NEW REGULAR COLUMN ON AUTOMOTIVE ELECTRONICS!

SEVEN COMPUTER UPS'S TO BE WON!

Australia's Top Selling Electronics Magazine

Electronics Australia

WITH ETI

NDD

AUSTRALIAN PUBLICATION

JULY 1992

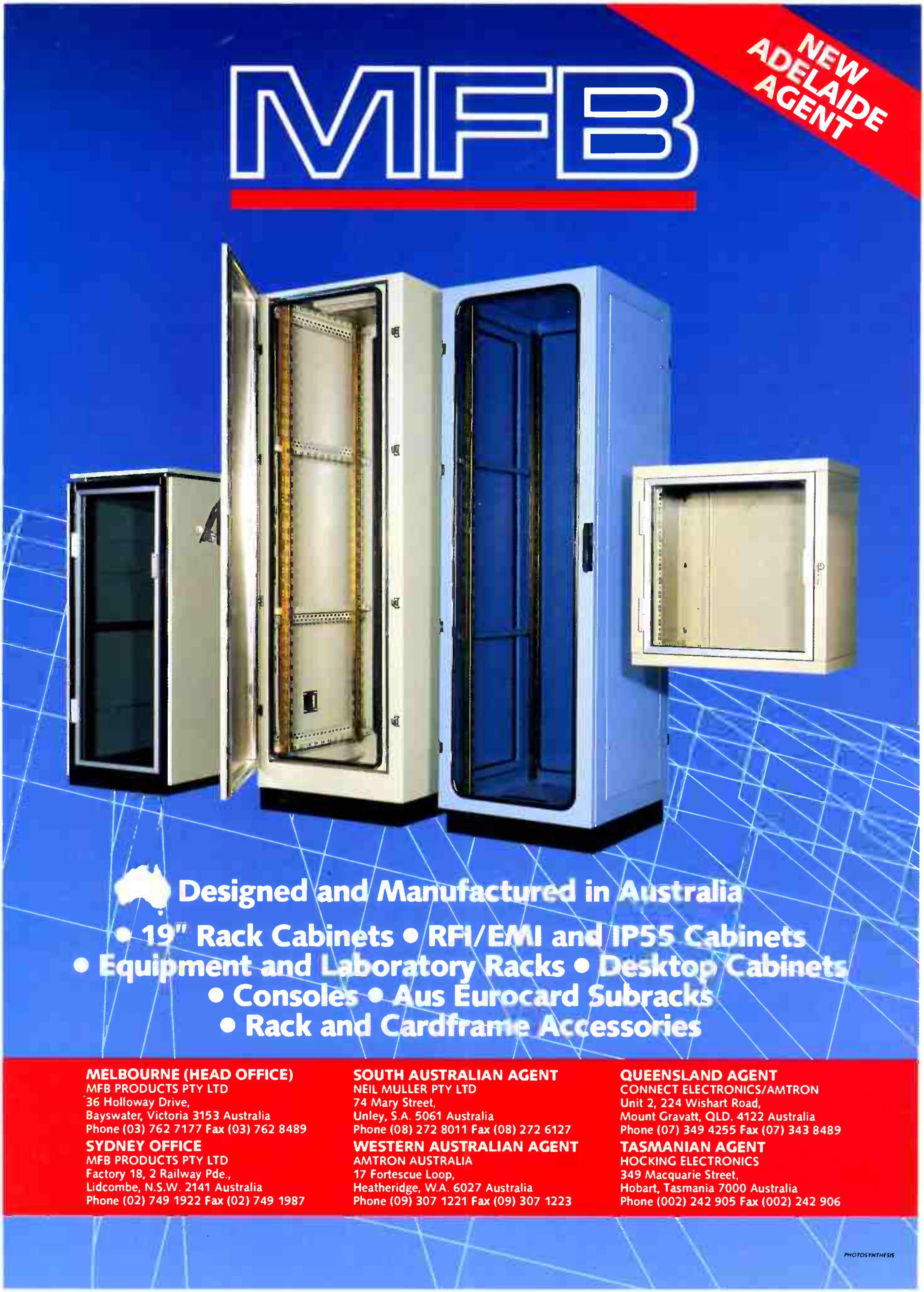
Aust* $4.95

NZ $6.95 incl GST

LOW COST SATELLITE TV SYSTEM ALLOWS YOU TO GET EXPERIENCE NOW, READY FOR PAY-TV:

BUILD OUR 'GAUSSBUSTER' & USE IT TO CHECK OUT RISKY E-M FIELDS * NEW ELECTRONIC KEY SYSTEM * LOW COST MULTI-STATION INTERCOM

9 312966 123633


MFB
NEW ADELAIDE AGENT
Designed and Manufactured in Australia
• 19" Rack Cabinets • RFI/EMI and IP55 Cabinets
• Equipment and Laboratory Racks • Desktop Cabinets
• Consoles • Aus Eurocard Subracks
• Rack and Cardframe Accessories
MELBOURNE (HEAD OFFICE)
MFB PRODUCTS PTY LTD
36 Holloway Drive,
Bayswater, Victoria 3153 Australia
Phone (03) 762 7177 Fax (03) 762 8489
SYDNEY OFFICE
MFB PRODUCTS PTY LTD
Factory 18, 2 Railway Pde.,
Lidcombe, N.S.W. 2141 Australia
Phone (02) 749 1922 Fax (02) 749 1987
SOUTH AUSTRALIAN AGENT
NEIL MULLER PTY LTD
74 Mary Street,
Unley, S.A. 5061 Australia
Phone (08) 272 8011 Fax (08) 272 6127
WESTERN AUSTRALIAN AGENT
AMTRON AUSTRALIA
17 Fortescue Loop,
Heatheridge, W.A. 6027 Australia
Phone (09) 307 1221 Fax (09) 307 1223
QUEENSLAND AGENT
CONNECT ELECTRONICS/AMTRON
Unit 2, 224 Wishart Road,
Mount Gravatt, QLD. 4122 Australia
Phone (07) 349 4255 Fax (07) 343 8489
TASMANIAN AGENT
HOCKING ELECTRONICS
349 Macquarie Street,
Hobart, Tasmania 7000 Australia
Phone (002) 242 905 Fax (002) 242 906
PHOTOSYNTHESIS

Electronics Australia WITH eti

Volume 54, No.7

July 1992

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

From the old...

This month, just for a change, our vintage radio columnist Peter Lankshear describes something to build: an authentic version of an Australian vintage radio 'classic'. It's the famous Little General, first described by our former Editor John Moyle back in 1940. (See page 88)

To the very new...

As part of this month's feature on data acquisition, Jim Rowe reviews the Datataker 5 — a very tiny single channel logger, made by Melbourne firm Data Electronics. Microprocessor controlled, it runs for a year or more on a 9V 'transistor' battery and is easily programmed using a standard PC — which is also used to retrieve the logged data. (See our story starting on page 128)

On the cover

Yes, that bloke with the thinning grey hair is our intrepid Editor, trying his hand at lining up one of AV-COMM's low-cost satellite dishes, on Aussat's A1 satellite. This is their one-piece dish, with an 'easel' type stand. See Jim's stories, starting on page 8. (Photo by Kevin Ling)

Video and Audio

Features

Projects and Technical

Professional Electronics

Columns and Comments

Departments

MANAGING EDITOR
Jamieson Rowe, B.A., B.Sc., SMIREE, VK2ZLO
FEATURES EDITOR
Peter Murtagh, B.Sc, Dip.Ed.
TECHNICAL EDITOR
Rob Evans, CET (RMIT)
TECHNICAL CONSULTANT
Peter Phillips, B.Ed., Dip Ed., ECC
CONTRIBUTORS
Neville Williams, FIREE, VK2XV
Jim Lawler, MTETIA
Arthur Cushen, MBE
Tom Moffat, VK7TM
Peter Lankshear
SECRETARY
Ana Maria Zamora
PRODUCTION EDITOR
Milli Godden
DRAFTING
Karen Rowlands
COVER DESIGNER
Clive Davis
PRODUCTION
Patrice Wohlnick, Mal Burgess
ADVERTISING PRODUCTION
Anthony Macarounas
CIRCULATION MANAGER
Michael Prior
PUBLISHER
Michael Hannan
ADVERTISING MANAGER
Selwyn Sayers (02) 693 9734
HEAD OFFICE - EDITORIAL
180 Bourke Road, Alexandria, NSW 2015
P.O. Box 199, Alexandria 2015
Fax number: (02) 693 6613
Reader Services: Phone (02) 693 6620
Subscriptions enquiries: phone (02) 693 9751
Book Shop enquiries: phone (02) 693 9751
INTERSTATE ADVERTISING OFFICES
MELBOURNE: 504 Princes Highway, Noble Park, Vic 3174. Phone (03) 795 3666. Fax: (03) 701 1534, Nikki Roche.
BRISBANE: 26 Chermside Street, Newstead, Qld 4006. Phone: (07) 854 1119. Fax: (07) 252 3692, Bernie Summers.
ADELAIDE: 98 Jervois Street, Torrensville, SA 5031. Phone: (08) 352 8666, Fax: (08) 352 6033, Mike Mullins.
PERTH: Allen & Associates, 54 Havelock Street, West Perth, WA 6005. Phone: (09) 321 2998, Fax (09) 321 2940, Tony Allen.
NEW ZEALAND: 63-73 View Road, Auckland, New Zealand. Phone: (09) 443 0250, Fax: (09) 443 0249, Advertising Coordinator
UNITED KINGDOM: John Fairfax & Sons (Aust), 12 Norwich Street, London, EC4A 1BH. Phone: (71) 353 9321, Fax: (71) 583 0348
ASIA: Headway Media Services Ltd, Room 2101, Causeway Bay Centre, 15-23 Sugar Street, Hong Kong. Phone: 516 8002, Fax: (862) 890 4811, Adrian Batten.
ELECTRONICS AUSTRALIA is published monthly by Federal Publishing Company, a partnership of General Newspapers Pty Ltd. **A.C.N. 000 117 322**
Double Bay Newspapers Pty Ltd. **A.C.N. 000 237 598**
and Brehmer Fairfax Pty Ltd. **A.C.N. 008 629 767**
180 Bourke Road, Alexandria, NSW 2015.

Typeset and printed by Hannanprint, 140 Bourke Road, Alexandria, NSW for Federal Publishing Company.
Distributed by Newsagents Direct Distribution Pty Ltd, 150 Bourke Road, Alexandria, NSW 2015. (02) 693 4141.
The Australian Publication emblem on the front cover of this magazine is there to proudly signify that the editorial content in this publication is largely produced and edited in Australia, and that most of the advertisements herein are the products and services available within Australia.
ISSN 1036-0212
*Recommended and maximum Australian retail price.

LETTERS TO THE EDITOR

Cost of auto electronics

The Serviceman has turned over a stone under which many 'nasties' are breeding, and I don't think he should put it back until these 'nasties' are examined at greater depth. He said he is yet to be convinced that cars and electronics belong together'. Particularly so, while manufacturers charge such exorbitant prices for replacement parts.

We hear many stories of people being asked to pay $1200 for an Engine Management Computer and he says 'they contain about $50 worth of parts'.

We know that it is useless attacking politicians to stir up the spare parts industry, as past efforts have come to nothing. You won't get any sympathy from the Service Departments of the Car Dealers: "Take it or leave it, mate. If you don't get your car serviced here, you deserve what you get." But what happens in a few years time, when all these new fangled gadgets start to break down through heat and neglect? The new car buyers — governments and professional rip off merchants — merely trade them in on a new one and claim the expense in the meantime as a tax deduction. The next set of owners are the ones who are going to face the expensive replacements, and how many working men can afford $1200 because when he had a flat battery his mate gave him a jumper lead start and hooked it up back to front?

The average non-dealer mechanic knows nothing of electronics, and I dare say the majority of auto electricians know little more. An old mechanic friend recently did a night course on Engine Management and I said, "Will you be able to repair a black box when you are finished?" He said, "Oh no! That would take another four years!"

Are we doomed to pay $1200 to the car dealers who will throw the old black box in the bin? Or will some enterprising electronically trained person see an opportunity and start an exchange service?

In a car magazine there is an advert, "Give your European car a power boost fit a special chip yourself in fifteen minutes! Send us $600." It would have to be a pretty good chip for that price, wouldn't it!

I am looking forward to further articles by Tony Mercer on this subject, perhaps he can recommend a book on the subject suitable for the layman.

Mechanic friend also said he would need to spend about $40,000 on test equipment. Is that the bottom line? Are all the old Mechanics doomed to redundancy?

Vic Oakes,
Mooloolaba, QLD.

Engineering image

I refer to your editorial in the February 1992 issue which concerned science and technology education and the problem of overcoming the 'boring subjects' attitude held by some young people. The Institution is naturally concerned mostly with encouraging studies in Engineering and you may be interested in some of the programs we have in place for high school students.

Sydney Division of the Institution of Engineers, Australia conducted a number of tours of major engineering works and installations for secondary school students and their careers advisers during 1990/91. Both career advisers and students were surprised at the career opportunities available for engineers and the significant contributions engineers make to society. Demand for these tours and information seminars increased, and the Institution recognised the need to address the lack of information available to secondary school students about engineering. This led to the development of the highly successful Neighbourhood Engineers Program.

Neighbourhood Engineers are the first point of reference for students. Essentially, volunteer engineers are assigned to their local schools to assist career advisers with more accurate information on engineering careers and to offer counselling to students. Engineers participating in the program have expressed a strong desire to serve their community and share with youngsters something of the excitement they have found in engineering; and a wish to enhance people's understanding and appreciate of engineering as a profession.

To provide further impetus to the Neighbourhood Engineers Program, the Institution, with the help of Rotary International, the University of NSW and the Education and Training Foundation of

[illegible]

NSW, conducted its first Engineering Summer School in 1992. More than 100 high school students from around NSW entering year 12 in 1992 attended the Summer School, which ran for one week. Students were given a taste of university life including living in one of the colleges. They gained first hand experience of engineering through experiments, visits to industry and interchanges with the Deans of Engineering, professional engineers, students and recent graduates of both gender.

Anyone requiring further information about these programs conducted by the Institution is welcome to contact us during office hours.

J.A. Dobell,
Director, Sydney Division,
The Institution of Engineers, Aust.
PO Box 138,
Milsons Point, NSW 2061.

Multi-circuit controller?

I have been a keen reader of *Electronics Australia* for many years and I particularly enjoy your projects. (I was also one of the participants in the 'great Earth Leakage Detector debate'.)

There is one project which I have never seen in any electronics magazine, even in a basic form, which I, and I suspect many other readers, would find extremely useful: a free standing time/day programmable multi-circuit switch. That is, a real time clock plus controller or processor, memory, and LCD display, capable of driving, say, 12 to 20 relays which could be switched on and off independently with multiple events under programmed control. There must be a range of LSI devices available now for clock radios, VCR's and the like, which would do most of the work.

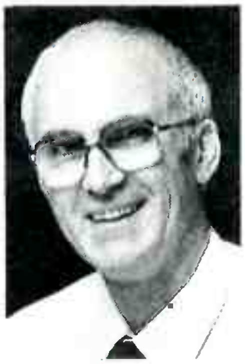
Such a unit could *simultaneously* run many household and other applications, such as a really advanced watering system, a complete 'wake up' sequence from music through to coffee percolator, and could turn lights, radios and all manner of things on and off independently, for each 'switch circuit', by time of day, day of week, and date. The possibilities are only limited by one's imagination.

I do not have the basic knowledge to design one myself without spending more time than I have in researching it, but I would certainly build one from a design of yours. I reiterate, there are probably many readers who would feel the same way.

F. Gotsen,
Hall, ACT.

Comment: Thanks for the suggestion, Mr Gotsen. It sounds quite a tall order, but we'll see if it is feasible. ❖

EDITORIAL VIEWPOINT



Everything from satellite TV to auto electronics

As I sit down to write this, the news has just come through that NASA's space shuttle *Endeavour* has landed safely, after its first eventful mission. I don't know about you, but I was fascinated by that saga where the astronauts finally captured Intelsat's ailing F-3 satellite, after a number of setbacks, and fitted it with a new rocket engine so that it could be sent up into the correct orbit.

It was all a lot more exciting in reality than even Kate Doolan had predicted, when she wrote her preview story for our April issue. Astronauts Pierre Thout, Richard Hieb, Thomas Akers and their colleagues are all to be congratulated, and we hope to have Kate Doolan's follow-up story on the mission next month.

Actually satellite technology seems to be a major focus in the magazine this month. We have the second instalment of Tom Moffat's articles on receiving weather satellite signals with your PC, for example. Tom gives the construction details for his really elegant Listening Post WESAT adaptor unit — which is much simpler than many competing units, you'll find.

Yours truly has also been trying out a low-cost system to receive the so-called 'fortuitous' PAL TV signals that are relayed by Optus/Aussat's A1 series satellites — and you'll find a couple of articles explaining not only what this is all about, but the kind of results you can get from a low-cost receiving setup. I can testify from personal experience that apart from anything else, it's a great way to get early first-hand knowledge of satellite TV reception technology...

Of course there's lots of other things in this issue, apart from satellite stuff. Among the project designs you'll find the 'GaussBuster', for example — a low cost unit that lets you sniff out potentially dangerous electromagnetic fields around your home and/or workplace.

There's also a really neat intercom design, which can be built with almost any number of stations, and an ingenious and highly secure electronic lock system which uses a completely passive 'key' technique. Our vintage radio columnist Peter Lankshear even tells you how to build your own authentic, 'original' *Little General* valve radio, from salvaged components.

