the tuned circuit F which feeds it in the block diagram Fig.2, keeping in mind the modulated RF signal as shown in Fig.7(a).

The details are shown in Fig.8. The tuned circuit F (which is the tuned load for the last RF amplifier E in Fig.2) has a small secondary winding L6. This winding couples the modulated RF signal to diode D1 and its load resistor R3. The diode allows all the positive (top half) half-cycles of the modulated RF signal to pass, and flow down the load resistor R3 to ground. The current flowing through the diode is shown in Fig.9, which is simply the top half of Fig.7(a).

All negative signal voltage (i.e, the bottom half of Fig.7(a)) is blocked by diode D1.

We see in Fig.9 that the fast details of the waveform, (at radio frequency), varying in amplitude slowly (at audio frequency), could be enclosed between the base line and the top envelope. And that top envelope is the shape of the audio sine wave.

All those fast RF components flow very easily down capacitor C6 to ground. We carefully choose the value of C6 to be large enough that it is a very low impedance to such high frequency signals. Therefore the high frequency components of the waveform Fig.9, in flowing down C6, develop almost no voltage across C6. We say that we have used C6 'to *bypass* all RF components to ground'.

DC & audio components

Clearly in the waveform Fig.9 there is more than just the RF components. There is a DC level, as shown by the fact that all of the waveform is above the zero baseline – everything is positive, nothing is negative (nothing below zero).

Furthermore that DC level is not constant, but varying at the slow audio rate. Such slow changes do not flow easily down capacitor C6, as its value is not large enough for that. Therefore those slow changing DC levels flow mostly down the parallel path R3. So across R3 is developed a varying DC voltage, positive at the top of R3, and changing at an audio rate.

As we have no use (at the moment) for that DC component, we pass only its audio frequency variations. To do this we place coupling capacitor C7 in the signal path, choosing its value to be quite large so that it can pass all audio frequency components, blocking only the DC level itself. Therefore the time constant (C7.R4) is made quite long, longer than the period of the lowest audio frequency we want to hear.

As you have possibly realised, C7 and R4 form a voltage divider, with the impedance (reactance) of C7 given by:

$$\text{Capacitor impedance } X_c = \frac{1.0}{(2\ \text{Pi}\ f\ C)}$$

If C7 is made so large that Xc is much smaller (at low audio frequencies) than the resistance of R4, most of the audio voltage will be developed across R4, to be passed on to the following audio amplifier.

We'll be looking at the audio amplifier in the next installment, so I hope you'll join us.

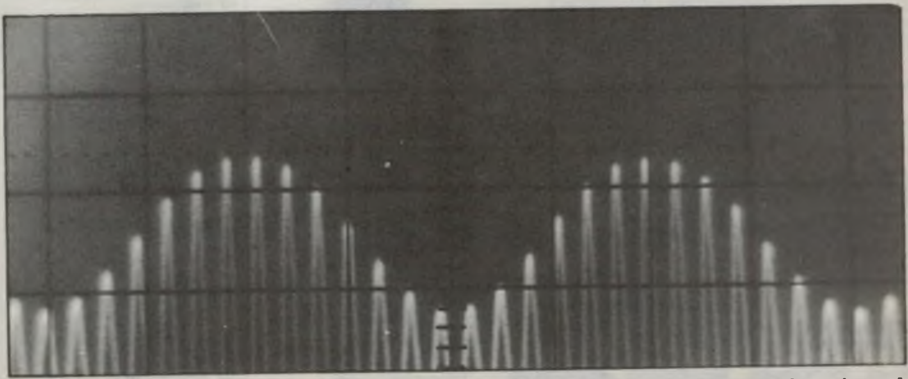


Fig.9: The output current of diode D1 in Fig.8 is just the positive half-cycles of the modulated AM signal, which contains a DC level varying at an audio rate.

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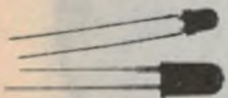

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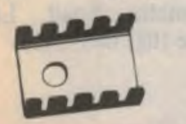

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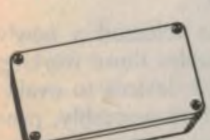

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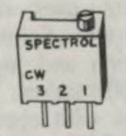

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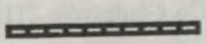

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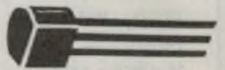

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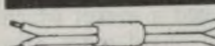

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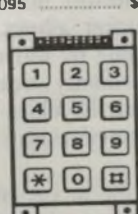

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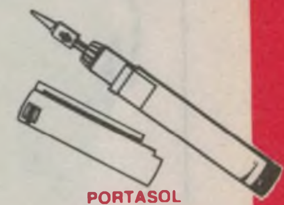

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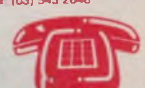

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RITRONICS WHOLESALE,
56 Renver Rd, Clayton.
Ph. (03) 543 2166 (3 lines)

Errors and omissions excepted. Prices and specifications subject to change.

MasterCard VISA

New Products

Headsets

Andlin Enterprises has been appointed authorised distributors of Plantronics headsets. Plantronics AG, of Switzerland, are the manufacturers of a wide range of headsets for many applications. They are used by NASA on their space mission and 9 out of 10 of the 250 biggest corporations in the United States.

Andlin Enterprises offers the complete range of Plantronics headsets and can supply a headset for almost any telecommunications application. They suggest that Australian executives should examine the advantages of using headsets instead of handsfree telephones, as they offer greater privacy and convenience.

Further information from Andlin Enterprises, 19 Quentin Way, Eltham 3095 or phone (03) 439 2204.

Low cost mouse

Electronic Solutions has just released a very high performance, industry standard mouse which sells for around one third the price of lower performance rodents. The mouse is a serial type and interfaces with all the popular packages. It automatically selects between Microsoft and Mouse Systems modes and comes with software to test, set up and operate.

A major improvement over other mice with the Electronic Solutions mouse is higher resolution and higher tracking speed – up to 600mm/sec. The ES Mouse is compatible with application software supporting Microsoft and Mouse Systems mice. This includes AutoCAD, ClickArt, Desqview, Dr. Halo, GEM. Microsoft Windows, Microsoft Word, Norton Utilities, PageMaker, PC Paintbrush, Personal Editor, Smartwork, TopView, Ventura Publisher and many thousands more. Introductory price is $99 inc. tax.

Further information from Electronic Solutions, PO Box 426 Gladesville 2111 or phone (02) 427 4422.

'ZIP' sockets

Utilux has introduced a socket which takes up half the PC board space of a conventional DIP socket. It's the Molex ZIP – which stands for Zig-zag In-line Package.

By arranging the connectors in a zigzag pattern the ZIP socket allows for denser electronic packaging by reducing the length required by ordinary sockets. In the Molex ZIP socket, IC chips are rotated at 90° with staggered leads exiting through the edge.

ZIP sockets are available in two sizes – 16 circuit for 256K chips and 20 circuit for 1 Megabyte chips. The socket's tin plated phosphor bronze terminals have dual beam contacts and housings are UL 94 V-O glass filled polyester.

Further information from Utilux, 14 Commercial Road, Kingsgrove 2208 or phone (02) 50 -0155.

PCB mount speaker

IRH Components, has recently released a new miniature, mylar cone speaker transducer on the Australian market. Called the KSS 3108, it has a frequency response of 500 – 4000Hz and a resonant frequency of 1250Hz.

The power handling capacity of the KSS 3108 is 100mW typical and 200mW maximum, delivering a minimum sound pressure level of 85dB(A) at 10cm with a 1kHz sine wave applied. The standard coil impedance is 8 ohms with other impedances available to special order.

The new speaker is PCB mountable on pin spacings of 17.5mm, and has dimensions of 31.5mm (dia) 15.1mm (height).

Further information from IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.

SMT trial kit

OK Industries has released a newly designed kit that enables those working with surface mounted devices to evaluate, practice or train on assembly, production or rework techniques.

The kit includes a full range of surface mounted components from chip capacitors, transistors, PLCC's and 100-

pin gull-wing flat packs. To accommodate the kit's wide variety of components, the SMT-K1 also contains a trial board designed for this purpose. The board and components come complete in a reusable conductive tray which prevents static introduction to work areas as well as providing storage.

Further information from Electronics Development Sales, 92 Chandos Street, St. Leonards 2065 or phone (02) 438 2500.

'Truckers' 27MHz CB

Standard Communications announce the release of the GME Elecctrophone TX830 AM 40-channel Super Deluxe Truckers Citizens Band Transceiver.

The TX830 continues the GME Electrophone tradition of the unique 'Auto Recall' on the Truckies Road Alert Channel 8. For easy use, the TX830 features the Ch.8 recall button conveniently located on the microphone.

The TX830 also eliminates the need in many applications for an additional extension speaker. With more sets being flush mounted into overhead consoles of large trucks, the TX830 is assured of ready acceptance among truckers.

Other features include variable RF gain and the LED indicators double as power/modulation indicators showing relative power and modulation levels when transmitting.

Further information from Standard Communications, 6 Frank Street, Gladesville 2111 or phone (02) 816 2198.

Computer cable

Belden Electronics now offers a lightweight, flexible and easy to terminate 100 ohm cable for the interconnection of computers and peripheral devices.

Belden 1162A is a twinaxial cable with an air dielectric design, two conductors, polyethylene insulation, a single tinned copper braid shield (offering 95% coverage to prevent EMI/RFI interference) and black PVC jacket.

The cable is UL listed, conforming to Style 2498 and is similar both in construction and electrical characteristics to Belden 9207 twinaxial cable.

For further information from Belden Electronics, PO Box 322, Clayton 3168 or phone (03) 240 0448.

Instrument carts

Tektronix has introduced a portable instrument pedestal and three carts for test and measurement instruments. The new products include the K501 Tek-Tilt Pedestal, the K217S Rack-Mount Instrument Cart, the K318 Utility Cart, and additional options to the K212 Portable Instrument Cart.

The K501 Tek-Tilt Pedestal features a swivel base that enables users to rotate and tilt bench-top portable instruments for easy operation and viewing. The K27S Rack-Mount Instrument Cart features rack-mount width, three trays (two tiltable), and lockable wheels. The sturdy cart is suited for the storage or transport of laboratory rack-mount instruments.

The K318 Utility Cart is a general-purpose cart for industrial personal computers and test and measurement instruments. The table height cart features an accessories drawer and a sliding tray to enhance work surface size.

Further information from Tektronix Australia, 80 Waterloo Road, North Ryde 2113 or phone (02) 88 7066.

DC-DC converter

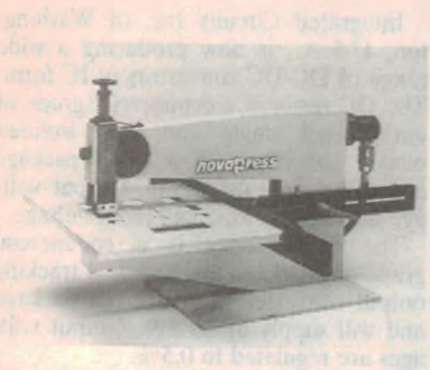
Integrated Circuits Inc. of Washington, U.S.A., is now producing a wide range of DC-DC convertors in IC form. The DC series is a commercial grade of unregulated single and dual isolated output converters in a small package and will supply up to 9W. Output voltage depends on load and input voltage.

The DCR series is a commercial grade of regulated isolated dual tracking output converters in a five pin package and will supply up to 4W. Output voltages are regulated to 0.5%.

The DIP-DC series is a commercial grade of isolated dual tracking converters in a standard 14 pin DIL package. Available power from each device is up to 1W with regulation to within 0.2%. These devices are fully protected against short circuits, will limit output current to 200% of maximum, and incorporate thermal shut down. The devices are also available in non isolated series.

Further information from Davidson Pty Ltd, 17 Roberna Stree, Moorabbin 3189 or phone (03) 555 7277.