By the way, we're also starting a new regular column with this issue: 'Automotive Electronics', written by Al Younger. Al is a long-time expert in this area, and has run training courses in the USA before moving to our shores. We're delighted to have someone with his experience preparing this column for us, because more and more electronics is appearing in cars, and it's clear that *EA* needs to help our readers keep abreast of this technology.

So all in all, I don't think you'll find any shortage of interesting reading in this issue. In fact you might well have the opposite problem — getting through it all, before our *next* issue arrives!

Jim Rowe

[illegible]

What's New in VIDEO and AUDIO

Columbia/Hoyts backs PAL Laserdiscs

Many Australian home video enthusiasts have acquired low cost NTSC-format Laserdisc players and matching NTSC-PAL transcoders, to allow them to play movies on these discs. This has been prompted, no doubt, by the enormous range of titles available from the USA at low cost — and the apparent lack of interest by local dealers, until recently, in pushing PAL Laserdisc hardware or software. But at last the local industry seems to have become aware of this groundswell activity by consumers, and is making a belated effort to swing the attention back to PAL format hardware and software.

Local video software distributor Columbia Tristar Hoyts Home Video has given its official backing to PAL Laserdiscs, announcing that in future its releases will be exclusively in this format. The company says it has gained the 'full support' of hardware heavyweights Sony and Pioneer, which have both released multidisc (CD/PAL Laserdisc) players at attractive prices, and also says that every software company is committed to releasing PAL format Laserdiscs 'in the near future'.

Apparently Columbia Tristar Hoyts Home Video (try typing that frequently!) itself has some 40 titles currently available on PAL Laserdisc, and is committed to releasing approximately 10 per month. Current titles include *Dances With Wolves*, *Ghostbusters*, *LA Story* and *Kramer vs Kramer*.

This is welcome news, but many thousands of titles are currently available from the USA in NTSC format. Small wonder that enthusiasts in Australia, like those in Japan, have expressed their impatience by making a *de facto* interim choice...

Kenwood mini has extensive DSP

Measuring only 270 x 120 x 300mm and weighing in at 6.5kg, Kenwood's UD-90 mini component system is billed as a 'mini for all seasons'. Apart from providing what is claimed as the most extensive Digital Signal Processing features to be found in a mini system, the UD-90 comprises a four channel surround amplifier, quartz AM/FM stereo tuner, seven band graphic equaliser/spectrum analyser, CD player, double cassette deck and two way three speaker system.

The four separate components are designed to be stacked vertically or side by side. The front speakers employ Kenwood's Digital Front Surround and Front Ambience Speaker Technology. The FAST circuitry keeps the music and surround signals separate despite the surround speaker units being housed in the front left and right speaker cabinets. Kenwood has included both Dolby Pro-Logic and Dolby-3-stereo

'Midi' component systems from Akai

Akai has introduced two new midi systems, the M40 at $799 and the M70 at $899.

The amplifier section of the M70 offers a conservative 30/30 watts per channel and incorporates a seven band graphic equaliser that offers custom frequency cut or boost at 63Hz, 160Hz, 400Hz, 1kHz, 2.5kHz, 6.3kHz and 16kHz. A matching seven segment LCD spectrum analyser also gives a visual indication of individual band settings. Akai has employed a motorised volume control, claiming it to be superior over noisier electronic type volume controls.

The tuner section is a two band synthesised AM/FM stereo design that can store up to 19 preset stations. The cassette deck section offers a double cassette deck with auto tape selector for normal or high position tapes.

It has provision for continuous play, high speed dubbing and also incorporates a Dolby B noise reduction system. The CD player offers a random play feature and music calendar that clearly displays track selection playing order.

The M70 comes complete with a three way bass reflex speaker system that Akai claims has a flat frequency response from 16Hz to 18kHz. The M70 also features a semi-automatic turntable with moving magnet cartridge and a versatile infra-red remote controller that can select power on/stand, volume up/down, input selector, CD operation and preset station caller.

The M40 offers similar appearance to the M70, but features a 25W channel amplifier, CD player, double cassette deck, AM/FM stereo tuner, semi-auto turntable and two way speakers. Both the M40 and M70 are covered by a 12 month warranty and are available at Akai dealers and selected department stores.

surround formats. The UD-90 is also provided with an output for an optional subwoofer. Additionally, you can select a number of sound fields such as; Arena, Movie, Jazz Club, Stadium, Church, or Disco and these can all be selected by remote control.

The heart of the UD-90 is the A-722 amplifier/tuner that offers 35+35W RMS to the front speakers and 18+18W RMS to the presence speakers. A motorised volume control is employed. The receiver section offers a quartz AM/FM stereo tuner that has 20 presets, a six event timer, and a preset calendar up to the year 2999.

The DP-722 compact disc player uses the latest one bit PDM technology with eight times oversampling digital filter, 20 track music calendar, 20 track random memory play, and digital output.

The UD-90 is covered by Kenwood's three year parts and labour warranty and has an RRP of $2799. The UD-90 is available from selected Kenwood dealers and department stores. For further enquiries contact Sydney (02) 746 1888.

Sanyo camcorder makes you the expert

The VM-D66P 8mm camcorder from Sanyo has several features designed to let the user concentrate on their subject, rather than having to fiddle with controls. The camera's 8x zoom lens with macro close-up capability lets you close in on distant subjects for exciting telescopic shots or zoom out for wide angle panoramas. Also, the macro area manual focus is suitable for shooting insects, flowers and other minute objects as close as 15mm (1/2') to the subject.

For the best possible picture, focus, exposure and white balance adjustments are very important. Sanyo's fuzzy logic automates all these adjustments so you can concentrate on what you are shooting. The VM-D66P lets you select one of our convenient shutter speeds at the push of a button —1/50, 1/120, 1/1000 and 1/4000 shutter speeds. When filming fast action sports, the most fleeting image can be captured with the high speed 1/4000 shutter. An infrared remote control gives you complete armchair command when the camcorder is connected to your television set. Other features include fade-in/fade-out, edit switch, auto date and time imprinting, recording review, linear time counter with memory stop, scene search, omnidirectional microphone, dew protection system, flying erase head, and SP/LP modes.

The VM-D66P has a recommended retail price of $1399.

Colour printer for video

A new high quality colour thermal printer requiring no ink or toner and equipped with built-in titling and mirror image features, has been launched in Australia by Polaroid.

Designed to be an ideal 'workhorse' printer for the burgeoning video market, the new A6 format TX-1000 printer is the latest addition to Polaroid's expanding line of electronic colour hardcopy devices.

In addition to its titling and mirror image capabilities, the TX-1000 also features built-in frame storage, reverse imaging, multiple print capability and wireless remote control.

Incorporating the latest advances in thermal dye diffusion transfer technology, the system produces 140 x 100mm full colour prints or transparencies with 138dpi resolution and 262,000 colours, making it the ideal output device for applications requiring high resolution and subtle colour tonality. The system is compatible with PAL broadcast standards (composite or Y/C input) and RGB signals. It captures a full 625 video lines.

The TX-1000 printer's titling feature allows the user to capture a high contrast title or graphic with a video camera and immediately superimpose it on a print or store it in memory for later use.

The title can be white or any of seven other colours — yellow, magenta, red, cyan, green, blue or black.

New Otari R-DAT recorder

The new Otari DTR-7 Professional DAT recorder/reproducer incorpates +4dBu active balanced analog inputs and outputs and an AES/EBU/SPDIF digital interface.

These make the DTR-7 well suited for professional applications in recording, broadcast, theatre and sound reinforcement.

Based on the DAT recording standard, the DTR-7 conforms to the basic format described by the EIAJ/DAT conference and offers complete electrical and tape compatibility with other DAT machines.

Features include: 48, 44.1 and 32kHz record sampling frequencies, and 32k-long play and 44k-wide track playback modes; a precise tracing mechanism; one bit delta sigma A/D and D/A converters; start ID, Auto ID Edit and Auto Renumber functions; sampling monitor function; bar graph peak meters with peak hold' active balanced inputs/outputs on XLR style connectors; selectable AES/EBU and SPDIF digital interfaces; and a parallel remote interface for connection for mixing console remote switches or the optional Parallel remote controller.

The DTR-7 is supplied with a wireless remote control as standard, with the option of a wired serial remote control or the optional Parallel Remote Controller. Rack mounting hardware is supplied with the DTR-7 as standard.

For further information circle 181 on the reader service card or contact Amber Technology, 5 Skyline Place, Frenchs Forest 2086; phone (02) 975 1211. ❖

[illegible]

[illegible]

Low cost way to get 'prior experience':

'BACK DOOR' INTO SATELLITE TV - 1

With pay-TV now struggling over the Australian horizon, many engineers and technicians are no doubt wondering if they'll be caught flat-footed when it finally arrives. But as it happens, there *is* a way for such people to provide themselves with valuable 'hands on' experience in satellite TV reception — and at surprisingly low cost. Until now, it's been something of an industry secret, known mainly to broadcasters and a few intrepid enthusiasts...

by JIM ROWE

One of the familiar faces I spotted at the Gosford Amateur Radio Field Day earlier this year belongs to Garry Cratt, who was a former colleague of mine a few years ago during my sojourn with a well-known electronics distribution/ retail firm. Nowadays Garry runs the firm AV-COMM, which imports and sells a variety of communications products and systems.

At the Field Day, Garry was demonstrating an intriguing Ku-band satellite receiving system, which AV-COMM is currently selling for the impressively low price of only $995. I guess it was the low price that first attracted my attention; but then I noticed that the system was delivering quite respectable-looking pictures from one of the existing Aussat (sorry, Optus) 'A-series' satellites.

Like many of *EA*'s readers, I guess, I was aware at that stage that over the last few years a small number of keen enthusiasts have been experimenting with satellite TV reception. But my understanding was that this activity was largely on the so-called 'C band', around 4GHz, and the satellites concerned were the Intelsat V series used for inter-continental program links.

The receiving setups I've seen for C-band Intelsat signals have all involved massive dishes about 4m in diameter, and have carried price tags of anywhere between $6000 and $12,000. Not surprisingly this has tended to limit their appeal somewhat, to only the most dedicated and well-heeled of enthusiasts.

Few people can afford to spend this kind of money merely to get experience with new technology, or to satisfy a hobby interest!

But from the pictures being produced by Garry's $995 system, things are obviously different nowadays on the 12.5GHz Ku band, and using Aussat signals...

Aussat/Optus has had its A-series satellites up above the equator to the North-East of Australia for years now — the first two went up in 1985, and the third in 1987. Since then they've been used to beam Ku-band signals to various parts of the country.

The various TV and radio networks use some of the satellite 'transponder' (receiver/transmitter combination) channels to transfer news and other programme material between stations, while some of the other transponder channels are used for broadcasting into remote areas of the country via the HACBSS (Homestead and Community Broadcasting Satellite Service) and RCTS (Remote Commercial Television Service) schemes. Still others are used for private data links, and things like the Sky Channel subscription TV network used by hotels and clubs.

One of the potential benefits of Ku-band operation, compared with C band, is that its higher frequencies allow the use of a smaller dish for the same antenna gain.

But working against this, in the past, was the fact that Ku-band front end converters tended to have poorer gain and (more importantly) noise figure — making it necessary to obtain *more* gain from the antenna, and hence pushing the dish size back up again.

Happily this factor has been overcome in recent years, thanks to the development of new semiconductor devices like MESFETs and HEMTs, which can provide very low-noise amplification and mixing at frequencies of 12.5GHz and beyond. It's basically this development that has allowed overseas countries to use dishes little larger than garbage-bin lids, for reception of satellite pay-TV signals...

Not enciphered?

But getting back to the Ku-band signals beamed down from Aussat's birds, I'd always thought that pretty well all of these were effectively enciphered — because of the way they use the B-MAC transmission system. To receive B-MAC signals you need a receiver fitted with the special decoder — together costing more than $2000, for a start.

I gather that if you want to receive *some* of the B-MAC signals (like the RCTS commercials), you also have to be vetted as a 'qualified viewer' by the broadcasters concerned, because B- MAC has inbuilt addressing to prevent decoding by unqualified receivers...

A complete B-MAC setup for receiving Aussat's Ku-band signals has tended to cost between $3000 and $3500, then, depending on the size of the dish required — typically between 1.5m and 2.2m in diameter.

So how is it possible to receive quite good quality pictures from the Aussat birds, using a receiving setup now costing only $995 for everything — dish, downconverter and receiver? This was the obvious question, and I lost no time in asking Garry for the answer, as soon as I saw his demo system in operation at Gosford.

The answer is quite interesting. It turns out that although *many* of the signals on the Aussat transponders are indeed transmitted using B-MAC, they aren't *all* encoded in this way. Some of the transponders used for relaying TV news and current affairs, station promo's and other material use standard PAL transmis-

[illegible]

[illegible]

[illegible]

Where the signals come from: an artist's impression of one of Optus/Aussat's new 'B' series satellite, below one of the older 'A' series satellites — with a couple of ghostly companions visible in the distance. A scene like this could well occur in the future, as the new birds will be placed in orbit at the same points of longitude.

sions, which needs no special decoder — it can be viewed using a standard PAL satellite receiving setup, which is nowadays available at much lower cost.

Of course these signals are not really intended for reception by anyone other than the ground stations of the networks concerned. They are sent through the transponders at all kinds of random times, when the networks need to do so.

Often they consist of just individual news stories (perhaps being fed back from a mobile news-gathering terminal), or a 'raw' unedited interview being sent from a studio in one city to a programme editing centre in another. There are no published schedules or programme guides, either; it's a matter of tuning in, being patient and seeing what material comes along.

Because of the 'lucky dip' nature of these unencoded PAL signals, they're often called *fortuitous television services*. And they pop up quite frequently, so that even though nothing is guaranteed, there's generally *something* of interest to be seen. Perhaps an interesting 'while it's happening' news story or current affairs interview (these are often much longer and more informative than the edited version that's ultimately broadcast), or occasionally a technical rehearsal for a forthcoming 'big event' network linkup.

In between times, there's often a test pattern of some kind, or occasionally a relay of international news material from one of the global services like CNN.

So there's actually quite a lot to see, on these transponders carrying 'fortuitous' PAL transmissions. And the big plus is that they *can* be received using a low-cost setup, such as that available from AV-COMM for $995.

This makes such a setup really quite suitable not only for anyone wanting to gain valuable experience in satellite TV reception technology, but also for enthusiasts who'd like to get a quiet preview of what's likely to be available in the future...

By the way, there are also quite a lot of *radio* signals sent over the Aussat transponders, and these too can be received using the same kind of low-cost gear. In fact Garry tells me that AV-COMM will probably have a satellite radio receiving package by the time these articles are published, for even less than the TV setup. More about this later.

Does all this sound interesting? It certainly attracted my own interest, and I lost no time in asking Garry if he'd be prepared to loan us one of his systems for a while, to try it out and write a story. He was indeed happy to do this, and that's how this article and the one that follows came about.

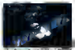
Satellite basics

But before we look at specific systems, let's sketch in some of the basic concepts involved in satellite TV transmission and reception — with particular reference to Aussat's satellites operating on the Ku band.

Aussat currently has three of the 'A series' satellites in orbit, in geostationary orbit over the equator at longitudes 156°E (A2), 160°E (A1) and 164°E (A3). The orbital radius of the three satellites is 42,164km — which places them at an altitude of about 36,000km. They're a long way up, when you consider that the radius of the Earth (at the equator) is only 6378km!

By the way, the new B-series satellites which will be replacing the A series in the new couple of years, will be placed in virtually the same positions.

Each of the three satellites has an effective total of 15 operating transponders. There are actually more than this, but the rest are 'spares' which can



be switched in to substitute for any that may become faulty.

In effect, each transponder has an 'uplink' receiver which responds to signals beamed up to it from Aussat's Earth stations, and a 'downlink' transmitter which beams this signal back towards Earth. The transponder receivers all operate in the range from 14.0 - 14.5GHz, while the transmitters all operate in the range from 12.25 - 12.75GHz.

Needless to say, the various transponders are allocated different frequency bands, in these ranges. These are each effectively 45MHz wide, with centre frequencies spaced at 32MHz intervals. To minimise interaction between the signals on adjoining transponders, their polarisation is made to alternate between 'vertical' and 'horizontal'. This makes the effective frequency spacing 64MHz, between transponders with the same polarisation.

For convenience, the transponder numbering is in ascending frequency order, but grouped according to polarisation. So for the downlink transmitters, which are the ones of interest for Earth-based reception, transponders 1 - 8 have vertical polarisation, while transponders 9 - 15 have horizontal polarisation. This is seen in Fig.1, which is reproduced by courtesy of Optus/Aussat.

Note that the transponder centre frequencies shown are the same for all three Aussat satellites. So in effect, there are 15 'channels' on each satellite, with the frequencies as shown. The small cross-hatched '16th channel' shown at 12.749GHz is used to beam down a beacon/telemetry signal, which Aussat uses to monitor satellite operation, etc.

The next thing to note is that the downlink transmitters don't all have the same output power. Those for transponders 1 - 6 and 9 - 13 have 12W output, while those for transponders 7, 8, 14 and 15 have 30W output. In general, those with 30W output are used for broadcasting (generally in B-MAC), while in the main it's the lower-output transponders that are used for news links and inter- station feeds.

So most of the time it's these lower-power 12W transponders that carry our 'fortuitous' PAL signals (Murphy's law!). In fact the main transponders of interest are numbers 4, 9, 12 and occasionally 1 on satellite A1 — all 12W transponders. The only exceptions are 30W transponders 8 on A1, and 7 and 15 on A3, each of which occasionally carries network feed material in PAL.

There's a further complication, for reception. This is that the downlink transmitters for the various transponders on each satellite are given different antenna beam widths and orientations. In fact there are some *seven* different downlink beams, only two of which are directed over the entire continent: 'national A' (NA) and 'national B' (NB).

The others are directed to more restricted 'footprints': 'central Australian' (CA), 'western Australian' (WA), 'north-east beam' (NE), 'south-east beam' (SE) and 'Papua New Guinea/south-west Pacific' (PNG/SWP) — which is really two alternative beams, with the PNG orientation available on A1 and A2, and the SWP beam only on A3.

Fig.2 shows the 'footprints' of a 30W national beam and a 12W NE beam respectively, for comparison. The figures on the various contours show the approximate expected relative signal strength, measured in dBW (dB with respect to 1W) and in terms of *EIRP* or 'effective isotropic radiated power'.

This means that the signal strength being used for comparison is that which would result from a power of 1W radiated from a 'point source' on the satellite — i.e., equally in all directions. So a figure of say 40dBW means 40dB above the level that would be produced by 1W radiated from the satellite isotropically.

Needless to say this reference level would be incredibly small, so even 40dB above it is still extremely low. Remember, we're talking about frequencies around 12.5GHz, and a path length of over 37,000km!

Basically what all this means is that the signal strength you can receive from each transponder, at a particular location on the continent, will depend not only on the power output from transponder concerned, but also upon what kind of beam it's being directed into.

The highest signal strength will tend to come from a 30W transponder which is being beamed right into your area; a little weaker, but still quite strong will be a 30W transponder in a national beam, or a 12W transponder beamed into your area; weaker again will be a 12W transponder in a national beam; and weakest of all will be a 12W transponder which is being beamed 'somewhere else'. As received by a typical current-technology system using a 1.8m dish, these signal levels correspond to received picture and sound quality varying from almost 'studio quality' down to 'non-existent'.

By the way, the received signal strength also depends upon weather conditions. Ku-band signals are attenuated by passing through water vapour, so the received signals are strongest in warm, dry weather and weakest when there's dense cloud and heavy rain.

Sound complicated? It is indeed, to a certain extent. But the bottom line is that in most locations on the Australian continent and Tasmania, you should be able to pick up quite watchable PAL pictures *most of the time*, from at least a couple of transponders. This is using a receiving system like that supplied by AV-COMM, with a 1.8m dish and current-technology electronics.

Needless to say, to receive the signals from any of the three satellites your dish must be 'pointed' quite accurately at the satellite concerned. Fig.3 shows the approximate dish axis azimuth and elevation 'look' angles for Aussat's A1 satellite, for various locations over the continent.

The lines radiating from the top right indicate azimuth (with respect to true North), while the arcs running roughly or-

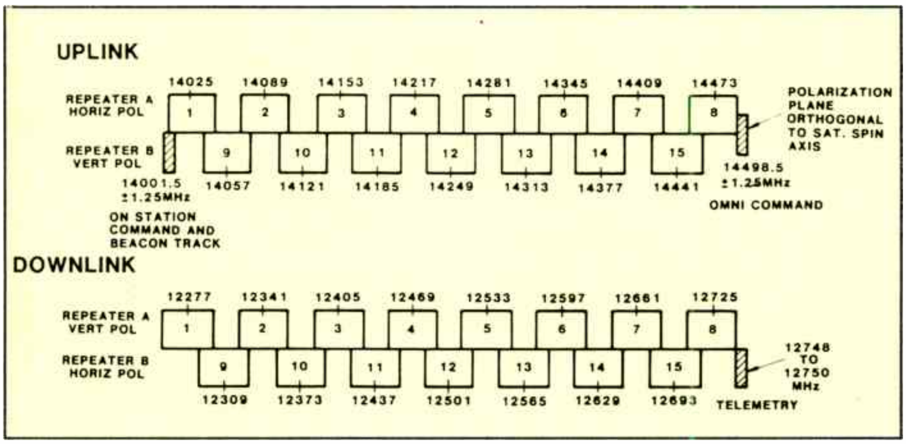


Fig.1: The uplink and downlink frequency allocations for the transponders on each of the Optus/Aussat saellites. The downlink frequencies are of main interest for reception, of course. Note that adjacent transponders are polarised at 90 degrees to each other, to minimise interaction. (Courtesy Optus).

[illegible]

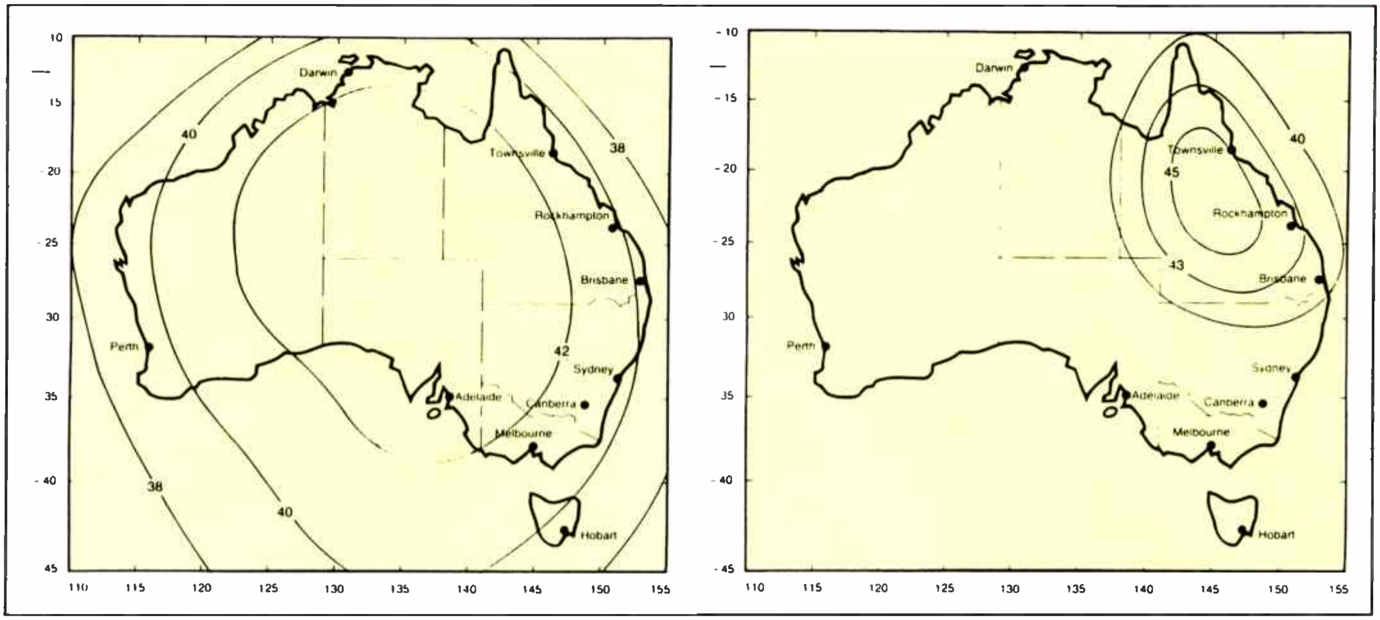


Fig.2: Two maps of the continent with contours showing expected signal strengths in EIRP (dBW), for different transponder powers and beams. At left is a National beam from a 30W transponder, while for comparison, at right, is a North-East beam from a 20W transponder. (Courtesy Optus).

thogonal to them show the elevation angles (with respect to horizontal). For example the azimuth and elevation figures for Sydney are 11° and 50°, respectively.

We'll look a little later at how this 'pointing' is done.

Just before we look at what's needed for basic satellite reception, you need to know a little about the transmission system used for satellite TV signals.

Transmission format

Unlike ordinary VHF and UHF television signals, satellite TV uses wideband *frequency modulation* (FM) for the video information as well as the sound. For the PAL signals which interest us for 'fortuitous' reception, the deviation used for the video signal is 30MHz p-p, which means that the FM video signal occupies a total bandwidth of about 40MHz (for a video bandwidth of 5MHz).

There's also a difference in the way the sound signal is transmitted, too. Instead of the 5.5MHz subcarrier frequency used for normal VHF/UHF television sound, satellite TV signals tend to use a variety of different subcarrier frequencies.

Often mono sound is transmitted on either 6.60MHz or 6.65MHz, while stereo is often transmitted using 7.38MHz and 7.56MHz for the two channels. This means that satellite receivers generally have to allow you to 'tune' the sound as well as the video.

Satellite sound signals also use wider FM deviation (typically +/-150kHz, rather than +/-50kHz), and tend to use different pre-emphasis and de-emphasis characteristics from the fixed 50us rollover characteristic used for terrestrial TV. Many satellite receivers therefore have a wider-bandwidth sound IF, and give you a choice of two or three different de-emphasis curves.

A further slight complication is that in addition to the FM used for the video and sound signals, the complete signal on each satellite transponder is 'wobbled' up and down in frequency, over a range of about 1MHz and at a rate of 25Hz. This is

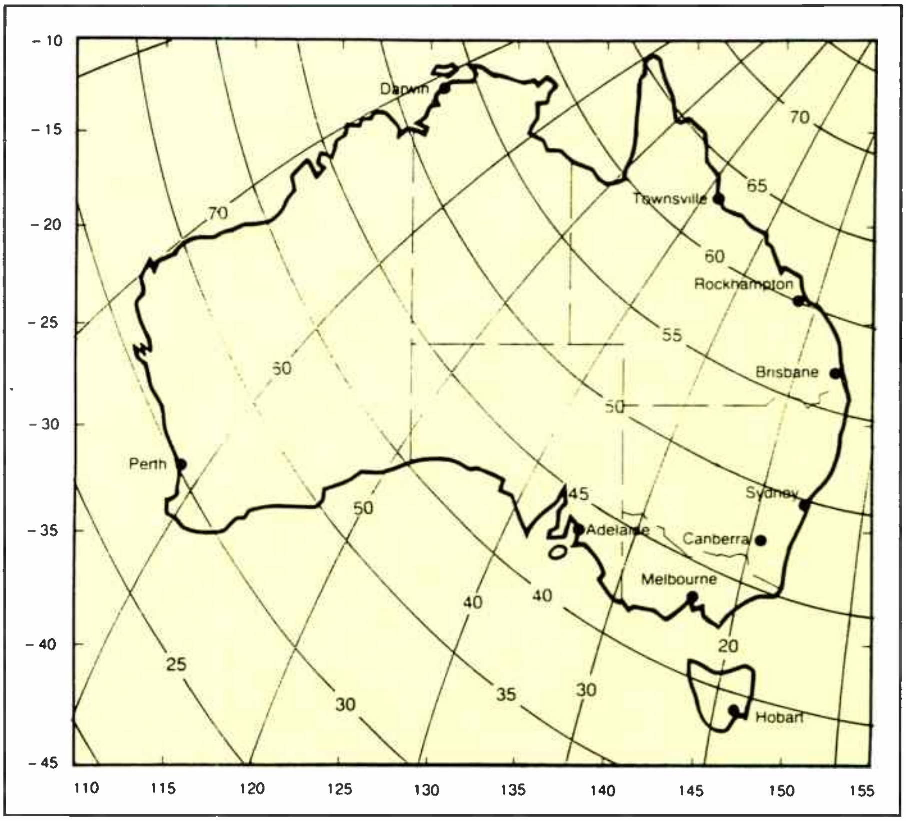


Fig.1: A map showing the basic pointing information for the Optus/Aussat A1 satellite, parked above the equator at 160 degrees longitude. The arcs radiating from the top right show elevation angles, while the straighter lines curving downwards from the right show azimuth angle. (Courtesy Optus).

called 'energy dispersal', and is used to minimise crosstalk between the signals on the various transponders.

Satellite receivers are designed to cope with this slow overall frequency modulation of the signal, tracking it via their AFC system and making it transparent to the user.

The basic system

Now let's look at what is needed for basic satellite TV reception. The simplified block diagram of Fig.4 shows the key components for a basic domestic system, plus a few options.

The parabolic dish is basically a large reflector, which collects the very weak 12.5GHz signals from the satellite and focuses them at a point on its axis, a little to the front.

Positioned at the focal point is a small feed horn, which accepts the signals and directs them through a small section of waveguide into the *low noise block downconverter*, or 'LNB'.

The LNB performs two basic functions. One is to provide low-noise amplification, to build up the level of the signals; the other function is to convert them from 12.25 - 12.75GHz down to a considerably lower range (950 - 1450MHz).

Both functions allow the signals to be passed down to the rest of the system via a co-axial cable, which can be quite long if necessary, without degradation.

In effect, the LNB is a low-noise 'masthead' preamp and downconverter. And it handles all of the signals from a satellite's 15 transponders together, as a single 500MHz-wide 'block' — hence the name *block* downconverter.

Note that the DC power used to operate the LNB is fed up to it via the same co-axial cable used to deliver its output signals down to the receiver. This is the same 'phantom power' system used in many conventional masthead amplifiers for VHF and UHF.

Just before we leave the dish and the LNB, there is in most cases a further item not shown in Fig.4. This is the 'polar rotator', which is used to adjust the LNB for the different polarisations used by a satellite's transponders.

Often it can also be used to make minor adjustments of polarisation, known as *skew adjustment*, to compensate for variations introduced by path disturbances.

Up until now, there have been two main kinds of polar rotator in use: the mechanical type and the ferrite or 'magnetic' type.

The mechanical system uses a stepping-motor drive system, to rotate the LNB mechanically on the dish axis, while the ferrite system leaves the LNB fixed and uses a small cylinder of ferrite material in the feedhorn waveguide — controlled by an adjustable magnetic field — to 'twist' the incoming waves by Faraday rotation.

Many current satellite receivers are designed to control either type of rotator, supplying current pulses (by switching +/-5V) to operate the mechanical type as well as a variable DC current (typically +/-35mA) to drive the field magnet of a ferrite rotator. Additional cable wires are needed to feed these control signals up to the rotator, from the receiver.

However a new type of LNB is just coming into use, which doesn't need a separate polar rotator. This type has a dual-polarised input waveguide and feedhorn, with two probe 'antennas' at 90° to each other.

The LNB is arranged to switch between the two probes, and hence respond to either horizontally or vertically polarised signals, by switching its DC supply voltage between two different levels (nominally +13V and +18V). Many of the newer satellite receivers have provision for using this type of LNB.

Note that with this newer kind of 'dual polarity' LNB, only a single co-axial cable is needed between the LNB and the receiver. This saves money and hassle, but on the other hand this type of system only allows H/V polarisation switching; fine skew adjustment is not possible.

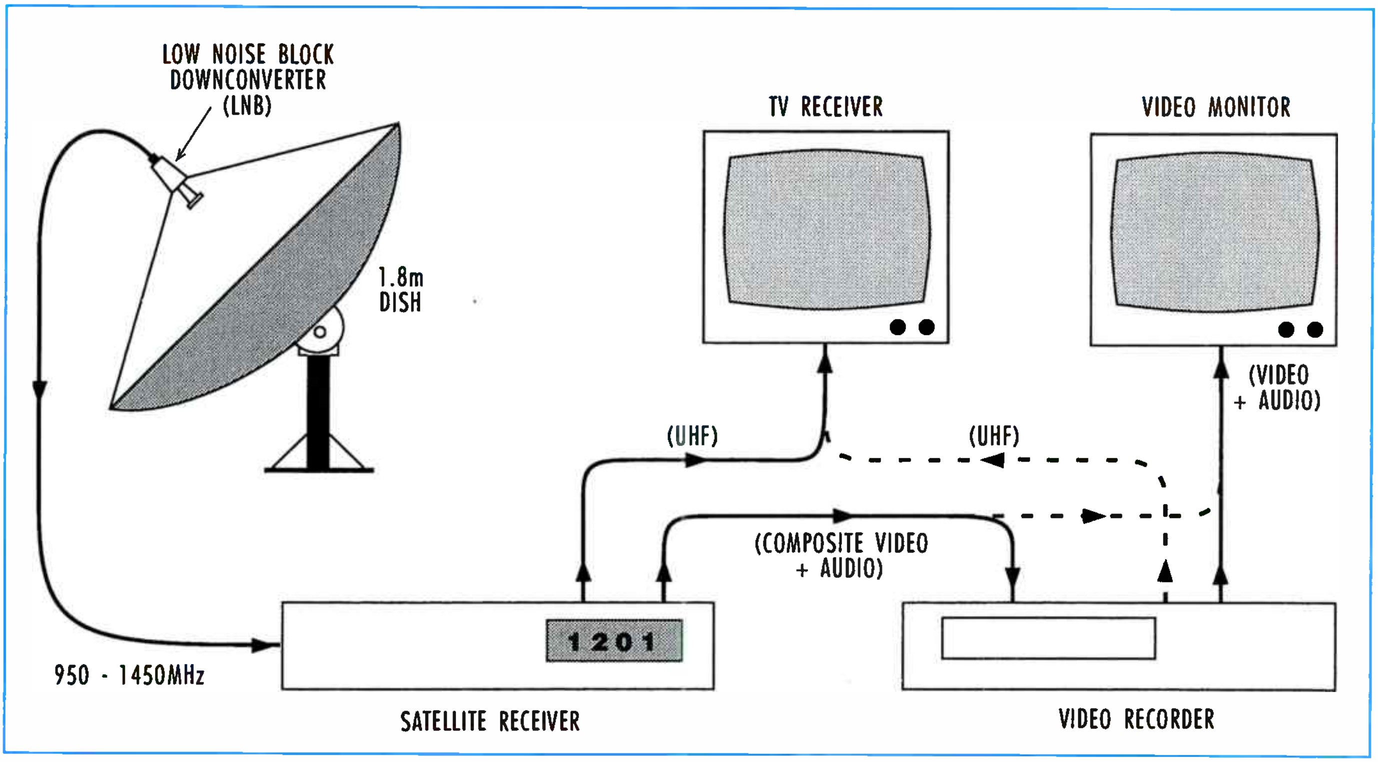


Fig.4: The basic elements of a satellite TV receiving system — plus a few optional extras. The low noise block down converter or 'LNB' both amplifies the incoming 12.5GHz signals and converts them down to frequencies in the range 950 - 1450MHz. The satellite receiver itself is therefore really a 'tuneable IF'.