New Products



Metal punch

Utilux has been appointed exclusive agents in Australia for the Novopress Benchtop Hole Punch HTL 400.

The Novopress is a compact easy to use machine weighing only 110kg and measuring less than a metre in width and depth, yet able to punch holes in sheet metal up to 3mm thick. Other materials such as stainless steel and plastics can also be punched.

The press is designed for use in the manufacture of switchboards and all types of metal fabrication. Round or square holes can be punched, as can double notch and rectangular and subminiature 'D' profiles. Special sizes can be manufactured on request.

Pre-painted metal can be punched and the holes located by adjusting the x, y co-ordinates with a stop device fitted with a millimetre scale. No marking of the centre of the hole is necessary. The view of the workpiece is not obstructed by the usual protective device while the material is being set up for punching. A safety lock prevents accidental triggering f the punch.

Further information from Utilux, 14 Commercial Road, Kingsgrove 2208 or phone (02) 50 0155.

Multilayer Ceramic Chip Capacitors

Kemet multilayer ceramic chip capacitors are produced in a plant designed specifically for chip capacitor manufacture. The process features a high degree of mechanisation as well as precise controls over raw materials and process conditions.

Kemet ceramic chip capacitors are offered in the three most popular temperature characteristics. These are designated by the Electronics Industry Association (EIA) as the ultra-stable COG (known in the vernacular as NPO), the stable X7R (military BX or BR), and the general purpose Z5U. A wide range of sizes are available to provide capacitance from 1 picofarad through 2.2 microfarads in 50, 100 and 200 volt ratings.

Further information from Crusader Electronic Components, 73-81 Princes Highway, St. Peters 2044 or phone (02) 516 3855.

Power waveform CRO adaptor

Jubilee Instrument's PM-8551 power waveform oscilloscope adaptor provides any general oscilloscope with voltage differential inputs and an inbuilt digital phase meter.

Dedicated to waveform measurement in the fields of power electricity and electronics, the 8551 has three opto-isolated differential inputs that scale and convert the input voltages to single ended BNC outputs, compatible with any conventional oscilloscope.

Under voltage measurement, each amplifier can accommodate a high voltage differential input of up to 1000V and its sensitivity can extend down to 400mV. The amplifier bandwidth exceeds 2MHz with 150nsec risetime. This is adequate for making accurate dv/dt measurements in the fastest switching and commutating circuits with SCRs, thyristors or transistor supplies.

The in-built phase measurement is achieved by using the Z-modulation facility of general purpose oscilloscopes, and the 8551 displays two bright markers on the waveform traces; one reference and one phase marker.

Further information from Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.

Books & Literature

Transducer guide

SENSORS AND TRANSDUCERS: A guide for technicians, by Ian R. Sinclair. Published by Blackwell Scientific Publications, 1988. Hard covers, 240 x 160mm, 153 pages. ISBN 0 632 02069 5.

Transducers are now so widely used, a knowledge of them is almost mandatory for those involved in fields such as gas fitting, hydraulics, mechanics and, oh yes, electronics. Books on these devices are suprisingly rare, particularly those dedicated to transducers only.

In his book, Ian Sinclair has attempted to describe the operating principles of all the more usual types of transducers, while avoiding the unnecessary use of mathematics and 'techspeak'. There are seven chapters, covering all the fields that sensors and transducers are used in. Included are chapters on strain and pressure, position, light, and temperature measurement.

Other chapters are devoted to sensors associated with solids, liquids and gases, the environment, even scientific research. Naturally, sound is given a complete chapter, covering the usual topics of loudspeakers and microphones, but also including ultrasonics and infrasound.

The book is very accessible, with the information presented clearly and with economy. In general, I felt that each device or concept was treated adequately and at a level that – to me, anyway – was satisfying. An absolute novice to the electronics field would find parts of the book a bit technical, but the physics associated with each device are presented without recourse to jargon.

This book will be welcomed by those who want to know the principles of operation of the devices. I feel it would make an excellent reference book in trade/technician level courses, but the RRP of $76 would be a substantial barrier to students.

The review copy came from Blackwell Scientific Publications, Victoria. (P.P.)

Antenna text

PRINCIPLES OF ANTENNAS: wire and aperture, by T.S.M. Maclean. Published by Cambridge University Press, 1986. Hard covers, 235 x 155mm, 360 pages. ISBN 0 521 30668 X.

This book is intended both as a student's textbook at final year undergraduate and postgraduate level, or for engineers involved in antenna design. However it is not intended to provide instruction in commercial antenna design.

The content is equally spread between wire antennas and aperture antennas and uses a quantitative approach throughout. There are 16 chapters giving an indepth mathematical treatise on topics such as the dipole, loop antennas, helical antennas, Yagi and log. periodic type antennas. Aperture antennas occupy seven chapters, and include material devoted to waveguides, parabolic reflectors and so forth.

The book is very high level stuff, and will necessarily appeal to a limited market. I am unable to judge its merits, as in general the content of the book is specific and out of my league. There are numerous books on antenna design on the market, and most seem to adopt a mathematical approach, perhaps explaining why the 'black art' syndrome has developed around the topic. But no one has ever explained, for example, why a coat hanger bent into the shape of Australia works better than a shiny whip antenna on the left mudguard!

The book has an RRP of $162, which may further limit its appeal. The review copy was supplied by Cambridge University Press. (P.P.)

Power electronics

POWER ELECTRONICS AND MOTOR CONTROL, by W.Shepherd and L.N.Hulley. Published by Cambridge University Press, 1987. Soft covers, 228 x 152mm, 473 pages. ISBN 0 521 31283 3. Recommended retail price $49.50.

Nominally a text for advanced students in university and CAE's, this book should also be of interest to engineers and senior technicians working in control and power engineering.

Essentially it covers all main aspects of electronic power control, but with less emphasis on traditional thyristor devices like the SCR and triac and more than you might expect on devices such as the GTO (gate-turnoff thyristor), power bipolars and power FETs. This is in line with the authors' belief that the 'reign' of the SCR is now drawing to a close, with power control and switching being increasingly handled by the other devices.

One noticeable result of this changed emphasis is that unlike earlier books on the same subject, there's no chapter on the commutation circuits so necessary with traditional SCRs.

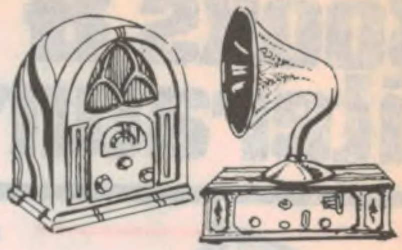
After initial discussion of the various devices and their characteristics, it progresses to control circuit design, switch protection and principles of adjustable speed drives. Then there are chapters on DC motor chopper control, single phase voltage control, three-phase induction motor voltage/resistance control, phase control in general and for DC motors, phase control of induction motors with natural commutation, and induction motor control via variable voltage, variable frequency inverters.

The text appears to be very concise, is well illustrated and includes all necessary maths plus numerous worked examples. In short, an excellent text on an important subject.

The review copy came from Cambridge University Press in Melbourne. (J.R.)

Vintage Radio

by PETER LANKSHEAR



The brief heyday of 'CATKINs'

No, *EA* has not branched out as a horticultural magazine! The catkins referred to are not willow flowers, but an interesting series of valves marketed by Marconi/Osram in England for a couple of years after their introduction in 1933.

The radio valve was a direct development of the electric lamp. Thomas Edison conducted investigations into the blackening of bulbs by deposits radiated from carbon filaments, and in the process noted that a unidirectional current could be made to flow to a separate electrode within the lamp. This 'Edison effect' as it was called, was later used by Professor Fleming in modified lamp bulbs for his first diodes, and Lee de Forest turned to a lamp manufacturer to construct his 'Audion' triodes, made by fitting a grid to the Fleming diode.

Thus, right from the start, the lamp industry was closely associated with valves, and used techniques with which they were familiar, such as the 'pinch' – a flattened tube in the base used to support the electrodes.

Naturally, glass was used for valve envelopes, and in general, its characteristics are ideal for this purpose. Although brittleness and lack of electrical screening were minor criticisms, it is strong, easily worked, heat resistant and above all, a good seal against a vacuum. Little wonder then, that it was used throughout the whole history of valve manufacture as the major envelope material.

Transmitting and special purpose valves have often used more exotic ceramics, however – including some incorporating beryllia, a known cause of leukaemia!

Had the valve not been tied to the lamp industry, it is likely that it would have evolved with a metal envelope. The early transistors reflected their valve associations and were frequently encapsulated in glass, but in their case, it was not long before metal and plastic took over.

Metal valves in 1923

Quite early on there was a realisation that valves might be better clad in metal. During 1923 the Belgian military, in a search for more rugged equipment, commissioned Philips to construct some metal cased valves. It was soon apparent however that fragility at that stage of valve development was not confined to envelopes, and the project was abandoned.

Twelve years later, the familiar and very successful American octal based metal valves made their highly publicised debut, and were eventually to become an international standard. Not so familiar were the earlier British made Marconi/Osram metal valves, which, although produced for only a few years, were to have a significant influence on the development of the octal series.

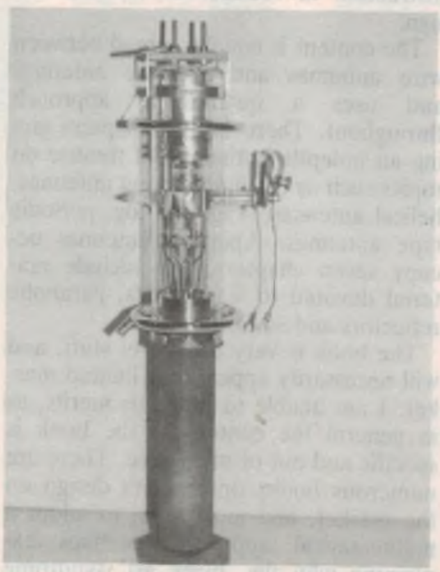


Fig.1: The Marconi water-cooled CAT9 transmitting valve, about 750mm tall. It operated upside down, with the anode surrounded by a water jacket.

Water Cooled Valves

The origins of these early British metal valves lie in high powered transmitting valves. A serious problem in the operation of early transmitting valves was the dissipation of heat, with the result that they were limited in size to a few hundred watts.

An efficient class C power amplifier generating a carrier of 1kW would be required to radiate 300 watts or so of waste energy, in the form of heat. The dissipation of class B amplifier generating the same power would be nearer 2kW. Anyone who has touched the output valve of a mains powered radio, typically heated only by about 10 watts, will appreciate the transmitting problem.

A practical solution for dealing with high powers is to have the cooling medium in direct contact with the anode, which must as a consequence form part of the valve envelope.

When this type of construction was first attempted, difficulties arose in maintaining a vacuum tight seal between the anode and the rest of the envelope. William G. Housekeeper of the Western Electric Company solved the problem in 1921 and made high powered valves possible, by an ingenious method of sealing a cylindrical copper anode to a glass envelope.

Today's transmitting valves have finned anodes cooled by air blasts, but the early transmitters used pure water in direct contact with the anodes. I have vivid memories of the problems of 40 years ago in dealing with an AWA 5kW transmitter which used a water cooled triode operating at an anode potential of 12,000 volts, whilst the water circulating pumps were at earth potential! The valve concerned was a Marconi CAT9 shown in Fig.1. 'CAT' stands for *cooled anode transmitting*, and the term has significance in our story.

Fig.2 (above): On the left is the MH4 Catkin triode with base and cover removed. Note the resemblance to the CAT9. The VMS4 variable-mu RF amplifier is at right.

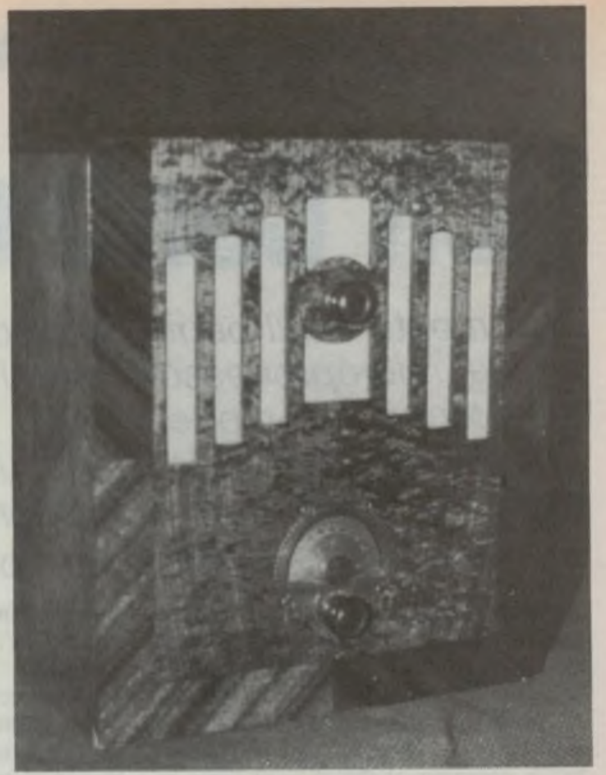


Fig.3 (right): The 'Dapper Five' Australian made receiver, which used three of the Catkin valves. It was made by Tasma, and sold under their own and the Genelex brands.

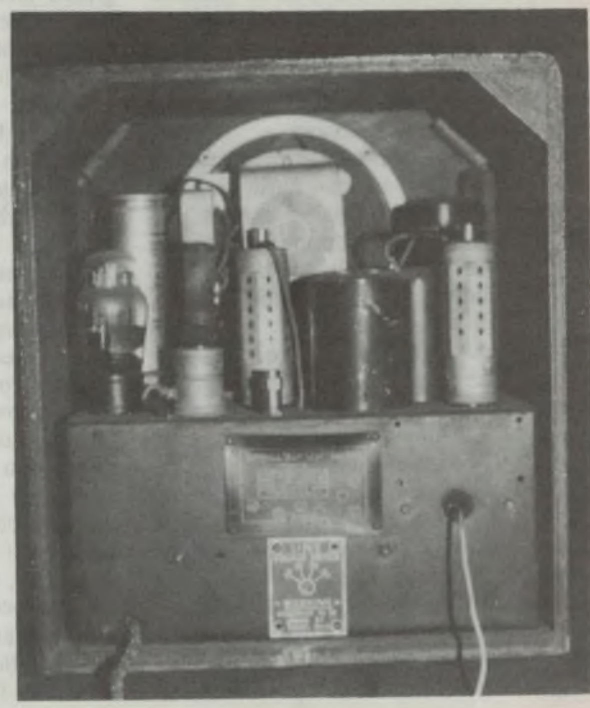


Fig.4: A look inside the back of the Dapper Five receiver shown above. Note the mixture of Catkin and conventional glass-envelope valves.

CATs in miniature

Despite the inconvenience of water cooling, these valves were widely used and during 1933, Marconi/Osram decided to adapt the construction technique of exterior anodes to some lower-power receiving valves – mercifully without the water cooling!

Just as with the transmitting valves, the anode was a vacuum tight copper cylinder with a glass base. The traditional 'pinch' was replaced by an annular ring, for electrode support in the base. Fig.2 includes a triode with the cover removed, and the physical relationship to the CAT9 is clear.

As these new valves were like miniature CATs, an obvious title was "CATKIN".

No attempt was made to create new electrical designs or designations for the catkins. Instead, several of the standard Marconi/Osram range of valves were produced in the new form and were interchangeable with the standard equivalents.

At that time it was common British practice to shield valves other than output types and rectifiers with a layer of conductive paint on the outside of the glass. Accordingly, many of the catkins were given distinctive metal shields with diamond shaped perforations. In the 5 pin series, there was no separate earthing connection, the shield being connected to the cathode pin. To avoid any risk of shorting the shield to the chassis, thin rubber washers are fitted to the bases of the shielded catkins.

The output pentodes and later production runs of the smaller valves were not shielded, so, be warned: In operation, unshielded catkins have anodes that are 'hot' in two ways!

As the series had no rectifiers, mixers or diodes, there were no completely catkin-equipped receivers. The Australian-made Genelex 'Dapper Five' receiver illustrated has a varied selection of valves, with an American 2.5 volt type 57 as a self oscillating mixer, a VMS4 intermediate frequency amplifier, MS4B detector and MPT4 output pentode. The rectifier is a glass U12.

In 1935, the American octal based metal valves were introduced and were soon dominating the market. Although the catkins were discontinued in 1936, they had played an important part in breaking away from the glass tradition, and had a significant influence on the development of the American metal valves. EA

Basic Principles of VCRs - Part 3

VCR Control Systems

This month we'll begin by discussing a typical microprocessor control system of the type found in a modern VCR. Then we'll look at the various servo systems used to control tape and head drum movement.

by DAVID BOTTO

In early model domestic VCRs, the user selected the various functions, such as PLAY, STOP, REWIND, FAST FORWARD, RECORD, and PAUSE by pressing hefty mechanical "piano" key buttons. However in the newer VCRs selection of the desired function is achieved by means of "feather touch" control buttons, or by use of a remote control handset. This method of control of the VCR relies on the use of digital and microprocessor devices.

As most *Electronics Australia* readers will know, there are two basic kinds of electronic signals. Analog signals are those which vary continually, as in Fig.1(a). Digital signals are signals that switch between two fixed values (Fig.1(b)); these values are known as digital or logic levels. For positive "logic" the more positive voltage level – i.e., +5V in Fig.1(b) – represents a binary "1", while the less positive level (here 0V) represents binary "0".

In Fig.1(b) four digital signals or "bits" as they are called are shown. If these digital signals were fed into logic circuitry following the direction of data flow shown by the arrow, the serial binary number would be 1010. In Fig.1(b) the number is read from left to right. Fig.2 is a table of binary values and their decimal/hexadecimal equivalents, which you'll probably recognise.

Modern VCR circuitry is extremely sophisticated, and may contain one, two or even three *microprocessors*. A microprocessor is an extremely complex integrated circuit (IC) device, the equivalent of the *central processing* or "number-crunching" part of a computer. It is intended for use with other digital circuitry in a microcomputer or other piece of digital equipment. It may be defined as a device contained within a single large scale integrated (LSI) circuit, which can perform a number of arithmetic and logic operations, receive instructions, and also send out its own instructions. To do this the microprocessor uses digital signals.

The special type of microprocessor used to control a VCR is more accurately known as a *microcomputer* chip. This type of chip incorporates all the facilities of a microprocessor, plus a ROM (read-only memory) containing a specially developed program of instructions designed to control the various functions, etc., of a VCR.

A microcomputer chip may be a virtually standard microprocessor that contains additional internal circuitry and instructions for use only in a particular VCR. For this reason it is often referred to as a "dedicated" device.

Fig.3 is a simplified schematic of a typical microcomputer VCR function control system. It uses a 42-pin four bit device. Stabilized +5V and 10V DC voltage supplies are used.

A/D ramp circuitry

For simplicity just six function control buttons are shown in Fig.3. However, an increasing number of function controls are found on the latest VCRs. To avoid the use of complex and expensive scanning keyboards, many VCRs now use a variation of the A/D (analog to digital) "ramp" circuitry shown in Fig.3 to select the required function.

The circuit uses two op-amps (operational amplifiers) A1 and A2, connected as voltage comparators. An op-amp, you may remember, is a direct coupled, multistage, high gain amplifier contained within a single IC. It amplifies the difference between the signal voltages fed to its positive (non-inverting) input, and its negative (inverting) input. The input impedance of an op-amp is usually in excess of one megohm, and the output impedance quite low – perhaps a 100 ohms or less.

In our schematic, if the positive input of A1 is higher than its negative input, then the output of the device will be high (binary 1). If on the other hand the negative input is higher than the positive input the output will be low (binary 0).

When none of the function buttons is depressed, the voltage on the + input of A1 is at 10 volts DC. This makes it higher than the voltage on the – input,

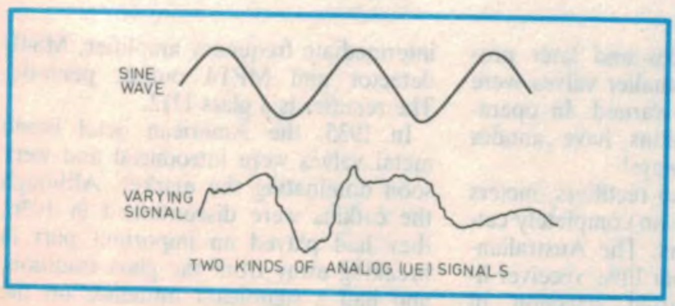


Fig.1(a): Two kinds of analog signal, a pure sinewave and a randomly varying signal.

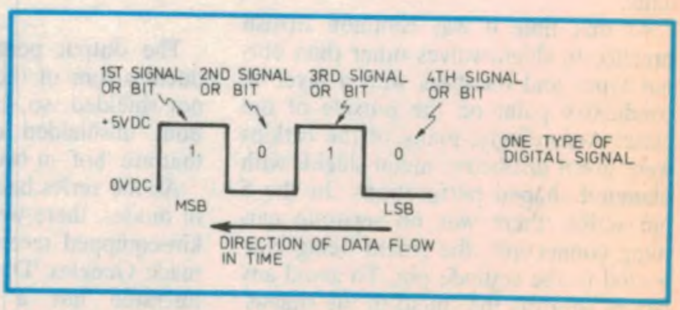


Fig.1(b): One type of digital signal, where '1's and '0's follow each other serially.

Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

Fig.2 (above): A table of the binary number values possible with 4 digital bits, with their decimal and hexadecimal equivalents.

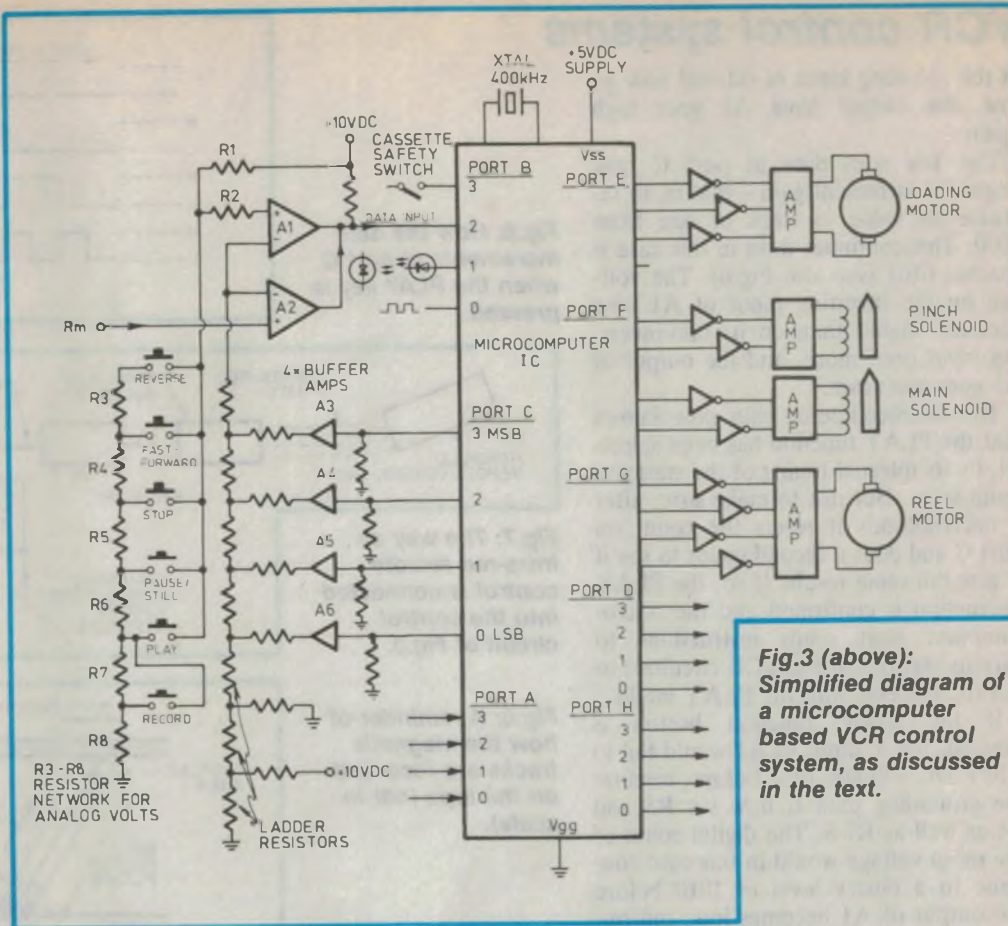


Fig.3 (above): Simplified diagram of a microcomputer based VCR control system, as discussed in the text.

so the output from A1 is high. This level is then fed into pin 2 (labelled data input) of port B of the microcomputer chip.