The receiver

The other main 'new' component of our satellite TV receiving system is the receiver itself. Despite the name, this is generally *not* a complete TV receiver with screen and all, but rather a box that is meant to go with a standard VHF/UHF TV receiver — or a video monitor.

Essentially the satellite receiver allows you to tune a desired transponder's signal, from the incoming 950 - 1450MHz block.

It then processes this signal to produce composite video and audio signals, which can be fed directly to a video monitor or a VCR. In addition most satellite receivers also *remodulate* the video and audio signals again, producing either a VHF or UHF signal which can be tuned by a standard TV set (Fig.4).

Note that because the LNB converts the incoming Ku-band signals down to the 950 - 1450MHz band, this is in effect the 'first IF', and the satellite receiver is really a 'tuneable IF receiver'. As LNB's for C-band satellite signals are also designed to convert down to the same 950 - 1450MHz band, this means that the same basic receiver can be used for reception on either band.

The satellite receiver itself converts the selected signal down to a lower 'second IF', in order to achieve adequate gain and selectivity. The second IF is generally around either 70MHz or 480MHz, and SAW (surface acoustic wave) filters are used in most modern receivers to achieve a suitable selectivity curve.

Virtually all modern satellite receivers are also microprocessor controlled, and use digital PLL (phase-locked loop) techniques for both input signal tuning and sound subcarrier tuning. The use of a microprocessor also allows them to provide a memory facility, to store all of the many tuning parameters involved for each satellite transponder, plus other possible features such as the ability to scan the incoming 950 - 1450MHz band.

So really all that's involved, for reception of 'fortuitous' PAL signals from Aussat's satellites, is a dish and LNB, plus a suitable satellite receiver. It's only if you want to receive encoded or encyphered signals that you need a further item: an appropriate decoder box. This generally connects to the 'baseband' output provided on most receiver units (which provides unfiltered video and audio information, from the video detector), and 'de-jumbles' it to produce standard video and audio.

Presumably when pay-TV finally reaches Australia, we'll be able to purchase suitable decoder boxes to go with standard satellite receivers. Of course as well as the additional decoder box, pay-TV also involves the payment of suitable subscription fees. Only when you pay these fees is the decoder box electrically 'unlocked' and allowed to operate.

In the following article, we take a look at AV-COMM's low cost package for fortuitous satellite TV reception. But hopefully from the foregoing, you now have at least a general insight into what is involved for satellite reception in general.

A final point to bear in mind. When pay-TV actually starts in Australia, it will be carried on Optus/Aussat's new B series satellites. And all 15 of the transponders on the B series will have no less than 50 watts of output for their downlinks. This is over *four times* the power from the A-series transponders that beam down most of the current 'fortuitous' PAL signals.

So if you get your satellite TV experience now, and learn how to coax a low cost system to produce the best pictures from those signals coming from 12W transponders, setting up systems for reception of pay-TV from those future 50W transponders is likely to be a breeze! ❖

Review of a low cost receiving system:

'BACK DOOR' INTO SATELLITE TV - 2

A low cost receiving setup for 'fortuitous' satellite TV can provide an excellent way to gain early first-hand knowledge of, and experience in this interesting and rapidly developing technology. Here we look at a currently available system that is well suited not only for the technician/engineer seeking to enhance their skills, but also for the hobby enthusiast eager to see for themselves what's already beaming down from those Aussat satellites.

by JIM ROWE

Hopefully by now, if I've done my job right in the preceding article, you have a reasonably clear idea of what's involved in satellite TV reception. Now we can take a look at the low-cost package for 'fortuitous' reception currently being sold by Sydney firm AV-COMM.

The basic $995 package consists of a 1.8m parabolic dish, complete with support stand; a low-noise LNB, complete with ferrite polar rotator and feed horn; a 'Dynalink 50' stereo satellite receiver, with PLL digital synthesiser tuning and full-function IR remote control; and 30m of high-grade cable to link the LNB and receiver. In short, virtually all of the additional equipment that's needed, to adapt a standard TV receiver for reception of satellite PAL signals.

The 1.8m dish is of pressed steel, powder coated for protection against the weather. It is of the 'prime focus' type, and comes with the tripod arms and support flange necessary to support the LNB assembly directly at the on-axis focal point.

The dish support stand uses a novel 'easel' construction, designed to simplify installation where a flat and level mounting position is available.

It is essentially a metal frame with a triangular base format, having two short posts at the front which attach to the lower part of the dish via hinges. A third telescopic post at the rear of the dish allows its elevation to be set, while the complete assembly can easily be moved to set the azimuth.

By the way AV-COMM can also supply on order an *alternative* 1.8m dish, formed from six sector 'petals' that bolt together. This dish has a more conventional support system, with a single-post stand made from a 1m length of stout 100mm steel pipe, an adjustable elevation/azimuth ('el-az') dish mounting assembly and brackets which can be used to attach the post to either a horizontal or vertical surface. This alternative dish assembly adds $50 to the package price.

The LNB provided in the package is very compact, measuring only 42mm square by 96mm long. It uses HEMT (high electron mobility transistor) technology at the input, and provides a very low noise figure of less than 1.4dB (1.3dB typical). The small signal conver-

The Dynalink 50 satellite receiver, complete with remote control.

"BACK DOOR" INTO SATELLITE TV – 2

sion gain is 55dB, and is flat within 6dB over the 12.25 - 12.75GHz range. The internal 11.3GHz local oscillator is also commendably stable, being rated to vary by less than +/-2.5MHz over the range from -30°C to +60°C.

Here again AV-COMM can also supply an alternative LNB with an even *lower* noise figure (1dB), if desired. This costs an additional $120, but provides improved reception in conditions of heavy rain and cloud. More about this option later.

The ferrite polariser included in the package is a very compact unit, as you can see from the photo. It mounts between the feed horn and the LNB body, and has a rated insertion loss of only 0.2dB. The matching feed horn is fitted with an adjustable grooved flange at the mouth, to allow optimisation of matching.

The Dynalink 50 stereo satellite receiver is a compact unit, which uses a microprocessor and digital PLL synthesiser system to provide stable tuning not only for the incoming IF signals, but also for two sound subcarriers.

It actually allows tuning any IF input signal between 950 and 1750MHz, in 1MHz steps, going somewhat further than is necessary for tuning the Aussat transponders (an IF of 1750MHz corresponds to an input of 13.05GHz).

The two sound subcarriers can be tuned separately to any frequency between 5.00 and 8.50MHz, in 10kHz steps. A nice feature here is that as well as allowing you to key in and adjust the two frequencies individually, the receiver also provides some 15 different preset 'recipes', corresponding to commonly used satellite sound formats.

A four-digit seven segment LED display on the receiver's front panel allows you to confirm most of its setup parameters, including IF tuning and sound IF tuning (MHz), audio bandwidth (kHz), audio de-emphasis rollover (50us or 'J17'), polariser skew angle (degrees), memory channel and so on. The receiver provides 50 memories for storage of transponder setup information, and these are stored in EEPROM so that the information is retained even when mains power is lost.

All receiver functions can be accessed from the IR remote control, even storage of setup information in a memory.

At the rear of the receiver, an 'F-type' UHF socket is used for the IF input/LNB DC power cable connection. A block of three spring connectors is then used to provide the 0 - 5V DC skew control signal for the ferrite polar rotator, and also a DC signal derived from the receiver's AGC line — which is fed up the remaining 'extra' conductor of the feed cable, and used at the LNB end as a guide to alignment of the dish, etc.

A group of eight RCA sockets are used to provide most of the outputs of the receiver, including video output, left and right audio outputs (two of each), a baseband output for driving a decoder, and a duplicated AGC output.

There's also a remodulated RF output, switchable between VHF channels 3 and 4. This appears on another F-type socket, while another of these connectors can be used to feed in the signal from a VHF/UHF antenna system, so that the satellite receiver automatically performs RF signal selection when it's used with a standard TV receiver.

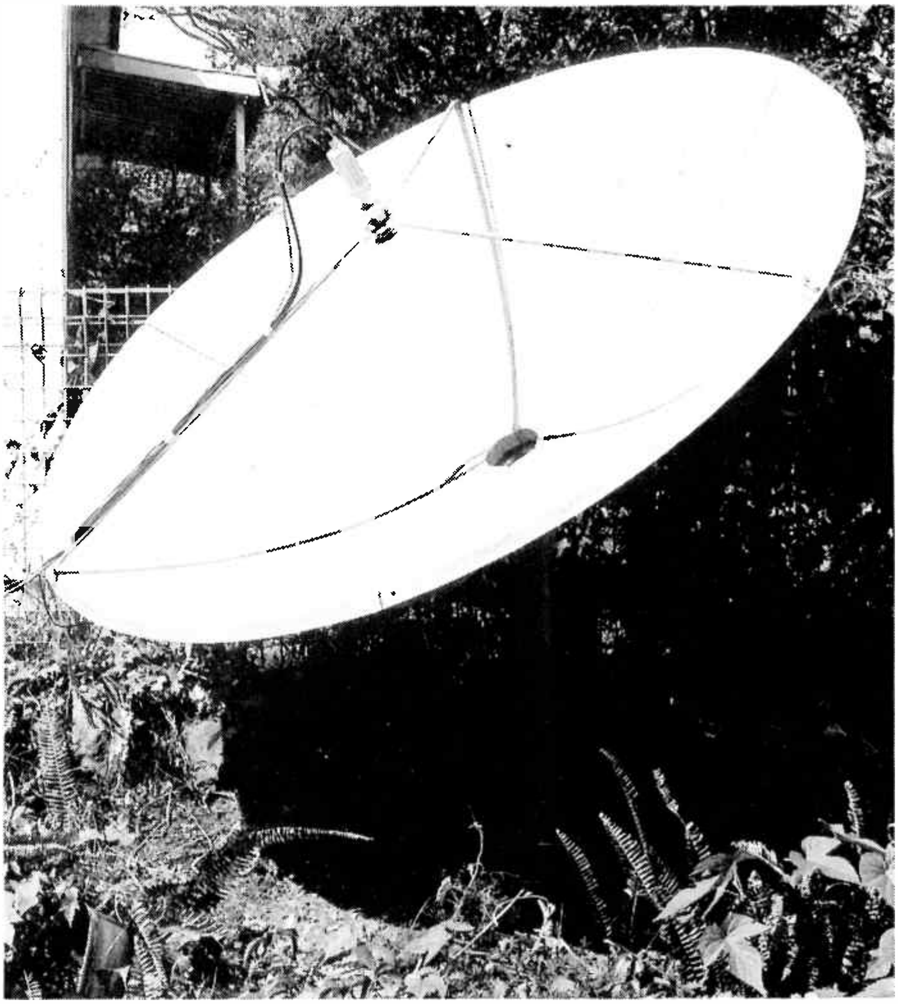
Incidentally as supplied by AV-COMM, all of the basic setup information for the Aussat transponders which carry 'fortuitous' PAL signals is preprogrammed into the Dynalink 50's memory channels, to help get everything going.

Some minor adjustments may need to be made, to suit each particular installation, but the bulk of the setup information is there already. AV-COMM also supplies the dish pointing information, for the purchaser's geographical location.

As a further option, AV-COMM can supply an alternative satellite receiver which offers on-screen readout of tuning and setup parameters, and also provides 99 memories. This receiver is also fitted with SCART output sockets in addition to the RCA type, for easier connection to a VCR/monitor and a decoder, and provides its re-modulated output on UHF (channel 36).

The remaining item in the package is the 30m feeder cable, which is a length of low loss 75-ohm coax which has a moulded-on cable with three conventional conductors, for the polar rotator drive and AGC metering signal.

The coax is fitted with F-type plugs at each end, for rapid and convenient connection at both the LNB and receiver. Longer lengths of cable can be supplied



In reviewing the AV-COMM system, Jim Rowe elected to try it with the 1.8m 'petalised' dish — here pictured among the weeds in his backyard. Note the LNB and polar rotator assembly mounted at the dish's prime focus.

to order if 30m is not sufficient, by the way, but this does involve additional cost. AV-COMM has found that 30m is generally adequate for most installations.

Installing it

Because I intended trying out the loan system at home, and my backyard really doesn't have a suitable level area to place the 'easel' type of dish stand, I requested that the system be supplied with the alternative 'petal' dish and the 'post' type of stand. This meant that I had to prepare a level area of only about 300mm square — but this still took a fair bit of effort, because my yard is basically solid rock!

The levelling process didn't take too long, however, and soon I had mounted the support post in position — fastening the base brackets to the rock with the eight Dynabolts provided in the dish hardware kit.

The next step was to assemble the dish carefully, following the brief but quite easy to follow instructions supplied. The dish must be assembled face down on a reasonably large flat area, which in my case meant the lounge room floor! Then it was a matter of fitting the el-az mount to the rear, and getting my son to help manoeuvre it out of the house, carry it to the prepared post and lower it into position.

At this stage the LNB mounting struts and support clamp were assembled, and mounted to the front of the dish — using a length of 25mm conduit fitted in the clamp temporarily, to make sure it was aligned with the centre axis of the dish.

This done, the opportunity was taken to set the dish pointing elevation and azimuth to their 'ball park' positions for the A1 satellite, using the pointing data for my location as supplied by AV-COMM.

The elevation was set using a straight 2.5m length of aluminium 'L' extrusion taped in position across the dish face vertically, with a small plumb-bob and protractor (see diagram); the azimuth was set using a compass to align the on-axis conduit, by eye.

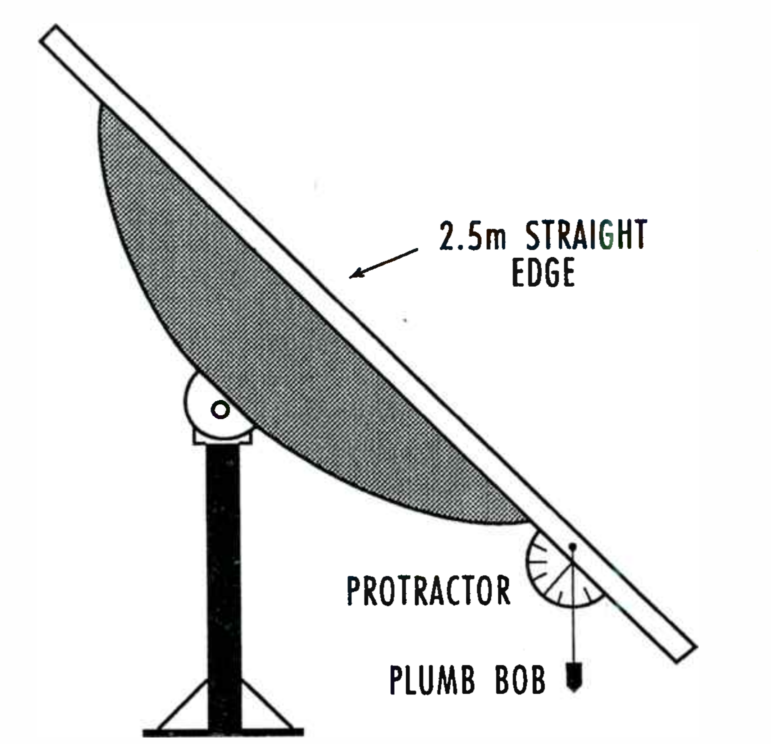
Needless to say, allowance has to be made for the fact that magnetic North (as indicated by a compass) doesn't exactly coincide with true North, in most cases. However AV-COMM had kindly allowed for the appropriate compass correction for my area, when suppling the pointing data.

After tightening the mounting bolts to prevent accidental movement, the conduit was then removed from the dish focus clamp. The LNB, polar rotator and feed horn were then bolted together, and fitted to the focus clamp — with the front of the feed horn the correct distance from the dish surface to ensure correct focusing.

This virtually finished the 'outdoor' end of basic system installation, apart from connecting the cable to the LNB and polar rotator, and running it indoors to where the receiver would be located. In my case the 30m cable length supplied turned out to be more than sufficient.

The satellite receiver was then set up near the TV set, and the various connections made. I elected to use the video and audio outputs from the receiver, and connect these to the appropriate inputs of the VCR. This allowed me to make recordings of interesting items, with the best possible quality; the TV set was driven via the VCR's modulated RF output.

The co-ax cable from the LNB was connected to the IF input of the receiver, and the three additional wires to the polar rotator and AGC terminals. Then it was time to fire up the receiver, VCR and TV, and begin the final tune-up.