You'll notice that the microcomputer IC has a number of these "ports", that are set up by internal circuitry to either receive or send digital information.

Fig.4 shows the output signals produced internally by the microcomputer of Fig.3, on lines 0 to 3 of port C. These signals are known as the key scan data. The numbers represent the binary values of these key scan waveforms. The four buffer amplifiers A3-6 and the "ladder" resistor network connected to their outputs combine these waveforms, to produce the "staircase" waveform shown. This is fed to the inverting (-) input of op-amp A1. The binary values of the key scan data, read vertically from the MSB to the LSB, are the equivalents of the hexadecimal numbers on the "staircase"(compare with Fig.2).

When one of the function buttons shown in Fig.3 is pressed, the flow of current through the resistor network for the pushbuttons reduces the DC voltage level on the positive input of A1 to an accurate pre-determined value. (Notice that for the record function to operate correctly, both record and play buttons

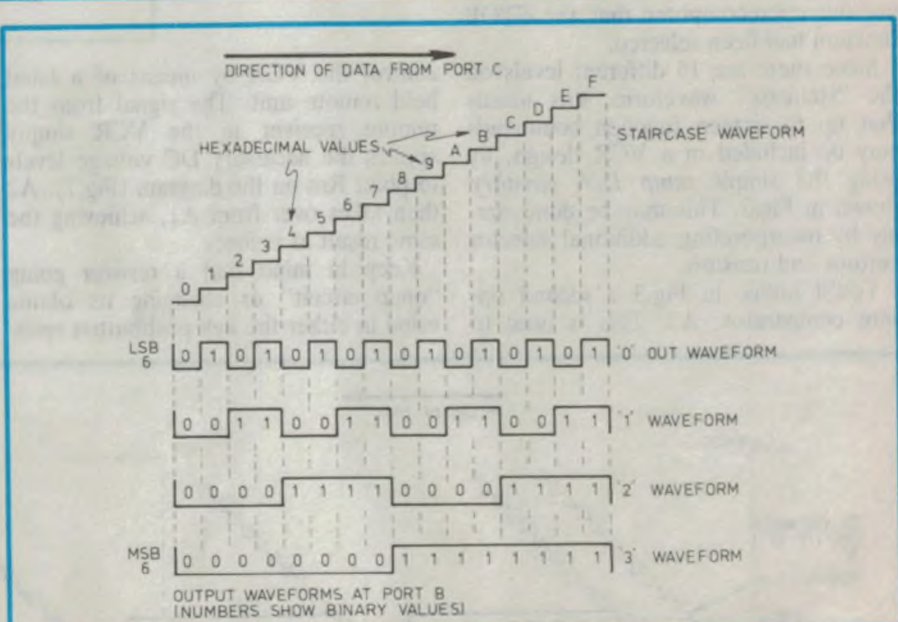


Fig.4: The output waveform at port B of the microcomputer of Fig.3, when no key is pressed.

must be pressed together.) For example if the "Play" mode is selected, the voltage at the + input of A1 is dragged down towards ground by resistors R7 and R8, falling from 10V to 2.99V. This is shown by the dotted line in Fig.5.

As the "staircase" voltage rises above 2.99V, (point "Z" on Fig.5), the output from comparator A1 now becomes low. This tells the microcomputer IC that a function button has been pressed, but not which one. Inside the microcomputer the four bit data from port C now resets to zero (0000). Since the voltage at the inverting input of A1 will now go low, the output from A1 goes high again.

The key scan data at port C now begins to increment gain – that is, to increase its value in steps of one from 0000. This continues until in this case it reaches 0101 (see also Fig.6). The voltage on the inverting input of A1 now becomes higher than on its non-inverting input once more, and the output of A1 goes low again.

The microcomputer chip now knows that the PLAY function has been selected, by its internal timing of the staircase ramp steps. But just to make sure, after 5 microseconds it resets the count on port C and does a second count to see if it gets the same result. If so, the PLAY instruction is confirmed and the microcomputer next sends instructions to various sections of the VCR circuitry, to put the machine into the PLAY mode.

If the STOP function button is pressed, the + input to A1 would fall to 6.37V DC – higher than before, because the grounding path is now via R5 and R6 as well as R7-8. The digital count of the ramp voltage would in this case continue to a binary level of 1010 before the output of A1 becomes low, informing the microcomputer that the STOP function had been selected.

Since there are 16 different levels on the "staircase" waveform, this means that up to sixteen function commands may be included in a VCR design, by using the simple *ramp D/A circuitry* shown in Fig.3. This may be done simply by incorporating additional selector buttons and resistors.

You'll notice in Fig.3 a second op-amp comparator, A2. This is used to control the VCR by means of a hand held remote unit. The signal from the remote receiver in the VCR simply applies the necessary DC voltage levels to point Rm on the diagram (Fig.7). A2 then takes over from A1, achieving the same result as before.

Keep in mind that a resistor going "open circuit" or changing its ohmic value in either the key pushbutton resistor network, or the ladder resistor chain (Fig.3), could stop the function buttons from operating or cause the selection of the wrong function.

The other ports

Remember that all ports of the microcomputer chip are capable of either accepting or transmitting data consisting of digital signals.

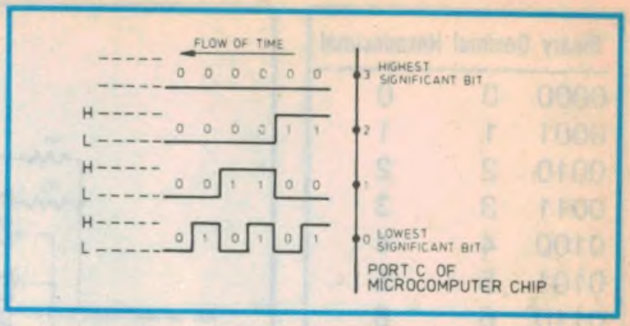


Fig.6: How the data increments at port C when the PLAY key is pressed.

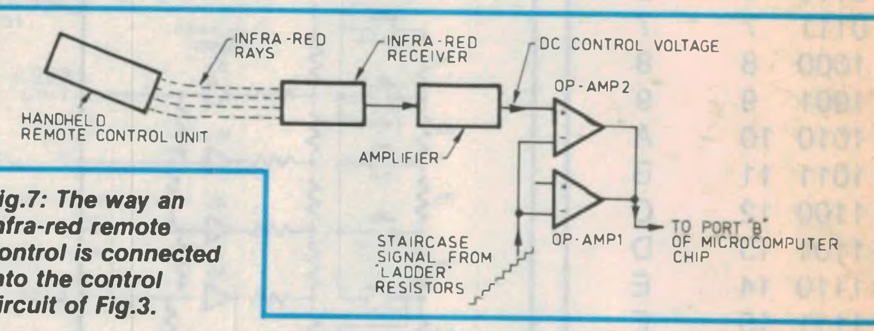


Fig.7: The way an infra-red remote control is connected into the control circuit of Fig.3.

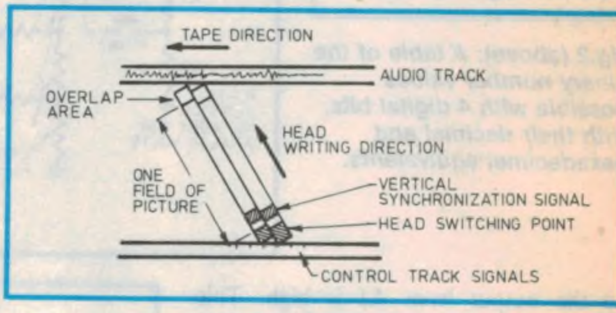


Fig.8: A reminder of how the magnetic tracks are recorded on the tape (not to scale).

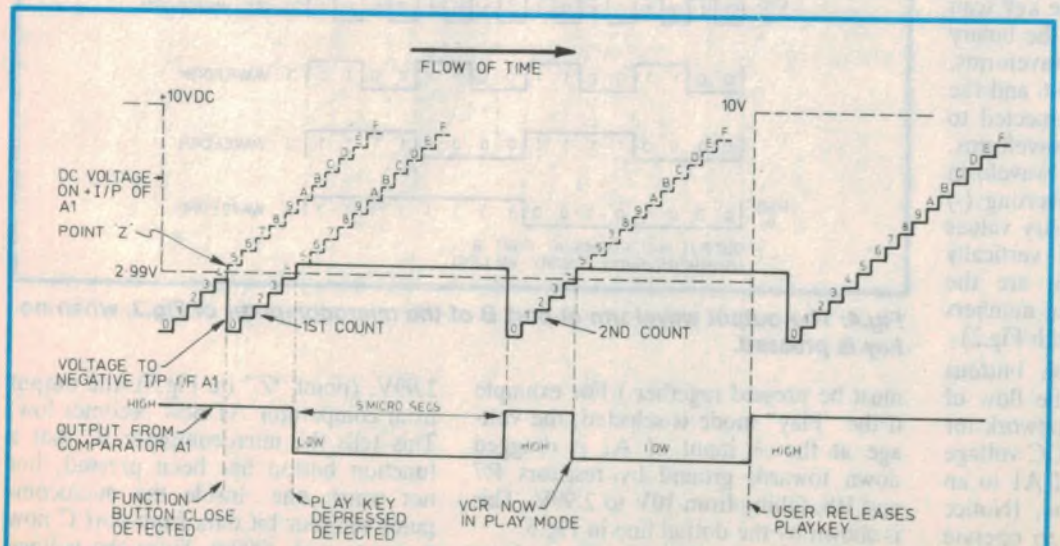
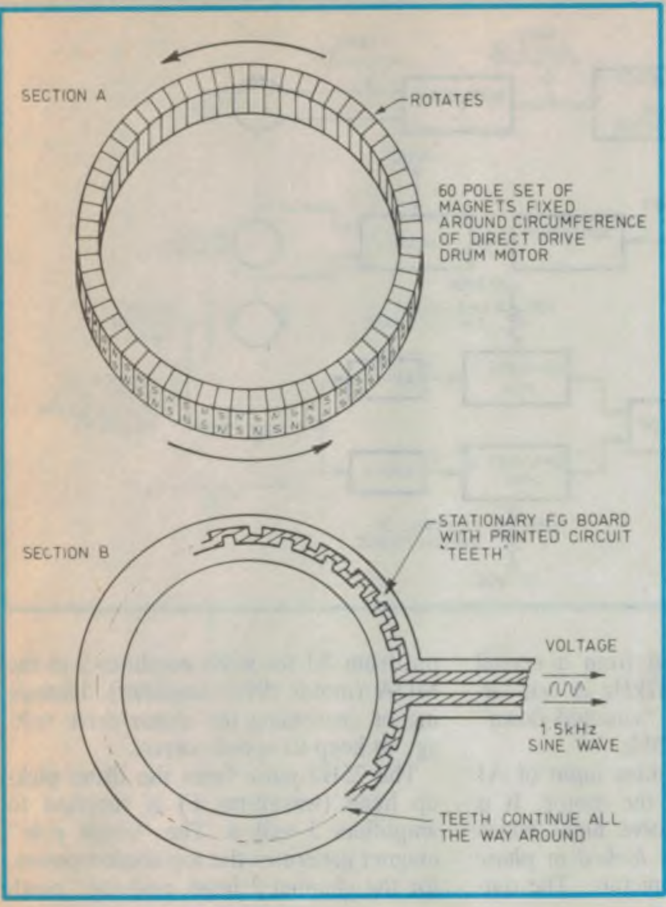


Fig.5: Operation of the ramp D/A comparator of Fig.3, when the PLAY key is pressed to select this mode.