Setting up the correct elevation for the dish is easiest done using a long straight edge, with a plumb bob and protractor. The angle between plumb bob string and straight edge is the same as that between the dish axis and horizontal.

And the results...

Since AV-COMM pre-programs the basic tuning data for the Aussat transponders into the receiver's appropriate EEPROM memory channels, the first step was to see if there was a sign of any picture on the likely transponders.

In my case there was only a faint and very noisy picture on one — the dish obviously needed a little fine adjustment to its pointing, which is apparently quite common.

To do this, AV-COMM recommends that you tune not to a 12W transponder (where the PAL signals are generally found), but to one of the 30W transponders. Even though most of these carry B-MAC signals, which can't be viewed with a PAL system, they *do* produce a stronger signal to make dish alignment easier.

So with the receiver set for transponder 8, I took my digital multimeter and small shifting spanner out to the dish. The DMM was then set to 0 - 4V DC and hooked across between the AGC and earth wires, to give a small reading (initially about 1.9V, if I recall).

Then the procedure was to loosen the clamping bolts on the dish mount, and very carefully nudge the dish in elevation and azimuth in turn, to produce the highest peak in the AGC voltage reading on the meter.

In practice, it seems to be best to try improving the azimuth first, by watching

the meter as you rotate the dish slightly to the left, and then back to the right. It soon becomes obvious which is the right way to go, and it doesn't take long to find the best initial azimuth position.

Then you tighten the azimuth clamp bolts a bit, loosening instead those for elevation. This lets you nudge the dish up or down a bit, to find the peak there as well. After this you can tighten the elevation clamp bolts, and go back and see if it's possible to improve the azimuth. A further check of the elevation setting might also be indicated, just to make sure everything is right before you tighten everything up fully.

In short, the fine pointing of the dish involves a number of iterations; but these are actually easier to do than to describe, and they really only involve about 10-15 minutes at most. What makes it so easy is that there's no need to keep running inside all the time, to check the effect of your adjustments. Thanks to the AGC voltage fed back up the cable, you can see the effect of your adjustments straight away on the DMM.

Once this fine pointing was done, and all of the mounting bolts tightened up carefully, I was able to go back inside — to find that quite respectable PAL pictures were now available on a couple of the transponders. A little later I discovered a similar signal from a third transponder, which had presumably been dormant earlier.

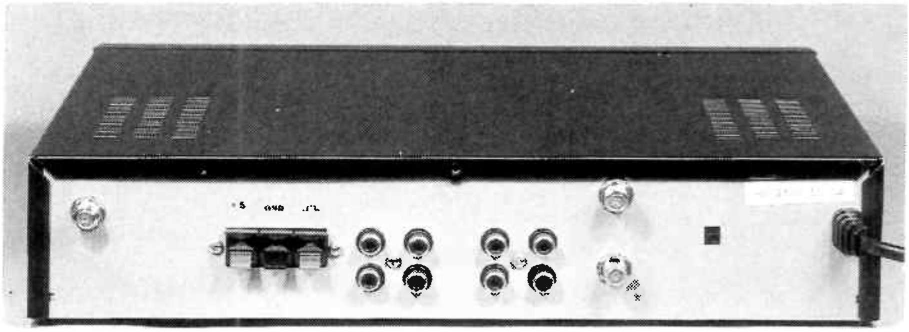
Curiosity being a characteristic of magazine editors, I then tried adjusting various receiver settings for each transponder from those that AV-COMM had pre-programmed, to see if any further improvement was possible.

Sure enough, I *was* able to achieve quite noticeable improvements in each case, by making adjustments to things like polarisation skew, receiver gain and even the exact IF tuning frequency.

I've found since then that the IF tuning frequency for minimum evident picture noise can often be significantly different from the nominal figure (i.e., the transponder's known centre frequency on the Ku band, minus the LNB's nominal local oscillator frequency of 11.3GHz).

The optimum tuning point also tends to vary, with both the ambient temperature and the time the system has been running — because the main reason for the deviation from nominal tuning frequency is actually *drift* in the LNB local oscillator.

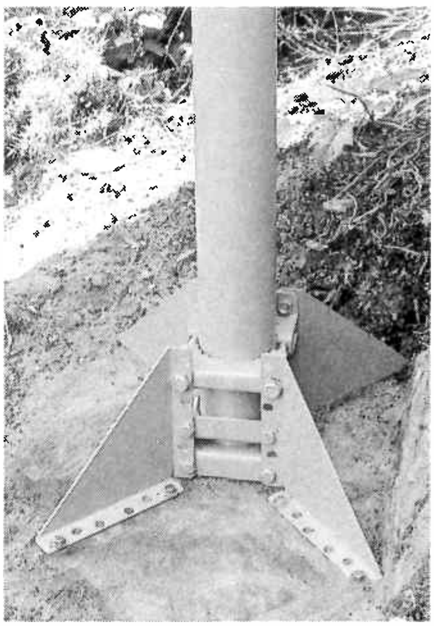
This isn't the only factor — another seems to be uplink carrier frequency differences, between the various base stations which access each transponder. After a while, you notice that signals originating from different base stations have slightly different tuning points, for best results. But on the whole LNB drift seems to be the main factor, and although it's by no means serious, the net result is that minor tweaking of the IF tuning can often give a worthwhile improvement in minimising picture noise.



The rear end of the Dynalink 50 receiver. At far left is the IF input from the LNB, while the three-terminal block provides the polar rotator control current and also the AGC voltage used in final dish alignment.

Another area which often responds to adjustment is the sound subcarrier tuning. Even on the same transponder, different subcarrier frequencies seem to be used at times, depending upon the programme material being transferred. Sometimes a particular transponder may carry mono sound at 6.60MHz, for example, and other times stereo sound at 7.38/7.56MHz.

At other times the best signal-to-noise figure seems to be with the tuning set for say 6.65MHz — so a bit of experimenting is often worthwhile.



The post for the 'petalised' dish has a set of clamps and brackets that allow it to be attached to either a horizontal or vertical surface. In Jim's case a 30cm-square level area had to be chipped from solid sandstone!

How good *is* it?

By this stage you're no doubt wondering just how good the reception *can* be, in a typical situation and using a basic setup like AV-COMM's package with its 1.8m dish and LNB with a noise figure of about 1.4dB. (These are the two components that most determine the final picture and sound quality, by the way.)

Well, the best answer I can give you is that it varies — especially with signals from the 12W transponders. At the best of times, say on a nice warm, clear, cloudless day when you've tweaked everything for best results, both picture and sound can be almost indistinguishable from good VHF or UHF reception.

The main thing you tend to notice is a small amount of 'sparkle' noise on picture areas that are in highly saturated colours; this is mainly evident on test patterns, and when conditions are optimum it can be very close to invisible on normal programme material.

I gather that this 'sparkle' noise is due to beating (heterodyning) between the noise and PAL (or NTSC) colour subcarrier. It arises because the FM transmission system used for satellite transmission tends to give the noise a 'blue' characteristic — that is, the noise level *increases* with signal frequency. But the beating with the colour subcarrier causes this high frequency noise to become what is effectively low frequency *colour noise*, making it much more visible.

In short, it's a drawback of both the PAL and NTSC systems, that they're quite susceptible to noise level when used with the FM system employed for satellite transmission.

Needless to say, this 'sparkle' noise tends to get significantly worse when the satellite signals are attenuated by cloud

[illegible]

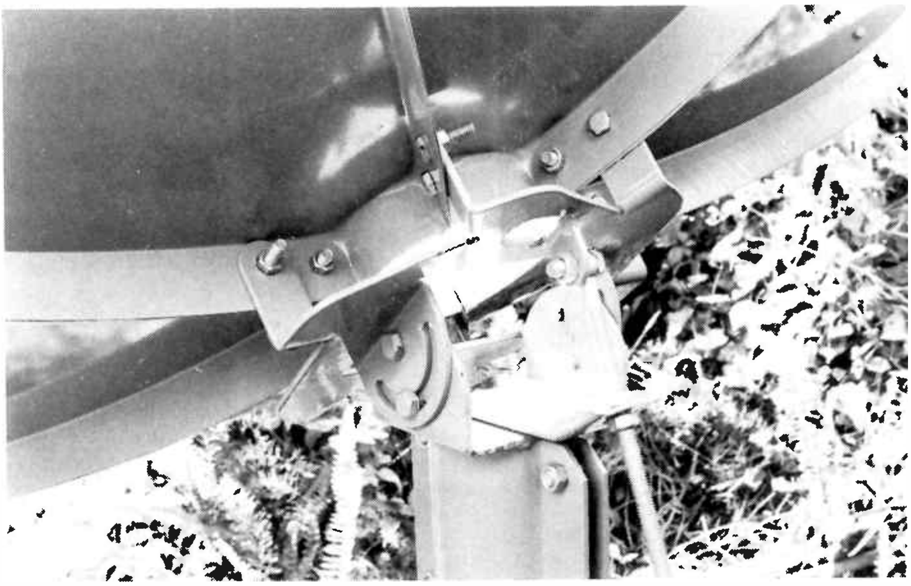
or heavy rain. So when it's really overcast and pouring down, the pictures from 12W transponders become quite poor — even if your system is really tweaked up for optimum results.

On the other hand, on those occasions when you are lucky enough to find a 'fortuitous' PAL signal on one of the 30W transponders, the picture and sound can be absolutely excellent — with not a trace of noise to be seen.

Very near 'studio quality', in fact. I haven't yet been able to check how the signal from a 30W transponder looks under conditions of heavy rain (30W transponders don't run PAL very often!), but I'd expect the picture to be still quite good even then.

What this means, I think, can best be summarised by saying that the combination of a 1.8m dish, a 1.4dB noise figure LNB and PAL signals from a 12W transponder is probably on the borderline, for reliable reception at high quality. Most of the time you can get pictures and sound of good, entirely watchable quality; but when it's raining heavily, you can virtually forget it.

The fact that the results from a 30W transponder are so much better (and dramatically so!) shows that it's basically a matter of sheer signal strength, and hence the achievable signal to noise ratio. Presumably with a dish of about 2.9m diameter (which would provide about 2.5 times the area), you'd get virtually the same excellent results from the 12W transponders — everything else being equal. But of course that would be a very much larger dish...



A close up of the 'el-az' dish mounting/positioning assembly at the rear of AV-COMM's 1.8m 'petalised' dish. It's quite easy to adjust both elevation and azimuth, simply by loosening the appropriate bolts and 'nudging' the dish slightly. After a couple of iterations, everything can then be tightened up.

Enhancements

How about using a lower noise LNB — what kind of improvement does *that* provide? Well, Garry Cratt very kindly loaned me one of his 1.0dB models, to try this out for myself.

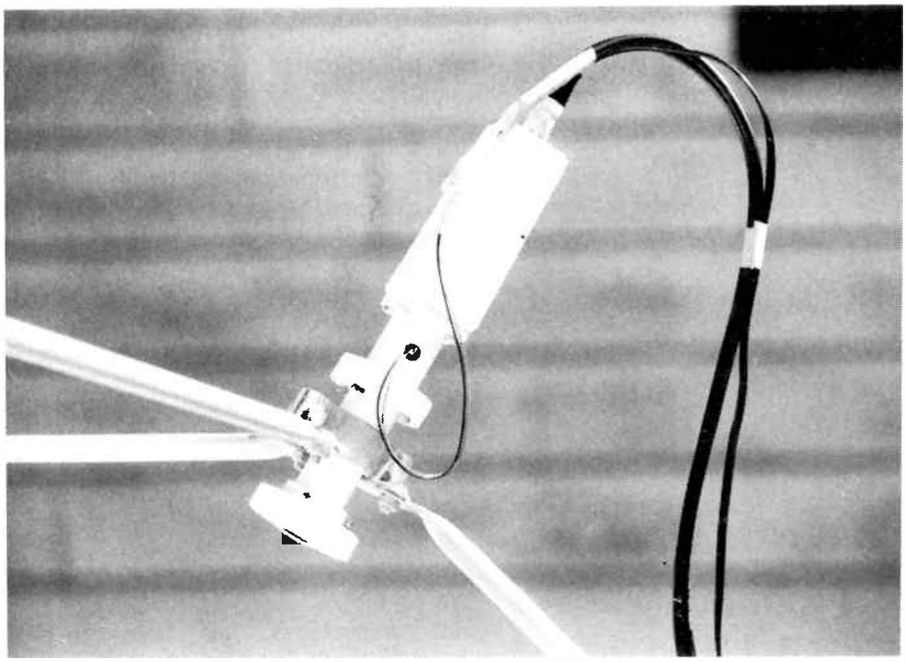
This was fairly easy to do; all that was involved was substituting it for the original LNB and lining everything up again — including tweaking the receiver IF tuning, to suit its slightly different local oscillator frequency.

After having done this and tried out the lower noise LNB for a while, I can confirm that it does provide a worthwhile improvement. This is mainly in terms of lower picture noise, for a greater proportion of the time. However the results with a 12W transponder signal are still noticeably poorer than you get with the occasional period of PAL on a 30W transponder, and still pretty poor in heavy rain.

While we're on the subject of system enhancements, Garry Cratt was also kind enough to loan me one of his alternative satellite receivers, with on-screen display of setup parameters and 99 memories instead of 50.

I found this a very nice receiver, and its on-screen display scheme is a little easier to use than the four-figure LED display of the Dynalink 50. It also has a bit more setup flexibility, with the ability to program things like IF gain (five steps) and video polarity, and seems to have slightly cleaner sound (perhaps due to a wider sound IF bandwidth). And of course it does offer SCART connectors on the back for the direct video and audio outputs, in addition to the RCA type.

Another slight difference is that its remodulated RF output is on UHF, tuneable between channels 30-39, instead of VHF channel 3/4. And it does offers those extra memories — although you



A close up of the LNB assembly. The LNB itself is the uppermost rectangular module, while the feed horn is the tubular component clamped in the mounting bracket. The polar rotator is the small unit between the two.

really won't need any more than 45 memories, even if you plan to look in regularly at all three Aussat satellites.

However I did find the remote control unit of the fancier receiver a little more confusing, with its pair of 'Channel' keys as well as those for memory selection. And the sound IF tuning is not quite as friendly as on the Dynalink 50, because it lacks the latter's 15 preset sound subcarrier frequency 'recipes'.

So I guess the main criteria, for deciding if you prefer the more expensive receiver over the Dynalink 50, are whether or not you want things like on-screen display of the setup information, SCART connectors and the re-modulated output on UHF. If you do, the fancier receiver is no doubt worth the extra money.

Radio reception

I had read in some of the literature that a few of the Aussat transponders carry radio signals, which can be picked up by tuning the LNB output signals with a UHF receiver. So I decided to try this out, while I had access to the AV-COMM system.

All you really need to do this, apart from the basic satellite receiving setup, is an IF splitter unit and a suitable UHF receiver capable of wideband FM reception. Since I invested in an Icom IC-R100 receiver some time back, and this tunes right up to 1856MHz in either AM, FM or WFM modes, the receiver was not likely to be a problem.

All I needed was the special IF splitter, which allows you to tap into the IF link between LNB and satellite receiver, without disturbing the DC supply feed for the LNB.

(By the way, tapping into the IF line with a splitter has virtually no effect on the received TV signal quality, because it's the dish and LNB that are the crucial elements. Thanks to the high gain of the LNB, the IF signals are so strong that the 3dB-or-so loss of the splitter has virtually no effect.)

As it happens, AV-COMM has suitable splitters available as well, and Garry Cratt was able to send one over so that I could try it out.

The result was that in short order, I was able to receive quite a range of high-quality radio signals via the IC-R100 — by tuning it through the IF frequency range corresponding to the transponder carrying the 'SCPC' (single channel per carrier) radio services.

The only complication I found was that the radio signals tend to 'walk' along the IF band slowly, so that if you find a signal and save its frequency in one of the IC-R100's memories, it may well turn out to have moved up or down when you recall the memory data later.

The reason for this is again drift of the LNB's local oscillator, of course. In fact if you tune in a radio signal when the system and LNB are cold, and then leave it on for some time, you have to adjust the tuning from time to time to 'follow' the signal and stay properly tuned.

I gather this is a problem with virtually all currently available LNB's, which are generally stable enough for TV reception but not for radio reception. However Garry Cratt tells me he's going to have an answer for this one too, pretty soon: an LNB with an inbuilt PLL (phase-locked loop) to stabilise the local oscillator, and reduce drift to almost zero.

All going well, a sample of the new PLL-stabilised LNB should be available very soon, and I'm hoping to get one on loan to try it out.

Garry also has plans to supply a complete 'satellite radio' receiving package, or possibly just a dish, the new LNB and a suitable power supply/IF terminal unit, to go with a standard UHF radio like the IC-R100.

This would be quite attractive for those who only want to receive the satellite radio signals, of course, because the satellite TV receiver itself isn't really necessary when you're receiving the radio signals; it's really only providing the DC power for the LNB.

Hopefully the radio side of fortuitous satellite reception can be the subject of a follow-up article.

Summarising, then, my experience with AV-COMM's low cost satellite TV system has been not only very interesting, but educational as well. It certainly provides an excellent opportunity to get 'hands on' practical experience in satellite reception technology, at a very reasonable cost.

If you're planning to get involved in the pay-TV industry when it gets going, I believe it would make an excellent investment. I gather from Garry Cratt that quite a few TAFE colleges and universities have already invested in systems like this, to serve as training tools for both staff and students.

Incidentally, virtually all of the components of the system are also available separately from AV-COMM, at very reasonable prices.