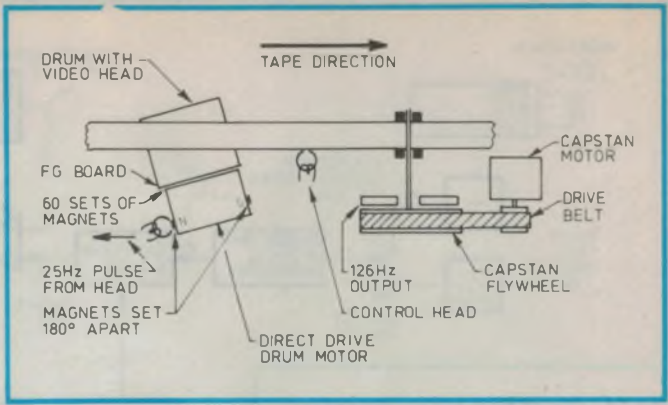


Fig.10 (above): Sketch of the VCR mechanism showing the parts that are servo controlled.

Fig.9 (left): Details of the head drum frequency generator or 'FG', which produces a 1.5kHz sinewave signal when the drum is rotating.

Port B handles three more input signals (Fig.3). The 0 line detects a 25Hz signal, that informs the microcomputer chip that the video head drum is rotating. The 1 line detects an input signal from a photocell reel sensor, so that if the cassette tape jams or breaks the microcomputer will know and stop the VCR. The 3 line is fed a signal from a switch which senses whether the protection tab has been removed from the tape cassette. If this tab is missing, the microcomputer will thus be able to tell, and refuse to activate the record function.

Port A is also programmed for signal input. Its four lines are fed by multiplexer circuits, which monitor a number of conditions in the VCR. These include the tape start sensor, whether the cassette viewing lamp is in order, the various cassette microswitch conditions, tape loading conditions, timer mode, etc. We will discuss these in a later article.

Ports D, E, F and H are all programmed internally inside the microcomputer chip to function as signal output ports.

Port E generates signals that are fed via an amplifier to drive and control the loading motor, switching it on and controlling the direction of rotation. Port G similarly controls the reel motor that winds and rewinds the magnetic cassette tape, while port F controls the two electromagnetic solenoids that move the pinch wheel and various other sections of the tape deck mechanism.

Signals from ports D and H go via digital switching circuits (known as "latches"), controlling the various functions responding to the instructions fed into line 2 on port B. These signals also turn the LED (light emitting diode) function indicators on and off.

Servo systems

Servo systems are used to control the rotational speed of the various motors in a VCR, detecting and correcting any variations in speed or phase.

Fig.8 represents a portion of a VHS tape pattern (except for the azimuth angle – see part two of this series). The patterns are similar in the Betamax format. Video head rotation must be kept at exactly one half of the vertical synchronizing signal frequency of 50Hz, which is 25Hz. Each field of the television picture is recorded on a single track by one video head, and the next picture field on the next track by the other video head. (You'll hopefully recall that each complete "frame" of picture consists of two interlaced fields).

When the recording is "played back" the servo system makes sure that the magnetic tape travels at the correct phase and speed so that the recorded video tracks are correctly synchronized. The switching period from the first video track to the second video track occurs at the beginning of each video track. This prevents this switching from producing noise during the active part of the picture.

To accomplish the above two servo systems are necessary. First, the *drum servo* circuitry which keeps the head drum containing the video heads at the correct speed and proper phase. And secondly, the *capstan servo* which ensures that the speed and phase of the magnetic tape itself are correct.

Head drum servo

In the case of a VHS machine using a direct drive motor, a number of permanent magnets are built into the motor. Detectors are built into the fixed FG (frequency generator) board (Fig.9). When the direct drive motor rotates, voltage is induced by the magnets (section A), into the fixed printed FG coil (section B). Because the poles of adjacent magnets are reversed, the output voltage alternates between positive and negative. This produces the 1.5kHz signal shown in Fig.9.

Fig.10 is a side view of the servo controlled mechanism. Two magnets of opposite polarity are set into the motor 180° apart. As the motor rotates a 25Hz pulse is generated in the pick-up head.

Fig.11 is a simplified block schematic of a typical VHS drum servo system. The 1.5kHz signal from the FG board feeds to amplifier 1, which converts the sine wave at point G into a square wave (H). The signal now passes through a frequency to voltage (F/V) converter. If the frequency of the 1.5kHz signal becomes higher, the voltage output of the converter drops. Conversely if the frequency decreases, then the voltage output increases.

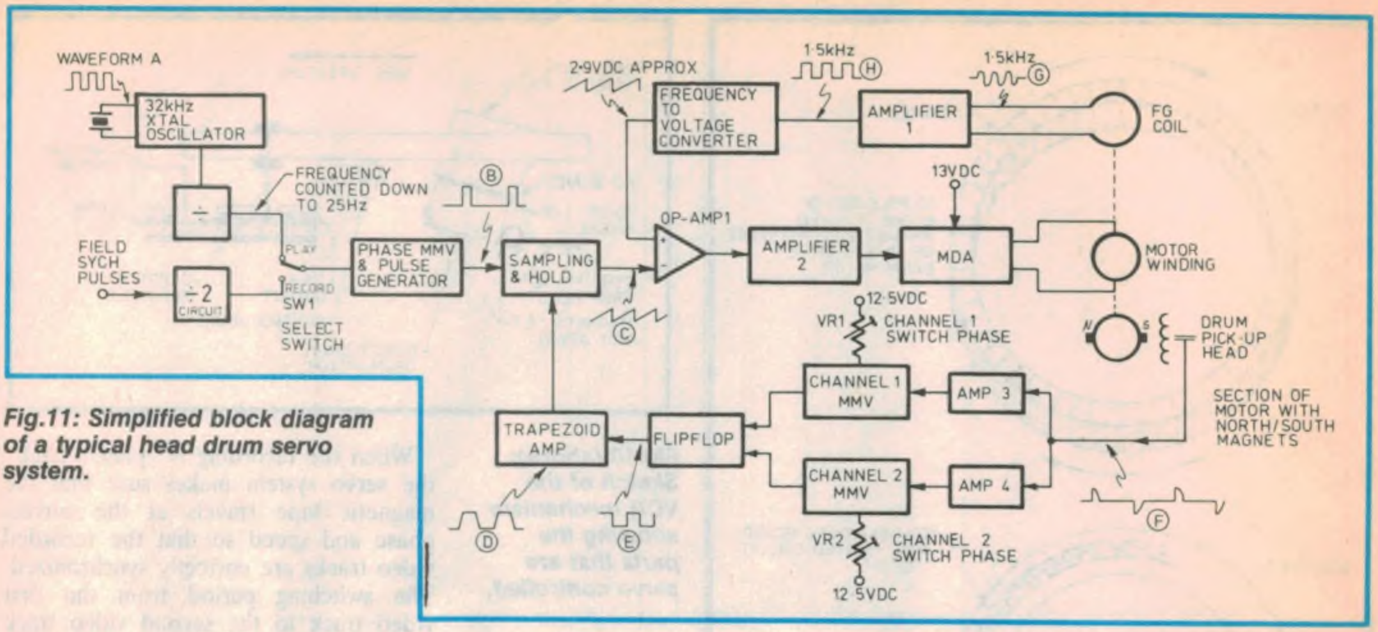


Fig.11: Simplified block diagram of a typical head drum servo system.

The output of the F/V converter is taken to the positive input of op-amp comparator A1, feeding the drum motor drive amplifier. The negative input of A1 is supplied with a reference signal, C. When recording this signal is obtained by dividing the frequency of the field synchronization pulses by two, whereas in the playback mode the reference signal is obtained from a crystal controlled oscillator (32kHz in our circuit), whose output is "counted down" by digital circuitry to 25Hz.

The input to the positive input of A1 controls the *speed* of the motor. It is the input to the negative input which keeps the drum motor *locked in phase* with each field of the picture. The output from A1 feeds via amplifier 2 to the MDA (motor drive amplifier), increasing or decreasing the motor drive voltage to keep its speed correct.

The 25Hz pulse from the drum pick-up head (waveform F) is supplied to amplifiers 3 and 4. The "south pole" magnet generates the top section pulses, for the channel 2 head, and the "north

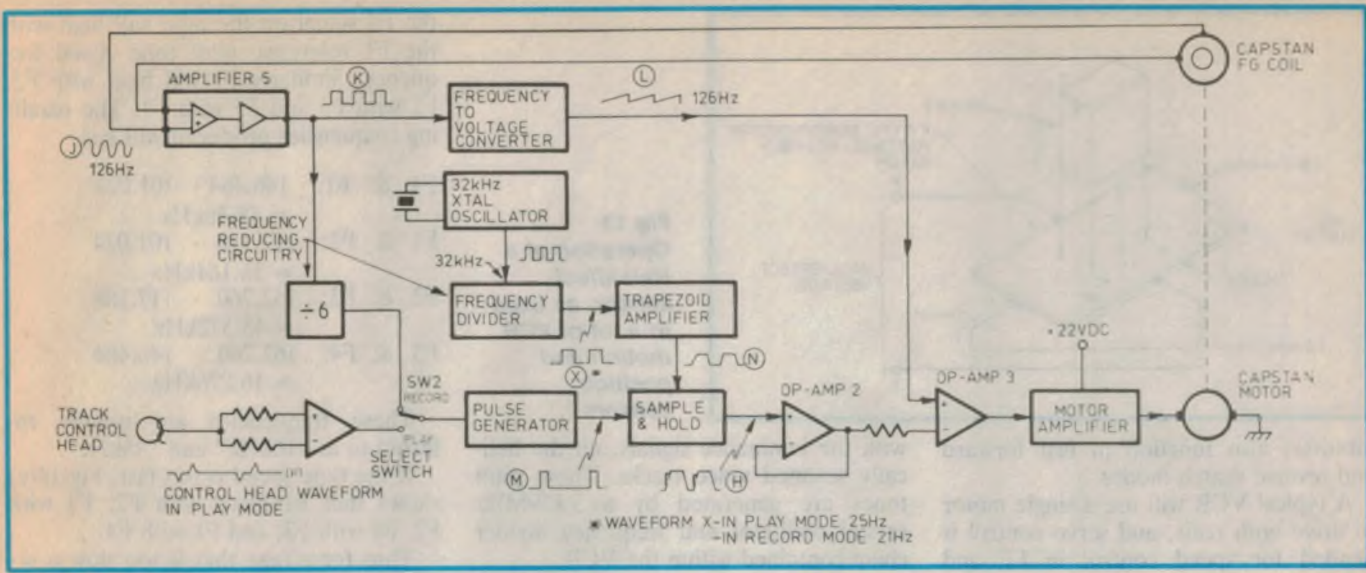


Fig.12: The block diagram for a typical capstan servo system, again simplified.

pole" magnet the bottom section pulses for the channel 1 head.

The signals from amplifiers 3 and 4 now pass via two MMVs (monostable multivibrators, or "one-shots") and trigger a flipflop to produce waveform E. (See part 8 of my *Colour TV* series, in the October 1987 issue of *EA*, for a description of one type of flipflop. Digital IC circuitry can also be used).

The flipflop signal identifies the phase of the video heads – i.e., which head is at that moment reading or writing the video tracks. The square wave output is fed to a trapezoid amplifier, producing waveform D. The width of these pulses changes with speed.

Circuitry in the sample and hold IC compares the trapezoid signal with the incoming 25Hz signal, producing waveform C at the negative input of A1 – which as noted earlier, controls the phase. So in this way the video drum rotation and hence the head scanning of the video tracks is kept "locked" to the video signal, in both play and record modes.

Most of the circuitry of Fig.11 including SW1, which is controlled by the microcomputer, is contained within a few integrated circuits.

The capstan servo

Fig.12 is a block diagram of typical capstan motor servo system. As you can see from Fig.10, the capstan motor drives the capstan by means of a belt.

Secured to the capstan flywheel is a circular magnet. Matching 60-tooth iron gears are fixed on the chassis and flywheel. As the gears cut through lines of magnetic force, voltage is induced in the capstan FG coil. The capstan rotates at about 2.5Hz, so the capstan FG output signal is about 126Hz.

In the record mode this FG signal is amplified by amplifier 5, which contains two op-amps. At the input of this amplifier the signal is a sinewave (waveform J). Amplifier 5 changes this to a squarewave (K). This signal serves two purposes. Firstly it is fed to a frequency to voltage (F/V) converter IC to control the speed of the capstan motor.

If the 126Hz square wave input frequency falls, the voltage output of the F/V converter increases. Conversely if the frequency rises the output drops (waveform L). This signal is supplied to the positive input of op-amp 3.

The second output path for the 126Hz squarewave output from amplifier 5 takes it to circuitry that reduces its frequency by six times, to 21Hz. It is then fed to a pulse generator to produce waveform M.

The output of the 32kHz crystal controlled oscillator (the same oscillator used in the drum control circuitry) is also passed through divider circuitry, which this time reduces its frequency also to 21Hz (waveform X). It then passes through another trapezoid amplifier, to become the *phase* reference signal (waveform N). This is compared with the pulse signal from the capstan FG, in the sample and hold/amplifier circuitry.

If the phase of the 21Hz signal derived from the capstan FG coil is incorrect, the waveform at point H changes to correct it. This voltage is supplied to the positive input of buffer op-amp 2, and then to the negative input of op-amp 3. Thus the signal from the F/V converter controls the speed, whilst the 21Hz signal provides the fine control "locking" in the phase of the capstan motor correctly. As in the case of the drum motor the output of op-amp 3 controls the voltage output of the drive amplifier supplying the capstan motor.

Play mode

In play mode the capstan servo circuitry operates exactly as in the record mode – with one difference. The *speed* of the capstan motor is still controlled by the FG signal and frequency to voltage circuitry as before. However switch SW2 is now in the play position. The play-back 25Hz control signal (R) from the tape control track (see again Fig.8) is fed through op-amp 4 to this position of the record/play switch.

In this mode the 32kHz quartz crystal oscillator is now "counted down" by the circuitry to form a reference signal of 25Hz instead of 21Hz. As before both signals are supplied to the sample and hold circuitry, to control the phase of the capstan motor. The tape control track at the bottom of the tape is laid down during the recording process, derived from the 50Hz field sync pulses.

The servo systems we've discussed are typical for a VHS machine. However you'll appreciate that the same basic principles apply to all machines, although the circuitry of different VCRs can vary considerably.

Reel motor

A reel motor, or motors, winds and rewinds the cassette tape. The reel

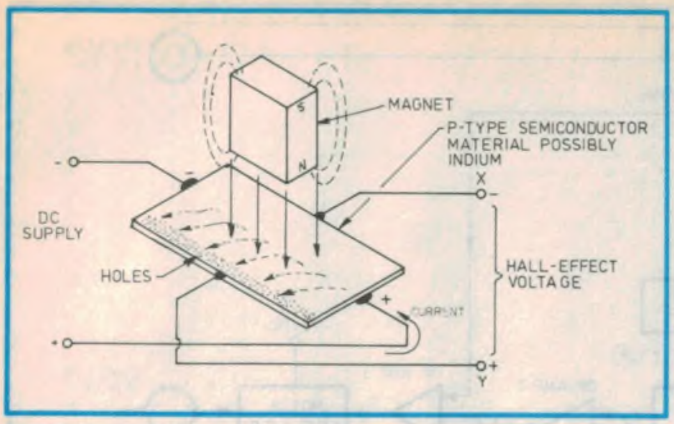


Fig.13: Operation of a Hall-effect sensor, as used in a lot of VCR motion and position sensors.

motor(s) also function in fast forward and reverse search modes.

A typical VCR will use a single motor to drive both reels, and servo control is needed for speed control in FF and REW search modes. We'll discuss this in a later article in this series.

The Hall effect

Fig.13 illustrates the basic Hall effect mechanism, using P-type semiconductor material. As a current flows through the material in one direction, magnetic flux from the north pole of the magnet causes the positive holes in the material to be pushed down to the bottom edge. The result is that a *Hall-effect voltage* appears across the material, between points X and Y.

If the magnet is reversed so that the south pole is nearest to the top of the semiconductor material, the holes collect at the top edge instead. The Hall-voltage generated is then reversed. (If N-type semiconductor material is substituted, opposite polarity Hall voltages are produced, but the principle is the same.)

The Hall effect is very useful in VCR technology, being used in a lot of motion and position sensors. Hall-effect devices are fitted to motors, pulleys, wheels, etc., and the generated Hall voltage is taken through the circuitry to the microcomputer chip. If a fault occurs and a component with a Hall-effect device fitted stops moving, the microcomputer chip senses the absence of one or more of the Hall voltages and stops the magnetic tape transport mechanism.

Video-8 ATF system

In the Video-8 system no control track signal is recorded on the lower edge of the tape as in the VHS and Betamax systems. During the record mode a sequence of four different automatic track finding (ATF) pilot tone frequencies are recorded in sequence with the luminance signals, on the helically scanned video tracks. These pilot tones are generated by a 5.859MHz crystal oscillator and frequency divider chain contained within the VCR.

Fig.14(a) shows the order in which the pilot tone frequencies are recorded (compare with Fig.13 in Part 2 of this series). F1 is 101.024kHz, F2 is 117.188kHz, F3 is 162.760kHz and F4 is 146.484kHz. The sequence then repeats. The upper sequence in Fig.14 represents the tape, and the lower sequence the tones from the crystal oscillator and frequency divider.

When the recorded picture is played back, the generated pilot tones within the VCR are compared with the pilot tones recorded on the magnetic tape (Fig.15). At the correct tape speed no output signal is produced.

Fig.14(b) shows what happens if the magnetic tape is running slow. Some of the F4 signal on the tape will beat with the F1 reference pilot tone signal frequency. Similarly F1 will beat with F2, F2 with F3 and F3 with F4. The resulting frequencies produced will be:

F4 & F1: 146.484 - 101.024 = 45.46kHz
F1 & F2: 117.118 - 101.024 = 16.164kHz
F2 & F3: 162.760 - 117.188 = 45.572kHz
F3 & F4: 162.760 - 146.484 = 16.276kHz

These frequencies are usually referred to as "16kHz" and "45kHz".

If the tape speed is too fast, Fig.14(c) shows that F1 beats with F2, F3 with F2, F4 with F3, and F1 with F4.

Thus for a tape that is too slow a sequence of beat signal frequencies of 45 - 16 - 45 - 16kHz is produced, whereas a too fast tape produces a sequence of beat frequencies of 16 - 45 - 16 - 45kHz. This is from the same sequence of reference tones from the 5.859MHz crystal oscillator.

The output of the mixer is then fed to an op-amp, which produces an error signal to regulate the capstan motor servo circuitry – correcting the speed as necessary.

In the fourth part of this series we will discuss how the VHS and Betamax systems record the luminance and colour signals. We shall also take a look at the "flying head" erasure system used in the Video 8 system.

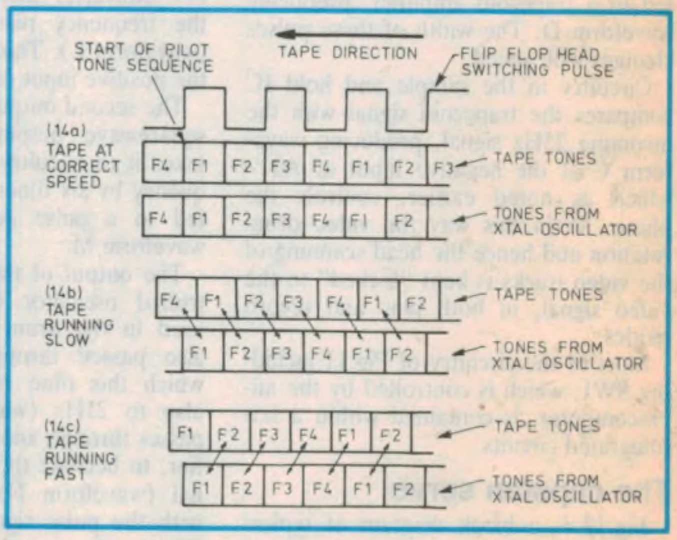


Fig.14: The function of ATF tones in the Video 8 system, as explained in the text.

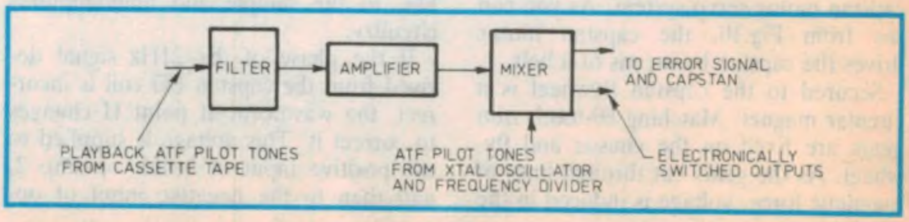


Fig.15 (below): Block diagram of the circuitry used to compare the ATF tones on playback.

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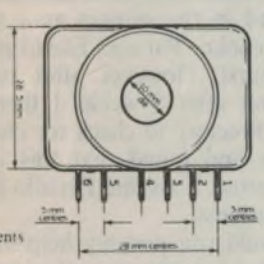

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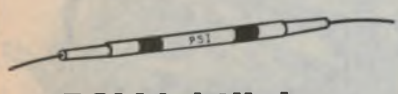

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Information centre

Train controller

I am having some problems with my Railmaster train controllers and I hope you can help me sort them out.

I constructed one controller last year and it is has been giving faithful service since then. However recently it started to misbehave. Whenever a short circuit occurred on the track the buzzer would sound loudly, and then switch off as it should, (and the LED would go out) but it would not totally switch off – it would buzz quietly and continuously until the whole unit was switched off. Gradually this background buzz has increased in volume.

I was not particularly concerned by this at the time because I was going to rehouse the unit into a larger box and add a second controller.

I made the new box, and located the original controller into the box along with an extra transformer for rail switch points. I didn't disconnect any wires or change anything except the location of the transformer in relation to the board.

Now comes the problem. The buzz has increased to a point that it rivals the noise when the unit detects a short circuit. However all aspects of the unit appear to work – it controls the speed (i.e, the voltage goes from 0-12), and the inertia works. The brake works, reverse works and if the track short circuits then the track overload LED comes on and the buzzer works (changes pitch). I did notice that the intensity of the track overload LED was dependant on the voltage going to the track, something I hadn't noticed before.

At first I thought I had found the problem because you could move the board to a different position and the intensity of the 'buzz' fell. A possible break in a PCB track but no, I checked it thoroughly.