My thanks to Garry for his loan of a system and the other items, so that I could carry out this review.

Further information is of course available from AV-COMM, at PO Box 386, Northbridge 2063; phone (02) 949 7417, or fax (02) 949 7095. ❖

[illegible]

PHILIPS' 'TOWER' CD AUDIO SYSTEM

The focus of Louis Challis' attention this month has been the Philips AZ9712 CD Audio System, which has a physical form very different from traditional music systems. Part of Philips' new up-market range dubbed 'The Collection', it certainly turned out to be innovative...

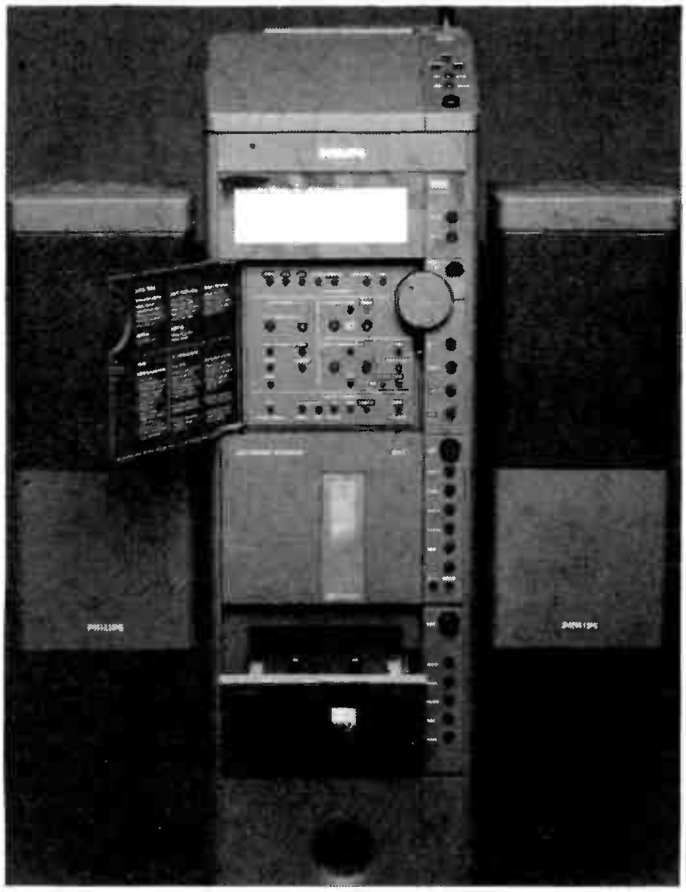
A product's *appearance* is now generally regarded as being one of the most critical factors affecting its marketability. The realisation of this factor has lead to a situation where all manufacturers now devote an inordinate proportion of their resources to improving the appearance of their products, in the belief that this will improve their share of the market.

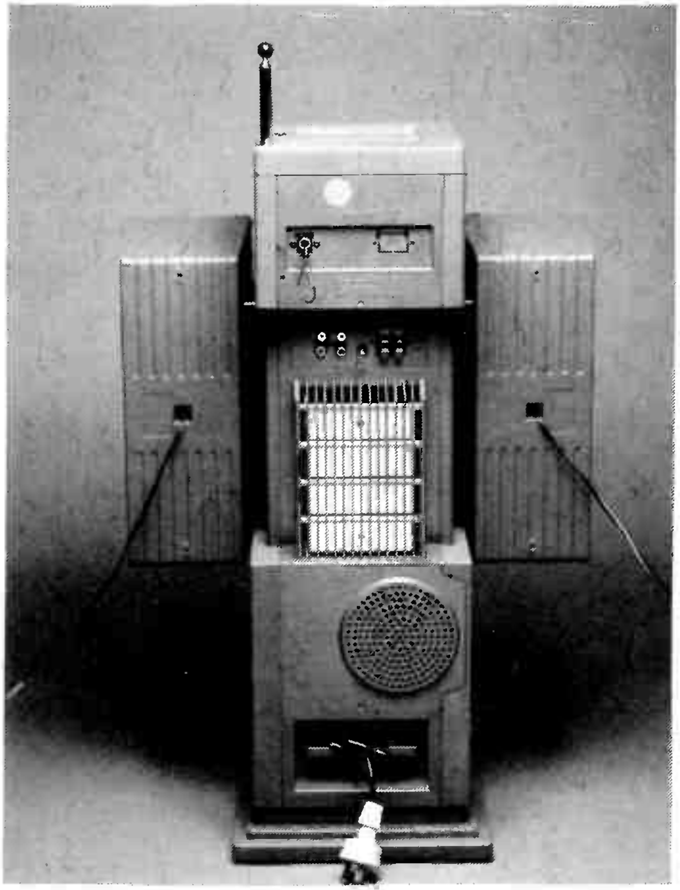
Now, whilst the vast proportion of new product designs can be considered as being *evolutionary*, only a small proportion could be described as being *revolutionary* — as such designs usually constitute significant departures from the norm, and thereby run the risk of alienating a significant proportion of intending purchasers.

Given the fickleness of the public, and the lack of success of market surveys to accurately foretell how the public will react to what could be considered to be a revolutionary design departure, a manufacturer really takes a gamble when it decides to release a revolutionary design. Possibly the only factor which tends to reduce the risk factor, with that type of revolutionary product, is when the product's performance is so good that even the detractors are convinced that this is the product they want.

What has prompted these observations is the new Philips AZ9712 Compact Disc Stereo Radio Recorder, which is one of the innovative new items in 'The Philips Collection'. This product is visually so different from previous generations of integrated multi-function, hifi units which you or I have previously seen, that I suspect you will either love it or hate it at first sight.

While other products offering similar capabilities have tended to be designed as either 'squat boxes' or 'wide boxes' (suitable for mounting on a sideboard or shelf), in contrast the CD Audio System is designed as a tall and .slender 'combi unit', which has been designed to sit on the floor. It incorporates a CD player,





A swing open door below the LCD display provides the control buttons for functions that are less often used.

The rear of the unit, shown with the satellite speakers clipped to the sides and the mains cord retracted.

AM/FM/LW radio tuner (although the LW mode will not be provided in the Australian units), and also has twin logic-controlled cassette decks.

The main unit contains three amplifiers, with an internal sub-woofer in its base, and two 'satellite' mid range/HF speakers. The speakers may be either clipped into both sides of the main cabinet, or remotely positioned, as required. The overall size of the unit is 660mm high by 330mm deep, with a width of 460mm when the speakers are attached. Total weight is 14kg.

The system's basic functions are supplemented by a very nifty clock timer and 40-function remote control.

Overall, the CD Audio System is reminiscent of the 'tower' format that many of the latest home and office computers have adopted. The first difference you notice is that it has a CD player, mounted at an angle under the sloping front lid. At first sight this sloping configuration is a trifle disturbing, but not for long; after all, there is no reason why the deck mechanism should be horizontal.

The CD player control buttons are similarly arranged in what is a somewhat unusual array, to the right of the hinged

Unlike many other domestic CD players, this one has a swing up lid — revealing the laser optics. This makes it easier to clean the lens, but also makes it easier for dust to reach it — so that cleaning is likely to be needed more often!

access cover. A lifting handle with sensible recessed well is located behind the sloping CD access cover, to facilitate carrying or moving the entire unit.

On the right-hand side of the handle, a 6.5mm stereo socket has been provided for headphones. To the rear of that socket a telescopic aerial has been provided, which extends up in height by 600mm and which can be angled to optimise the FM signal reception.

Near the top edge of the front face of the CD Audio System, the designers have incorporated an illuminated LCD display which provides a wealth of information — but which really ought to have been angled as well, to provide improved vision from a standing position in front of the unit. With the panel at a height of only 550mm from the floor, you either have to squat down on to your haunches or stand back beyond arms' length to conveniently read the information on the screen.

Admittedly the remote control makes the latter option practical; however when it comes to setting the time clock or the alarm you really need to use the programming keyboard which covers all the secondary controls, which has been discreetly placed behind a hinged door. These controls are somewhat low also, and unless you again squat down on your haunches, they are just too hard to read.

The programming keypad behind the hinged door has the acoustic controls as a row of buttons at the top, to select frequency contours suitable for JAZZ, POP, CLASSIC, SURROUND and TURBO BASS, with a MUTE button and a DEFEAT button. On the left-hand side of the panel are the CLOCK timer, START/STOP timer and TIME SET/SLEEP SET buttons, while on the right hand side are the CD programming buttons which allow you to STORE and REVIEW selected CD tracks.

On the lower right-hand side of the programming keyboard, there are a series of eight buttons which allow you to store radio channel frequencies as well as alphanumeric codes, up to six digits in length, for each of three bands. Thus for example, station callsigns like '2MBSFM' or '3L0' or 'FOX RAD' may be stored for each individual AM or FM radio channel, to be recalled and displayed when that channel is selected.

Across the bottom of the programming keyboard panel are the 'infrequently used' function pushbutton controls for the tape deck, which allow you to select normal or chrome tapes, normal or high speed dubbing (an unusual plus), or the ARCS — which allows you to automatically rewind the cassette tape to its start, for CD recording. There is also a Dolby B noise reduction selector button and an AUTO REVERSE/MODE button, which is pressed repeatedly until the appropriate LCD display, conforming to your requirement, appears.

The individual functions provided by this button are: NO REVERSE, SINGLE REVERSE, CONTINUOUS REVERSE and AUTO PLAY — which provides non-stop playback of Deck 1 and Deck 2 sequentially.

This array of functional controls is particularly impressive, and frankly shows just how far the designer can go when the microprocessor-based digital electronics are integrated into an item of consumer electronics which is relatively modest in cost. But on the other hand the 'User Handbook' provided with this system does not adequately describe the use of these controls on a step by step basis, and this detracts from what might otherwise be a very positive marketing feature. Had it not been for the provision of the system's Service Manual a few days ago, I doubt that I would have discovered many of the attractive features which have been provided in this system.

The major function controls for the system are arranged in a linear array down the right hand side of the front panel. These include '+' and '-' buttons next to the LCD display, to select pre-set stations logged in the tuner's memory; a STANDBY/ON switch for activating the power for the system; and a large rotary volume control, which is remotely controllable and which incorporates an unusual LED — whose colour changes from green through amber and then to red as the rotational volume increases, and which glows red when the system is in a 'standby' mode.

On the panel below the volume control are four manual pushbuttons to select CD, TUNER, AUX and TAPE, which are paralleled by similar controls on the remote

MEASURED PERFORMANCE OF PHILIPS COMPACT DISC AUDIO SYSTEM MODEL NO. AZ9712/00 - SERIAL NO. WT0092000117220

1. Frequency response 8Hz to 22kHz + 0, -1dB

2. CD player linearity

Nominal Level	Left Output	Right Output
0dB	0.0	0.0
-1.0	-1.0	-1.0
-3.0	-3.0	-3.0
-6.0	-6.0	-6.0
-10.0	-10.0	-10.0
-20.0	-20.0	-20.0
-30.0	-30.0	-30.0
-40.0	-40.0	-40.0
-50.0	-50.1	-50.2
-60.0	-60.4	-60.4
-70.0	-71.7	-71.8
-80.0	-89.1	-90.7
-90.0	-96.9	-93.7

3. CD player distortion @ 1kHz

Level	2nd	3rd	4th	5th	THD%
0	-93.2	-108.4	-105.5	-89.7	.004
-10	-98.7	-83.2	-103.6	-86.5	.0085
-20	-	-76.6	-	-87.3	.015
-30	-	-74.3	-	-82.5	.02
-40	-	-72.2	-	-62.5	.08
-50	-	-54.5	-	-54.6	0.2
-60	-	-37.9	-	-40.4	1.6
-70	-	-28.5	-42.9	-28.4	5.4
-80	-24.8	-19.0	-	-13.9	23.8

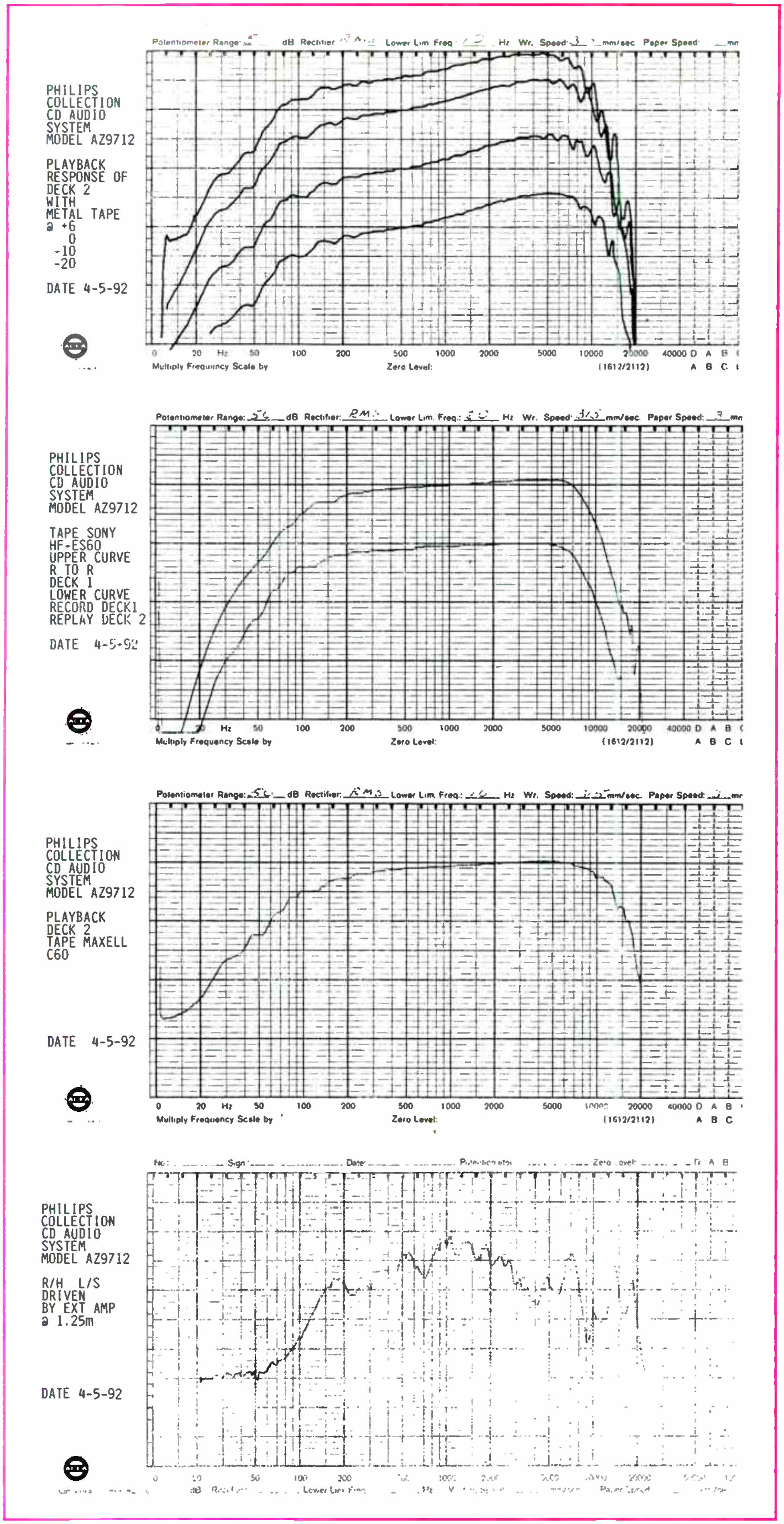
4. Frequency response of FM tuner **Measured satellite Speaker terminals**
150Hz to 20kHz*
* The actual frequency response is greater than 20Hz to 20kHz

5. Record/replay frequency response of cassette deck No.1
Defeat mode 130Hz to 8.5kHz (+/-3dB)*
* Real frequency response is thus greater than 50Hz to 8.5kHz

6. Replay frequency response of cassette deck No.2
Defeat mode 150Hz to 11kHz (+3dB -6dB)*
* Real frequency response is thus greater than 50Hz to 11kHz

7. Frequency response of loudspeaker
System in Turbo mode Nominally 40Hz to 20kHz +/-10dB

[illegible]



Four of the performance curves for the CD Tower System, as measnured by Louis Challis — not without a certain amount of difficulty. Shown here are curves for the tape decks and another one revealing the response of a satellite speaker.

control. Below these are two rows of functional controls for TAPE DECK 1 and TAPE DECK 2 — the major differences between the two decks being that deck 1 has FORWARD and REVERSE play as well as FORWARD and REVERSE recording buttons, whilst deck 2 only offers PLAYBACK in the forward direction.

Although both decks offer the convenience of CD synchronisation, neither incorporates a tape counter. Nor, regrettably have the designers opted for the alternative option, in which the LCD display could provide similar tape counter information. This would appear to be a potentially serious oversight, and one which may well discourage many intending purchasers.

The design of the CD player is unusual, and with the hinged lid up the laser optics and the associated swing arm mechanism are directly exposed to view and to touch. While the laser optics are potentially more vulnerable, the lens is nonetheless somewhat easier to clean as a result of this configuration.

The CD player's small pushbutton controls are arranged on the right hand side of the hinged lid, as noted earlier, with a MODE switch for NORMAL/SHUFFLE/REPEAT/SCAN selection, PREVIOUS or NEXT track selection buttons, PLAY/PAUSE, STOP/CANCEL and a somewhat larger and more sensible OPEN button at the front leading edge — which unlatches the lid and allows it to smoothly open up with virtually no sound at all.