At this point I started swapping over components from the new controller I was building. I also bought some new components. I changed the transistors BC327, BC337, BD139, both LM324's the 4.7uF cap, the 2.2k resistor and the buzzer. No effect at all (even moving the board had no effect).

I checked the voltages shown on the circuit and they seemed OK. One thing I did notice was that the voltages on the base, emitter and collector of the BC327 were all about the same – around 10-12V from memory, I think.

So I reconstructed the new controller board, (using some of the components taken from the original board when I had been swapping things over), connected it up to the old panel (power supply, pots, LEDS, & switches) and it performed exactly the same way as the old board: buzz, buzz, buzz!

At this time I became a little frustrated, the circuit blew a fuse (and so did I!), and I didn't have a replacement fuse, so I've turned to the typewriter in desperation for some long distance help. Can you give me any clues in curing this problem? (D.B., Castle Hill NSW).

• ***The problem you have experienced may be due to an anomaly with the LM324 IC. That is, its output may not be switching fully high (12V) or low (0V).***

The output of IC2c may be normally high as required, but not fully at 12V, and the buzzer will still sound since Q3 is biased ON. This will occur if the high output is only say 11V instead of 12V. The solution here is to include one or two forward-biased silicon diodes (say IN4001) between the emitter of Q3 and the 12V rail.

Similarly, if pin 14 (output) of IC1d is only at 11V, the LED will illuminate. Here, another forward biased diode should be connected in series with the LED, with the same A-K polarity.

We would also recommend another forward biased diode in series with the base of Q2. This will ensure that Q2 is fully OFF when the output of IC2a is low.

Guitar amplifier

I am currently building your 27 Watt Guitar Amp, from your publication *Audio and Video Projects* of Sept. 1986. Having nearly completed the job, I find I am unable to obtain a small component to complete it.

The part I am missing is the 14uH choke, type VPC14A. I have tried all the electronics stores in Brisbane to no avail. I then wrote to the company mentioned in the project as a supplier for this choke, Paradio Electronics of Darlinghurst. However after receiving no answer after 5 weeks I then consulted the directory to check for change of address and found that this company is not listed. I assume Paradio is no longer in business.

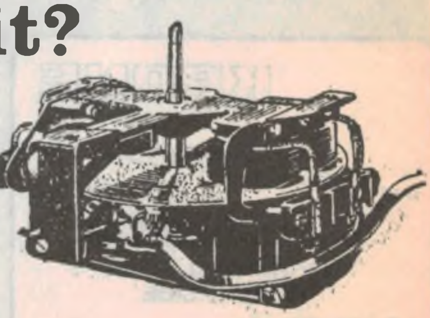
Could you possibly help me? Do you know of a company that could supply this part? Failing that, could I make it myself if you let me know what wire gauge, number of turns and what to use for the core.

Would it be possible to omit this choke altogether? As a matter of curiosity could you give me a brief explana-

What was it?

This month's mystery item is a device which appeared in the late 1920's, for a specific purpose, and was then superseded. It was related to a device found nowadays in most homes and buildings...

Answer next month)



October's Mystery Item

The item pictured last month was a wire-wound resistor, intended initially for use as a valve plate load. It was made with pointed end caps, and fitted into a holder with spring end contacts and screw terminals. Values available ranged from 2000 ohms (rated at 40 milliamps maximum) up to 100k (rated at 5mA maximum), with a tolerance of 5%.

tion of its function. (G.R.F., Burpengary Qld.)

● ***The 14uH choke for the Playmaster Guitar Amp is no longer available as an off the shelf item. However it may be constructed by winding 18 turns of 20 B&S enamelled copper wire on a high density ferrite rod 30mm long by 10mm diameter.***

More recent designs recommend an air cored inductor of about 6.8uH, which is constructed by winding 24.5 turns of 0.8mm enamelled copper wire on a 11mm plastic former.

The RLC network is a rationalisation of the Zobel networks used in amplifiers to ensure stability with highly reactive loads. If the inductor is to be left out the entire network must be omitted, including the capacitor and resistor. In this case, the amplifier will probably operate satisfactorily, but with a reduced guarantee of stability.

Cycle intercom

I have build the Motor Cycle Intercom described in the February 1984 issue. Has there been any 'Notes & Errata'? If there has not been any I will describe my problem.

The unit works fine except if you talk longer than five seconds, after which a loud squeal sets in (i.e., feedback or instability). Also when I talk I hear myself (very very faintly). I suspected that somewhere I had linked the two channels. But after hours of checking and rechecking I cannot find the fault. Can you help? I commend you on a splendid magazine. (C.C., Nedlands WA).

● ***The problem with your intercom appears to be unique to your unit, since we have received no similar correspondence or published any notes or errata.***

The feedback in question may be due to interaction between the microphones at their DC voltage source. That is, if the 47uF capacitor is faulty, backwards, or not connected to the 1k and two 4.7k resistors, the two microphone signals will be mixed together – affecting both inputs. Also, the power amplifier will slightly modulate the supply rail and the microphone's DC supply, which in turn drives the amplifier – another potential feedback loop.

If this is not the case, a little testing may yield further information. The best approach may be to disconnect sections of the circuit until the problem stops – this may isolate the problem to a particular area.

Masthead amplifier

I have installed DSE's 'Super Band 5' TV antenna and the MK2 Masthead amplifier kit, all OK.

My problem is selectivity. Our local translator station transmits TV channels 50 & 53, and about 106MHz FM radio. Also my antenna is directly behind the homestead's antenna array for our 3-channel VHF radio telephone.

Without the amp I received snowy black and white pictures, but now I get signals right across both VHF and UHF – even a telephone conversation.

What is my next move? Not move closer to town I hope. (R.J.McC., Fitzroy Crossing WA).

● ***It would appear that your local translator station is causing front-end overload in the masthead amplifier. If the local station has some period during which it ceases transmission, then you could observe the other channels to see if the problem remains (provided that the more distant stations don't go off-air at this time also).***

If the problem persists then the cause of the interference may be coming from a more local source. Masthead amplifiers themselves, if installed incorrectly, can oscillate and become quite effective transmitters. The oscillations are then of course radiated by the connected antenna.

As your antenna is located close behind another antenna, then you should check to see whether the other antenna has a masthead preamp, and if so, if it is causing the trouble. Simply switch the other preamp off, and see if there is any improvement to the reception. It is also possible that it is your pre-amp that is oscillating.

One common cause of this phenomenon arises through the use of ribbon cable for the input and output of the amplifier. If the two cables are located close to each other, then coupling between the two cables creates a feedback path around the amplifier, resulting in oscillation.

Reflex op-amps?

After reading the article about the reflex/regen receiver in the March issue, which I much enjoyed I might add, a couple of ideas have remained in my mind. I am wondering whether it is possible to reflex op-amps, maybe even as a stop-gap measure, and whether it is possible to bring the smaller 160pF tuning capacitors up to the 360pF mark

NOTES & ERRATA

CAPACITOR METER ADAPTOR (August 1988): Due to component tolerances, it may not be possible to achieve correct compensation for stray capacitance using trimmer capacitor VC1 – which has a minimum capacitance of 2pF. To allow correct compensation, connect a 3.3pF NPO ceramic capacitor directly across the Cx input connections on the copper side of the PCB. The correct compensation setting should then occur well within the range of VC1. (File No. 7/CM/16)

TRANSISTOR/FET/ZENER TESTER (February 1988): The wiring diagram on page 84 shows R5 as connecting to switch S1b, lug (1). In fact it connects to switch S2b, lug (1). The circuit diagram on page 83 is correct. (File No. 7/VT/18)

PLAYMASTER 30-30 AMPLIFIER (August 1988): The circuit diagram incorrectly shows R27 in two positions. The one connected between pins 6 and 2 is correct, while the other connected between pin 6 and the positive rail should be deleted – the component overlay is correct. (File: 1/SA/80)

LAMP SAVER (June 1986): The PCB wiring diagram on page 27 shows the values transposed for the resistor just above D5 and the resistor shown vertically to its right. The former should be 100k, and the latter 1M. Also the labelling on diodes D2 and D4 is transposed. The circuit diagram on page 25 is correct. (File: 2/PC/45)

LOW OHMS CURRENT SOURCE (September 1988): The wiring diagram on page 89 has the labelling transposed for the 'out' and 'common' connections of U1. A wire link should also be shown connecting the third and fifth lugs on the larger of the two tagstrips, from the junction of VR1 and R1 to the common lead of U1 and diode D1. (File: 7/MS/21)

50MHz DIGITAL FREQUENCY METER (May 1988): The PCB overlay shows tantalum capacitors C11 and C4 polarised incorrectly. Also, transistors Q4 to Q7 inclusive are orientated incorrectly, with collectors and bases transposed. (File: 7/F/34)

CORRECTION: On page 9 of the September 1988 issue, in the story 'DSE selling Sanyo Vision 8', the price of the Sanyo Digital VCR should have been shown as $1499. We apologise for any inconvenience caused by this error.

Information Centre

with external components? (P.S., Mt Riverview NSW).

• *While it may be possible to reflex op-amps, an intuitive look at this reveals some potential problems. The high gain of op-amps means that if any RF remains on the AF waveform, and can be fed back to the input with the audio, there is a strong possibility of the op-amp oscillating. A second problem concerns the bandwidth of op-amps, which is deliberately restricted in their design in order to prevent oscillation when negative feedback is applied. This also means that the op-amp will be of little use at radio frequencies.*

It is possible to use a 160pF tuning capacitor in place of a 360pF unit, by paralleling it with a 220pF fixed capacitor. However, this will also drastically reduce the tuning range of the circuit. A better solution might be to alter the value of the inductance in the circuit so it resonates at the correct frequency when the 360pF capacitor is replaced by the 160pF unit. However, without knowing the specifics of the circuit involved, it is dificult to say whether either of these modifications will compromise performance of the circuit.

Lamp Saver

I had the problem of early failure of a single incandescent 40W lamp, a small E/S base flame shape used in an Argus magnifier lamp. Because this had an average life of no more than two weeks, I thought of a Lamp Saver design I'd come across in your issue of June 1986.

I ordered the PC board and bought most of the components from your advertisers in York Street, when on a Sydney trip – except for the silicon bilateral switch, which was out of stock (2N4992).

Subsequent trips to Sydney show the item still out of stock and checks with other suppliers, even Geoff Wood could not help.

It's interesting that no other incandescent lamp in the house has this problem and the possibility of heat build up seems unlikely as most cases of failure are at switch-on, and usually late at night. Although I haven't had a recording volt meter, spot checks with an AC meter haven't shown voltages above 250V (W.V.A., Stockton NSW).

• *Unfortunately we can't suggest a source of supply for the 2N4992, which now seems to be unavailable. You may have to use the ST4 asymmetrical trigger diode, and possibly modify the circuit values slightly.*

Why do the small lamps tend to have a short life? When any incandescent lamp is operating, tungsten atoms tend to vapourise from the filament and leave the filament thinner. This can happen in a localised fashion – causing a local rise in resistance and power dissipation. This in turn causes a 'hot spot' and accelerates the vapourisation, giving a kind of feedback action which causes weak spots to develop. It is these weak spots which tend to give way when the lamp draws heavy current – as it does when power is first turned on, with the filament cold and its resistance much lower than its value when operating.

Physically small lamps run hotter than larger types, so that these weak spots tend to develop faster and give a shorter life.

Circuits like the Lamp Saver extend lamp life by preventing the surge of current when power is applied. They don't prevent filament vapourisation, or the formation of weak spots. But because the initial current surge is much lower, the filament can get much weaker before it will fail. So although failure is not prevented, it is postponed by a worthwhile amount.

Letters

Continued from page 7)

We presented the very same material to some other magazines and would like to say that your interpretation and summary was by far the most intuitive. It seems that you have felt some of our frustrations before and have put those into a succinct few words beautifully.

Peter Stein,
ME Sound Pty Ltd.,
Dyers Crossing, NSW

Serviceman

Continued from page 58

that pin. What I didn't test for was an actual contact between the pin and the socket contacts.

I know *now* that there was a properly made, heavy duty earth on the socket but I had never realised this because it was out of sight, under a heavy steel strap that held the socket to the front panel. I only found it after I had removed and dismantled the socket.

This earth lead had never made contact with any normal plug, because the socket prongs were nearly a quarter of an inch apart. Most earth pins sat in the socket without coming within touching distance of the earth contact.

It wasn't until I put a bent plug into the socket that an earth pin came close enough to complete the earth link, with the noisy result just mentioned.

Another factor that masked the error was that most live chassis TV's have only a two pin power plug. Two pins, no earth pin – therefore no chance of making accidental contact.

I have removed the earth link from the output socket so the same accident cannot happen again. But I shudder to think about how many times in the past four years I might have set myself up as a bridge between a live chassis and earth.

All I can say is, if you're going to do it, please do it properly. And get someone to check your work.

Frankly Frank

Continued from page 38

tion which signed 840-odd treaties with its native Indians and broke all of them, which has murdered four of its elected presidents, arranged the murder of one other nation's president (Dziem in Vietnam), assisted in the murder of another (Allende of Chile), tried to procure the murder of another (Castro of Cuba), has still to ratify many of the Geneva accords on the rules of war, has had to offer a pardon to one of its recent presidents because of his illegal acts in office and other things too numerous to mention. It wouldn't fail to tell the truth about a single airliner disaster, would it? "I do believe it, though I know it lies".

CD Reviews

Continued from page 40

century and the RV441 work on this disc was originally written for recorder.

Although most of the works presented here are in the lesser known category, they are all quite brilliant baroque pieces in their own right and quite well known in the flute reportoire,

Gazzellonis' playing is quite stunning, and his breathing, particularly in the Vivaldi 1st movement almost leaves you breathless.

His interpretation is first rate but whether it is due to this older recording or his tone production, – (I suspect some of both) the sound is not as full as the later recordings of Gallway on RCA.

Soundwise I feel it is rather middle register heavy with somewhat too much reverb, but none the less very pleasant. It does represent good value considering the price and the playing time and these top – notch performers.

50 and 25 years ago..

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

Wireless Weekly 3d

November 1938

Parramatta Celebrations: An extensive system of outdoor sound amplification is being arranged for the 150th anniversary celebrations at Parramatta.

A series of 30 loudspeakers is being installed by Amalgamated Wireless in Church Street, between St. John's Anglican Church and Parramatta River, so that the crowds who throng the streets will hear everything connected with the proceedings.

The importance of radio: Last week a nation-wide panic was caused throughout the United States when one of the major networks broadcast a dramatised description of an invasion from another planet.

Though nothing on the same scale has happened before, the incident calls to mind a similar occurrence in London nearly 14 years ago, in the early days of broadcasting, when a too vivid description of a Communist uprising in the British capital caused a sensation throughout the country.

RADIO, TELEVISION and HOBBIES

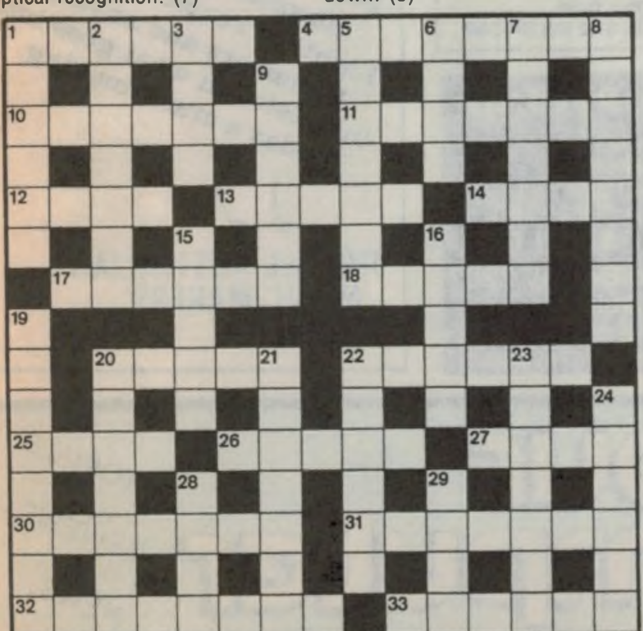
November 1963

40 years of radio: It is appropriate to record that this month sees the fortieth anniversary of the commencement in Australia of an officially authorised medium-wave broadcasting service. While various marine, communication and experimental stations had been operating during the previous ten years, it was on November 13, 1923, that station 2BL opened in Sydney, with a power of 1,500 watts, and for the express purpose of providing radio broadcast entertainment.

Electronic TV standards conversion: A prototype, all-electronic television standards converter was demonstrated by the B.B.C. recently, when television pictures transmitted from Brussels on the European 625-line standard were converted to the British 405-line standard.

Basically, the converter works by dividing the incoming picture into 600 vertical strips. If the picture is on the 625-line standard then each strip will be made up of 625 minuscule elements – one for each line. These elements are "smoothed" together to remove the gaps between the lines, and so for each strip there is an output which shows continuously the picture detail in the strip. The strips are then scanned 405 times a second to produce the required 405-line picture.

NOVEMBER CROSSWORD



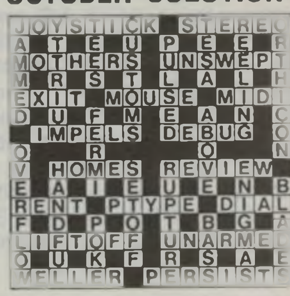
ACROSS

1. Sound control. (6)
4. Such are the eyes of those always examining filters! (8)
10. Specialised character for optical recognition. (7)
11. Secures wanted signal and keeps there. (5,2)
12. Optical read-only memory. (4)
13. Name of nerve used in 1 down. (5)
14. What keeps studio microphone out of sight? (4)
17. Correspondence college with electronics courses. (6)
18. Former unit of magnetic induction. (5)
20. Put lines in parallel! (5)
22. Checked operation. (6)
25. Voltage of a standard battery. (4)
26. Clamp connector to cable. (5)
27. Greek philosopher famous for paradoxes. (4)
30. Such are memory components sent from warehouse. (2-5)
31. Adjust TV brilliance. (7)
32. Run out of voltage. (8)
33. Kind of valve. (6)

DOWN

1. Sighting system using optical fibres. (6)
2. Name of person on marine radar watch. (7)
3. Unseen pressure-sensitive security components. (4)
5. Kind of book for those lacking 1 down. (7)
6. Sources of intense light. (4)
7. Expressly, what an endless cassette tape has. (2,5)
8. Field of physics for the effect of forces. (8)
9. Visualised data. (6)
15. Phase. (5)
16. Brand of battery. (5)
19. Flashing lights which may restrict 1 down? (8)
20. Part of a telephone. (7)
21. Famous name in electronics, ---- Packard. (7)
22. Kind of switch. (6)
23. Topical prefix always seen in EA. (7)
24. Characteristic of contacts in rapid switching. (6)
28. Proponent of theory of electromagnetic radiation. (4)
29. Base for biologists to breed bacteria. (4)

OCTOBER SOLUTION



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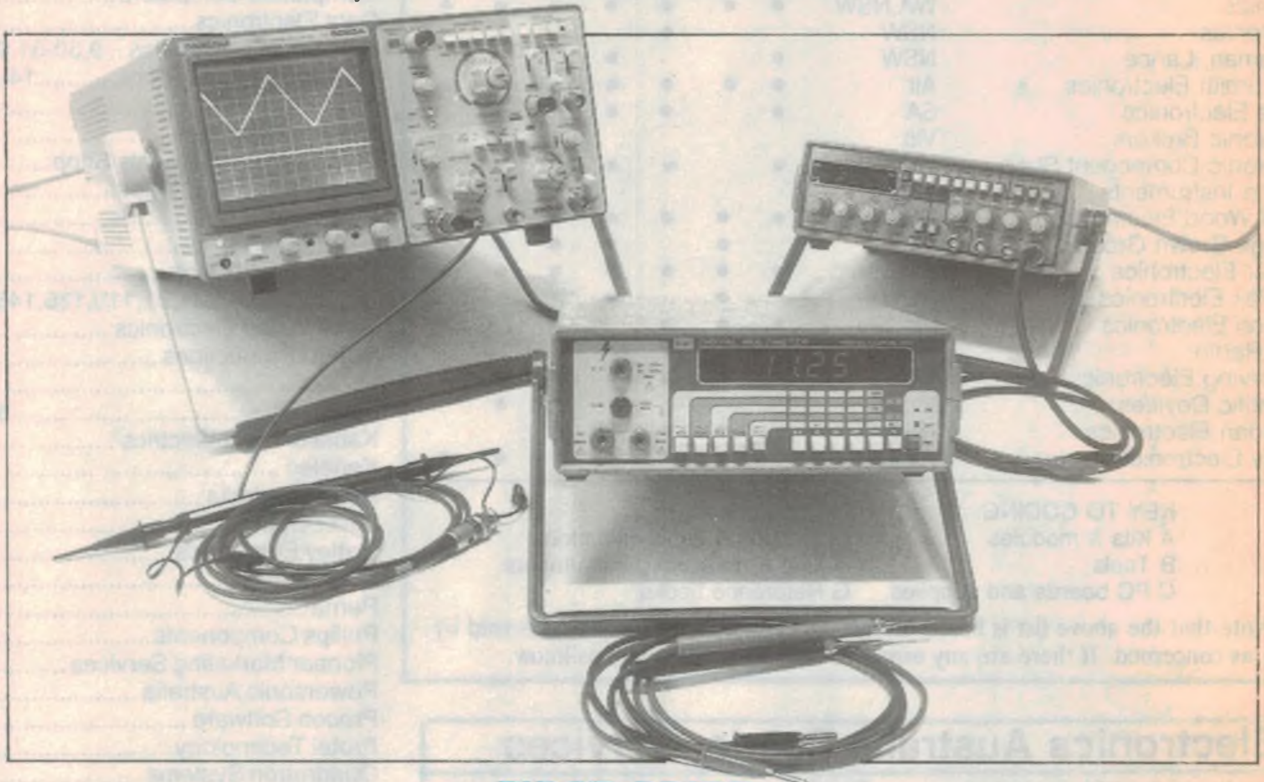

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CONDITIONS OF ENTRY

1. The competition is open only to Australian Residents authorising a new/renewal subscription before last mail Wednesday November 30. Entries received after closing date will not be included. Employees of the Federal Publishing Company, Emona Instruments 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 transferrable or exchangeable and may not be converted to cash. 4. The judges decision is final and no correspondence will be entered in to. 5. Description of the competition and instructions on how to enter form a part of the competition conditions. 6. The competition commences on 24 August, 1988 and closes with last mail on 30 November, 1988. The draw will take place in Sydney on 2 December, 1988, and the winner will be notified by telephone and letter. The winner will also be announced in The Australian on Monday, 5 December and a later issue of this magazine. 7. The prize is KIKUSUI DSS-5020 20MHZ dual trace oscilloscope with inbuilt digital storage facilities $3500 GW Instruments GFG-8019 multi-function 0.2 Hz-2 MHz function generator with inbuilt 6-digit 10 MHz frequency counter and sweep generator $644 & GW Instruments GDM-8035F high accuracy 28 range 3-½ digit digital multimeter $293. 5 consolation prizes of Escort EDM-1122 handheld digital multimeter $149 each. 8. The promoter is The Federal Publishing Company, 180 Bourke Road, Alexandria, NSW 2015. Permit No. TC 88 2324 issued under the Lotteries and Art Unions Act 1901. Raffles and Bingo Permits Board Permit No. 88 1441 issued on 12.8.88. ACT Permit No. TP88 832 issued under the Lotteries Ordinance, 1964.

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