The illuminated LCD panel at the top front of the system is neat, and offers clear information with large 'NO CD, DISC' and 'PLAY' displays, supplemented by large counter numbers for the CD mode and useful (but regrettably only partial) information on the other control functions displayed. Around the perimeter of the display are small squares in which other control functions are displayed, as well as relatively small CD track availability numbers. The information provided, though modest, is adequate as it is only likely to be viewed when loading a disc.

The tuner section has been designed to cater for the central European market, with an LW (long wave) band covering 148 to 284kHz, a mono AM band covering 522 to 1611kHz, and a stereo FM band covering 87.5 to 108MHz. The LW and MW aerial requirements are each satisfied by internal ferrite antennas, while the FM requires either a separate external 75 ohm coaxial antenna to provide optimum signal sensitivity, or alternatively the extending whip antenna.

As noted earlier, the tuner incorporates 24 memories where station frequencies can be stored (eight per band), each of

[illegible]

which also has the ability to be annotated using the programming keyboard.

The CD Audio System incorporates two separate, 11-watt amplifiers, which are dedicated to the left and right external speakers, and a separate 13-watt amplifier which is connected to the 'turbo boost' woofer incorporated at the base of the cabinet. The woofer has a forward pointing port and a perforated plastic grill at the back.

The turbo bass unit covers a bandwidth from 50Hz to 200Hz, whilst the satellite speakers cover the frequency range 150Hz to 20kHz.

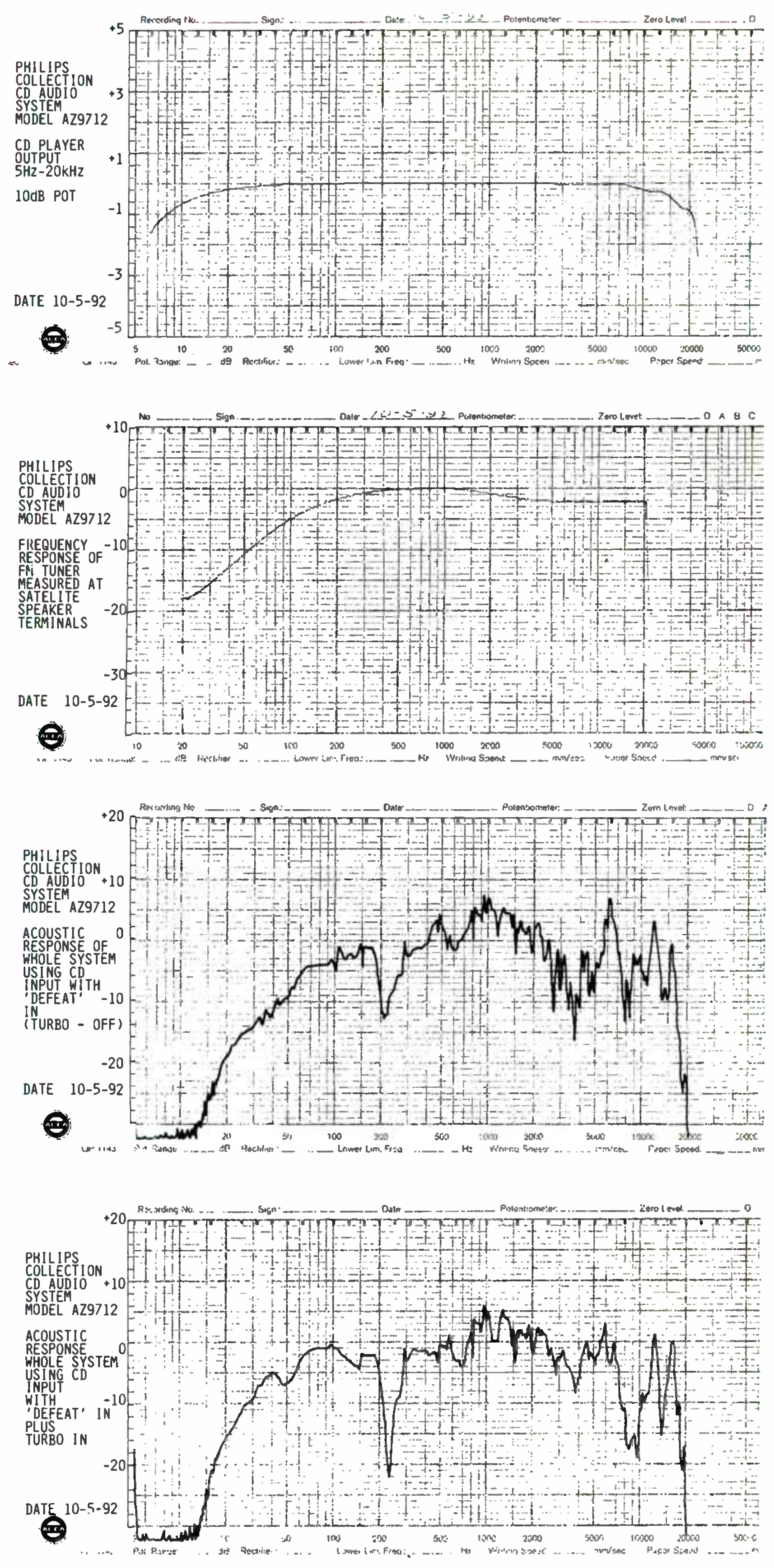
On the back panel of the CD Audio System are a pair of sockets which provide 'AUXILIARY LINE IN' and 'CD PLAYER OUT'. There are also two colour-coded spring loaded sockets, for connecting the satellite speakers, and a 12-16 volt coaxial socket through which external DC may be connected to operate the unit. The mains lead is provided with a recessed socket, on which the mains cord may be looped for transportation, while the two satellite speakers are simply removed by means of a spring-loaded pushbutton on each side of the cabinet.

Objective tests

Fortunately the frequency response of the CD player is capable of being conveniently measured at the two coaxial terminals on the back panel. Regrettably this convenience is not matched by any of the other components, such as the radio tuner or cassette players. As a consequence, I was forced to evaluate their frequency responses (and characteristics) at the satellite speaker terminals, or as an acoustical signal in the anechoic room.

In fact the testing and evaluation of this unit proved to be far more complex than I anticipated — primarily because the unit does not provide simultaneous access to all inputs and outputs. Even the outputs of the two amplifiers which *are* accessible, are modified by the presence of the selective LOW PASS and HIGH PASS filtering — in accordance with the selected settings and the fixed bandpass filters.

Thus by way of example, the output signals on each of the satellite speaker terminals neatly roll over by 3dB at 150Hz and by 20dB at 25Hz. These drooping frequency characteristics are of course compensated for by the bandpass characteristics of the associated subwoofer, to whose terminals there is no direct access. The measured frequency response of the speakers were recorded with the satellite speakers attached to the cabinet, and this gave rise to a series of



Further curves for the system, showing CD player output, FM tuner response and the overall acoustic response with the Turbo function in and out respectively.

[illegible]

adverse frequency interactions which were particularly noticeable at 200Hz, as well as some related notches in response at frequencies between 8kHz and 16kHz.

The frequency response of the CD player did turn out to be good, measuring effectively flat from 50Hz to 8kHz and only 1dB down at 8Hz and 22kHz. When that frequency response is converted into a measured response on the axis of the unit at 2m in the anechoic room, the response is effectively within +/-10dB from 40Hz to 18kHz, if one ignores the interference and comb filter frequency effects of the three acoustic sources.

With 'turbo boosts' activated, the lift in acoustic output in the critical 30Hz to 150Hz region is clearly effective — but whilst monitoring the output in the anechoic room, I became acutely aware of the interaction between the turbo boost and the self-resonance characteristics of the cabinet. These were considerably less attractive than the swept frequency response would indicate.

The technical information to describe the frequency characteristics of each of the optional contour characteristics — i.e., JAZZ, POPS, CLASSICS and SURROUND — was not provided in the User Manual. It was only after I had completed *my* measurements in the anechoic room that I discovered that by selecting the DEFEAT Mode, I could in fact achieve a nominally flat response.

In the POP mode there is a 6dB boost at 7kHz; in the JAZZ mode a 6dB boost at 200Hz; in the CLASSIC mode there is 5dB boost at 100Hz and also 4dB at 10kHz. In the TURBO BOOST mode, there is 9dB boost in the left and right channels, together with a 10dB boost out of the bass amplifier — and similarly of course for its acoustic output.

The performance of each of the respective tuners could only be evaluated as an audio output signal, or as a high pass component of that response at the satellite speaker output terminals. By sweeping the audio input to the FM signal generator across the band to produce a level recording, I was able to measure the response of the FM tuner, albeit with a drooping low frequency response associated with the low frequency selective pre-filtering of those speaker channels. The response over the critical portion of the range is suitably flat and smooth, and the FM tuner functions well and quite adequately.

The record/replay frequency performance of cassette deck 1 is only fair; it provides a measurable level of performance which is not really good by today's standards.

The measured frequency response for the replay of cassette deck 2 shows the effect of our inadvertent selection of the POP mode, which produces a +6dB gentle rising response at 7kHz — whose implications were only realised long after the results had been logged.

The frequency response of cassette deck 1 is passable, but not outstanding, and not as good as indicated by the Service Manual — which suggests that the frequency response is 90Hz to 12.5kHz. My measurements revealed a reasonably smooth performance, but one which falls short of the standard of performance which I expect for a piece of equipment with 'high tech' features of this type.

The replay frequency response of tape deck 2 is considerably better than that of deck 1, but as deck 2 is likely to be used to play cassettes recorded on deck 1, the overall replay performance of the system is likely to be prejudiced by these characteristics. A compact cassette recorded on deck 1 and replayed through deck 2 is limited to approximately 7.5kHz.

Subjective tests

When it came to carry out my subjective evaluation at home, the system evoked considerable commentary from my family and friends — all of whom were initially either attracted or disturbed by the unusual appearance of the system.

It was with interest that I noted each person in turn acknowledging some different characteristic which they personally liked or disliked — although none of them stated that they liked all of the 'different' features exemplified by the system.

I used a number of conventional test discs and pre-recorded compact cassettes to assess the overall performance of the system. The first of the discs was the Chesky *Jazz Sampler and Audiophile Test CD Volume 1* (Chesky JD37).

This particular disc is one of the most practical and convenient audiophile test discs currently available (and if you are a serious listener, it's a must for your collection). It incorporates listening environment diagnostic recordings (LEDR) test data, which is most suitable and extremely effective in evaluating a stereo system as well as its interaction with the room in which it's to be used.

This disc confirmed very positively that unless the Philips' system's satellite speakers are appropriately separated, then the spatial qualities of the reproduced sound are significantly impaired. The rest of the music on the disc was good and the system provided a creditable performance.

The second disc which I used featured Yo-Yo Ma and Bobby McFerrin, on a new Sony Masterworks disc called *HUSH* (SK 48177). This particular disc is an unusual combination of Bobby McFerrin (who I think most of you will have heard by now), providing a lead accompaniment with the famed cellist Yo-Yo Ma. Together they play a wide range of classical music, which includes Vivaldi's *Andante* and Rimsky Korsakov's *Flight of the Bumblebee*, and for each piece the system performed admirably.

The last disc used in my subject evaluation was Michael Murray playing *Bach at St Bavo's* (Church) (Telarc CD-80286), which to the uninitiated is the famous great church at Haarlem in the Netherlands.

Each of the Preludes, Fugues and Toccatas on this particular disc constitute relatively difficult pieces of music for any conventional hifi system speakers to reproduce, at reasonable level and with appropriate tonal balance.

With the 'turbo' sound function activated, the system displayed a low frequency replay performance characteristic which was far better than I would have expected from such a small system. The calibre of that performance convinced me that the next generation of sound systems are all likely to incorporate similar small sub- woofers and similar 'turbo bass' systems, emulating the characteristics of this system.

By making use of the ARCS button, I was able to record this disc straight onto the compact cassette with almost a negligible effort, and thereby produce a cassette to play in my car. Although the cassette was not as good as the original, it was certainly adequate in terms of its original frequency content.

Summary

The Philips AZ9712 Compact Disc Audio System is radically different from competing systems, to the point that most intending purchasers will unquestionably make their comparisons more on the basis of the functionality and appearance of those competitors, rather than on the features and functionality of this system.

Dollar for dollar this system offers reasonable performance, and once you master the controls, unrivalled flexibility. The system is clearly designed to cater for the requirements of a 'first hifi system', and is well suited for a flat dweller or for a person with a need for a system that can be moved conveniently from room to room.

The Philips Compact Disc Audio System may not necessarily thrill you at first sight, but it probably sets the pattern for a whole new generation of 'look alikes', and sets those look alikes an interesting and potentially rewarding task!

The quoted price for the system is $1369; you should be able to find it at Philips dealers. ❖

SEVEN UNINTERRUPTIBLE PO

Have you ever worked away at your personal computer for a couple of hours – only to lose the whole session's work, because there was a sudden power failure before you could save it?

When you power your PC using the Upsonic 'PC MIGHT 55 Uninterruptible Power Supply (UPS), this kind of problem is a thing of the past. As soon as the mains power drops, the UPS switches your computer over to backup power, from its inbuilt battery. Switchover is almost instantaneous – typically only 4 milliseconds, which is so fast that your computer never misses a beat. And the UPS can keep your computer running from its battery for anywhere between 6 and 20 minutes – more than enough time to save your precious work away on disk, and often long enough to keep you going until the mains power is restored.

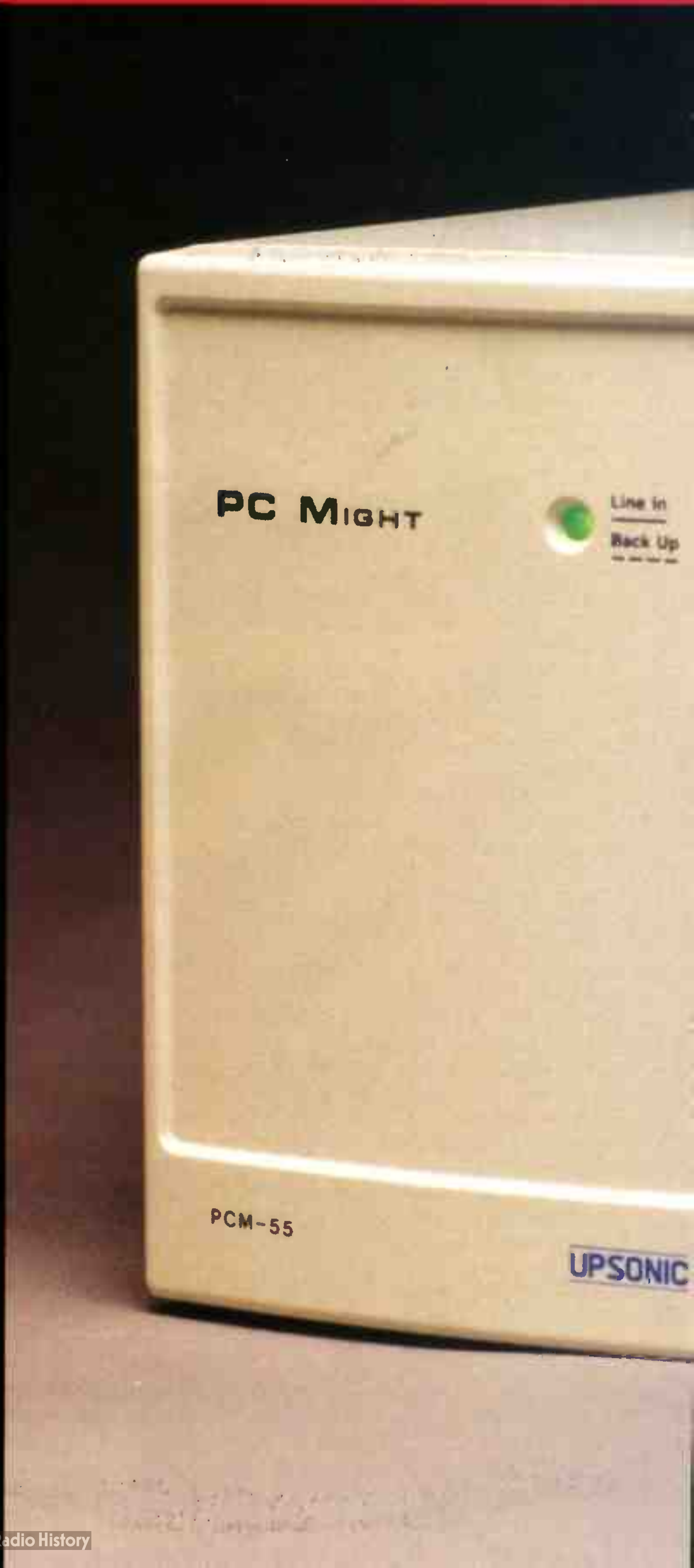
The PC MIGHT 55 is so compact that you can usually tuck it out of sight, under your workstation. It measures only 365 x 170 x 115 mm, and weighs 13.5kg. Yet it can deliver a full-load power of 330 watts (550VA), which is plenty to cope with almost any modern personal computer and video monitor combination. It's also very quiet, generating only 55dB of noise in standby mode and 60dB in backup power mode (measured at 1m). It has two internal 12V/7Ah lead-acid 'gel' batteries (supplied), which fully recharge in only 10-12 hours after mains power is restored - even if you run them 'flat' during a blackout.

And the good news is that SEVEN lucky *ELECTRONICS Australia with ETI* readers now have the opportunity to WIN one of these great PC MIGHT 55 UPS's – simply by taking out a 12-month subscription, or renewing/extending their existing subscription, before September 23, 1992! A 1 year subscription is only $47, including postage. So subscribe now and have Australia's best electronics magazine delivered to your door !

We know that many readers will find this offer attractive because nearly 75% of our readers use a PC, either at work or at home or both. So here's a chance to subscribe to your favourite electronics magazine, and also be in the running to win a UPS – and never worry again about losing your computer's data...

But hurry – this offer closes on September 23, 1992.

HOW TO ENTER: Simply phone our toll free number 008 800 933 and have your credit card details ready. If you do not have a credit card then fill out the coupon attached anc post. If the coupon is missing, send your name, address, phone number and cheque to: Federal Publishing Company Reply Paid No. 3, P.O. Box 199, Alexandria, NSW 2015. Any enquiries can be made by phoning (02) 693 6666. Unsigned orders can not be accepted.



WER SUPPLIES TO BE WON!

EACH UPS VALUED AT $958!

FREE GIFT!

As an added bonus, everyone who subscribes, renews or extends their *ELECTRONICS Australia with ETI* subscription between now and September 23, 1992 will receive one of these high quality solid aluminium, focussing mini torches – normally valued at $9.95, but YOURS FREE!

CONDITIONS OF ENTRY: 1. The competition is only open to Australian residents authorising a new subscription or renewal to Electronics Australia before last mail on 23.09.92. Entries received after closing date will not be included. Employees of the Federal Publishing Company Pty. Ltd., Upsound, their subsidiaries and families are not eligible to enter. 2. South Australian residents need not purchase a subscription to enter, but may enter once by submitting their name, address and a hand drawn facsimile of any coupons to the Federal Publishing Company Pty. Ltd. P.O Box 199 Alexandria, NSW 2015. 3. Prizes are not transferable or exchangeable and may not be converted to cash. 4. The judge's decision is final and no correspondence will be entered into. 5. Description of the competition and instructions on how to enter form a part of the competition. 6. The competition commences 24.06.92 and closes last mail on 23.09.92. 7. The draw will take place in Sydney on 25.09.92 and the winners will be announced in a later edition of Electronics Australia. 8. The prizes are 7 x $958 Upsound Uninterruptible Power Supplies. Total Prize valued at $6,706. 9. The promoter is the Federal Publishing Company Pty, Ltd, 180 Bourke Rd, Alexandria NSW 2015. Permit No. TC92/0000 issued under the lotteries and Art Union Act 1901; Raffles and Bingo Permit Board No. 92/0000 issued on 00/00/92; ACT permit no. TP92/0000 issued under the Lotteries Act 1964; NT permit No. 92/000.

Moffat's Madhouse...

by TOM MOFFAT

"The helicopter is on fire..."

When you watch the news on television, what impression do you get? Slick presenters, not a hair out of place? Glitzy reporters, perfectly dressed and groomed, speaking with authority about any subject under the sun? Well, that's the part you're supposed to see.

But behind it all there's a rough-and-tumble 'producer', trying every trick in the book, dirty and otherwise, to try and pull some kind of news service together before the evening deadline. The people in the field, the reporters — and more importantly the camera crews — have to think on their feet, even if they're knee-deep in mud.

I spent something like 12 years in television news, before I got into this magazine game. During that time I was shot at, spat at, flour bombed, punched and kicked, arrested, and seldom bored. Every day is a new adventure. All this came back recently during a 30-year reunion of staff from the Tasmanian TV station where I spent six years. These stories kept coming up — "Do you remember how we conned the...", etc., etc.

Missing bodies

For instance: One day there was a plane crash on the West Coast of Tasmania. First reports suggested all aboard were killed, and it was immediately a story of national interest. Television crews from the mainland networks flocked to the nearest town; we got there a little earlier, since we had less distance to travel.

The national media wanted action — that is, *bodies*. Bring back film of the bodies at all costs. They stormed the police station: "Where are the bodies? Where are the bodies?"

The local coppers weren't too impressed when the visitors came the heavy on them, and they became tight-lipped. But we, the 'amateurs' from Hobart, quietly let it be known that the bodies at that moment were in the Town Hall.

This sent the mainlanders into a frenzy; they roared off in their rent-a-cars to film the bodies. Every now and then we'd see them flash by in a different direction, searching for the Town Hall. It was a long and fruitless search, because there wasn't a Town Hall. In fact there weren't any bodies either; all the plane's occupants were quite alive, in the local hospital — where we'd just interviewed them about how the Tasmania Police had performed a daring rescue to remove them from the downed plane!

By the time the national TV people figured out what had happened, we were long gone, with our exclusive film in the can. The hospital authorities had closed the hospital to further media access, so the mainlanders went home empty handed. As I remember the big city TV stations had to use the interviews done by the local yokels. Ah well, all's fair in love and war, as they say. Sorry fellas!

Franklin blockade

But by far the biggest multi-media operation ever to hit Tasmania was the blockade to prevent the building of a dam on the Franklin River. This was not only a national but an international event. It happened back in 1983, long before the days of take-it-with-you satellite earth stations. The scene of the action was on the West Coast and the nearest satellite terminal was in Hobart, two hours flying time away. That meant you would have to be at the airport and away by four o'clock to have any hope of getting your material on air at 6:30.

If we could just satellite the stuff from the west coast somehow, we could gain a couple more hours of coverage time each day. The Hobart TV station and Telecom got together and came up with a grand scheme. There were small broadband telephone links running all around the state, and these were backed up by 'protection channels' that could take over in the event one of the main links failed.

The idea was to connect a string of protection channels together end-to-end, with the west coast terminal point at the Telecom microwave station on a hill outside Queenstown. This would provide a useful television link, although it would promptly disappear if one of the main telephone circuits failed and the protection channel was needed to replace it.

Since the Queenstown installation was unmanned, Telecom arranged for a quick-and-nasty, but very effective, user terminal. We were given a length of RG-59 coaxial cable with a BNC connector on the end, and an audio lead, kept rolled up in a meter-box outside the front door. There was a telephone in the box as well. When we wanted to send our material to Hobart, it was only necessary to roll out the video and audio cables and connect them to the camera's video recorder for playback. We could then ring Hobart and tell them to start recording, and transfer the whole day's action.

The mainland networks, who'd been flying their tapes back to Melbourne every day, heard about our system and wanted part of the action. This was obligingly given, for a price of course.

Every afternoon the interstate news cars would queue up in the Telecom station's compound, waiting until somebody would wave the coaxial cable in the air and shout "Next!". Then one recorder would be moved out, another would be plopped on the ground, and the next transfer would begin.

The camera crews were thankful for the transfer system; it gave them a couple more hours filming time and avoided the danger of their tapes missing the Melbourne flight. But some of the reporters weren't too impressed. "Why should we have to sit out in this God-forsaken place in the wind and teeming rain just to send our stories back?" I guess, being non-technical people, they didn't realize there was no option, other than the plane.

It wasn't long before we realized that the end of the coax could be connected

directly to the camera instead of the recorder. We were then able to send live pictures and sound, although the setting still remained Telecom's front yard. But it WAS from the West Coast, and it WAS live — for the first time ever.

We opened the evening news live from there. We had a crummy old portable TV that could connect to the car battery to receive our own station from a west coast translator. My job was to listen for the news theme on the old TV, and then turn to camera and say "Here on Tasmania's West Coast another 60 people have been arrested in the fourth day of the Franklin Blockade. There goes another car-load now!". And the camera would pan around to see a police paddy-wagon way off in the distance, heading toward Queenstown jail.

This was real intrepid stuff. The wind was howling and the rain was pouring down, and the location was living up perfectly to its reputation for nasty weather. By now the mainlanders were having drinkies in their motel rooms and watching the evening news. They were a bit startled to see, instead of a slick newsreader, a fool in a raincoat showing the world the last of the paddy-wagons coming in at that very moment. And I think they were a little sorry they hadn't thought of it first!

Boat or chopper

News crews never walked during these big operations, or travelled in cars. We travelled by fast boat, or helicopter. The scene of the Franklin blockade was about 80km away from the nearest town of Strahan, over a large harbour and the Gordon river. Whoever got there first in the day usually got the best coverage, before police jacked up about the 'media circus'. So everyone was bidding with the local fishermen to hire the fastest boat. We ended up with a big Shark Cat, with twin 150hp Mercury engines that could cruise easily at 50 knots.

Once at the blockade all the boats would cruise up and down the river, jockeying for position in case something interesting happened. We watched the police, they watched the greenies, the greenies watched us. Everyone would circle around and posture like a pack of dogs spoiling for a fight. When something did happen, the whole place would erupt in a frenzy of action.

You might have seen on television the incident when a barge came chugging up the Gordon River carrying a giant bulldozer. The greenies in their little rubber duckie boats paddled right in front of the barge, daring it to run them down. The police in their boats tried to clear them away, and we in *our* boats tried to move in as close as possible to film the action. It made damn good television, and that day's coverage was shown right around the world.

We'd get back after a day of that, feed our tapes up the link, and then head back to Queenstown, exhausted. After a shower and maybe a quick snooze we'd then head out to sample the small town's nightlife, which was remarkably good. There were several fine eating places, one of which was renowned for having the hottest, most powerful peppered steaks in Australia. You could eat one of these, maybe two if you were really brave, and wash them down with lots of beer as the sweat broke out and ran down your face. Yum!

One day after a particularly heavy peppered-steak-and-beer evening, we hired a helicopter to fly up the full length of the Gordon and Franklin rivers and over the blockade site to get some aerial footage. These helicopter trips over southwest Tasmania are magnificent. You fly over some of the most rugged country in the world, stuff so dense and steep it would take weeks to bushwalk it. The chopper can do the same thing in an hour. But it's a little dangerous — if something goes wrong, there's absolutely nowhere to land.

We were cruising over this wild territory at about 2000 feet when the pilot suddenly threw the helicopter into a tight turn and headed back the way we came. He was sweating something awful, and he hadn't even had any peppered steak. "What's up?" we said.

"The helicopter is on fire..."

And with that the pilot began going through his emergency landing procedure, even though there was nowhere to land. I wasn't really too impressed with this; I'd been in one helicopter crash in Victoria and didn't want to repeat the experience.

Then we knew what the pilot knew. There was a strong smell of burning rubber, and it was getting worse every moment. Perhaps it was better to attempt a landing in the tops of the trees; it was preferable to coming down in a ball of flames. That is considered bad form, particularly in bush fire season. We prepared ourselves for death.

Funny thoughts go through your mind. I was sure I'd dreamt of that smell in bed the night before. A premonition? I was sure the smell was familiar...

And then it all became clear. Strong peppered steaks have a powerful effect on the digestive system, resulting in the generation of foul gasses which must be released from time to time.

A certain member of the helicopter party who shall remain nameless had noted the onset of a bout of this flatulence, left over from the previous night's indulgence. A helicopter is a very noisy machine, and this person was confident he could relieve his distress and nobody would notice. In short, he let one rip. But he forgot all about the smell side of it, and it was only a few seconds before the helicopter was in full emergency mode.

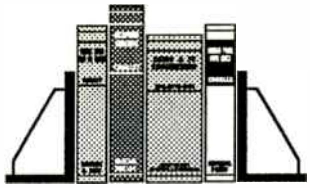
It was necessary to confess to the pilot. "You did WHAT!?"

Yes, I had — sorry! But relief washed over his face, as he restored the helicopter from crash to cruise configuration.

When the guys in the back seat learned they were going to live after all, they brightened up a bit and quickly opened the windows. We were soon headed back toward the Franklin River, but only after a warning from the pilot: Next time you guys have a night on the peppered steaks, you walk!

As I said, you seldom get bored... ❖

NEW BOOKS



Technical maths

MASTERING TECHNICAL MATHEMATICS, by Norman H. Crowhurst. Published by TAB Books, 1992. Soft cover, 230 x 150mm, 493 pages. ISBN 0-8306-6438-6. Recommended retail price $33.95.

Norman Crowhurst wrote his first maths text over 30 years ago. His aim was to teach maths in the way it should be taught — so that the student always understands. There's no doubt his latest book still embodies this approach.

The four main sections of the book cover: arithmetic as an outgrowth of learning to count; introducing algebra, geometry and trigonometry as ways of thinking in mathematics; developing these along with calculus; and using them as analytical methods.

This is a one-stop, comprehensive source of maths instruction, starting from simple counting and ending with differential equations. All through the text the utility of maths is explained, with many illustrations and applications.

What I found interesting was the inclusion of the 'old ways' of doing calculations — my generation was drilled in these efficient, short-cut methods, often without understanding why they worked! These are contrasted with the 'new maths' approach, with its emphasis on understanding the 'why'. He also explains the very simple, repetitive methods used by electronic calculators. Such calculators he sees as a very useful tool in learning mathematics. His emphasis is on being accurate (and checking), with no one method being 'correct'.

A very useful reference for any student of mathematics — from junior high school right up to early tertiary. It shows very clearly the basis of maths, and its logical development, along with its practical application.

The review copy came from McGraw-Hill Australia, 4 Barcoo Street, Roseville East 2069. It is available from technical bookshops. (P.M.)

Analog design

TROUBLESHOOTING ANALOG CIRCUITS, by Robert A. Pease. Published by Butterworth-Heinemann, 1991. Hard covers, 263 x 184mm, 217 pages. ISBN 0-7506-9184-0. Recommended retail price $70.

Bob Pease is one of the world's best known analog circuit designers. He's senior scientist in industrial linear IC design at National Semiconductor, having worked there since 1976 and authored many of the firm's 'classic' application notes. Before that, he spent 14 years as a designer at Philbrick. During his career he has published over 60 articles, and holds more than ten US patents. So Pease really knows his analog circuits.

Back in 1989, the highly respected US magazine *EDN* ran a series of his articles entitled 'Troubleshooting Analog Circuits'. The articles were intended to provide a sound basic insight into analog circuit operation, and thus help new engineers and technicians in tracking down sources of trouble.

The series was incredibly popular — not just because of the down-to-earth knowledge they imparted, but because of Pease's friendly informal style. *EDN* soon collected them together as a reprint, but even this didn't satisfy the demand. So finally Bob Pease himself was encouraged to update and expand upon the original articles, to produce this book.

I read the original articles, and was mighty impressed. They were full of all kinds of sound, practical information on analog circuits and the tricks you often need to get them going. This book seems to have all of the same stuff and more.

In short, I regard it too as a 'classic' in this field, and one that belongs on the reference shelf of anyone involved in analog circuit design — especially those fresh out of uni or college, where this kind of thing doesn't seem to get much attention anymore. But there's lots there for 'experienced' old timers, too...

The review copy came from Butterworths' Australian office, but copies are apparently available at all major and technical bookstores. (J.R.)

Tips for hobbyists

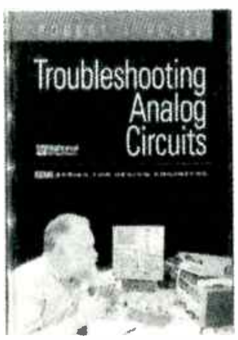
THE ELECTRONIC WORKBENCH, by Delton T. Horn. Published by TAB Books, 1991. Soft cover, 235 x 190mm, 253 pages. ISBN 0-8306-2525-9. Recommended retail price $31.95.

The goal of this book is to provide an overview of general electronic test equipment — to give anyone setting up an electronics workbench a clear idea of what is needed.

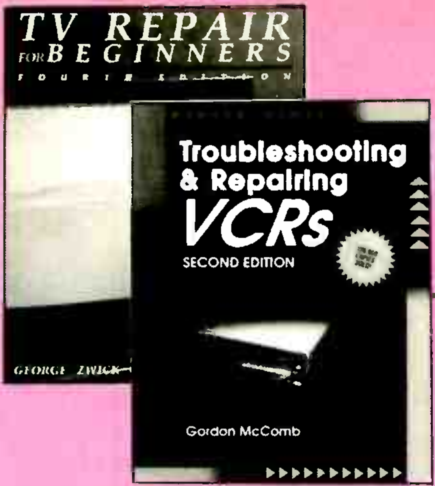
The first two chapters cover the tools needed for a functional workbench, and the techniques needed for soldering and construction. Chapters 3-4 deal with the multimeter and oscilloscope (the longest chapters in the book, as these two instruments account of about 80% of most practical electronic work). Other useful, but less essential, types of test equipment are explained in chapters 5-10; while chapter 11 explores automated test equipment, and computer control and data storage. Chapter 12 deals with the often overlooked aspects of safety.

This book would be very handy for a beginner, because it is practical in nature and does not make any assumptions. Its chapters on using multimeters and oscilloscopes would be valuable for anyone unfamiliar with these instruments.

The review copy came from McGraw-Hill Australia, 4 Barcoo Street, Roseville East 2069. It is available from technical bookshops. (P.M.) ❖



[illegible]



TAB McGraw-Hill NEW & BESTSELLING BOOKS

REPAIR & MAINTENANCE

TV REPAIR FOR BEGINNERS, 4th edn
Zwick 0.8306.2180.6 RRP $37.95
Completely updated and illustrated with schematics and photos, this book makes it easy to find and correct a huge variety of problems, on all types of set. It even guides you on which repairs you can safely do yourself, and which need professional help. 345 pages
BESTSELLER

TROUBLESHOOTING AND REPAIRING SOLID STATE TVs, 2nd edn
Davidson 0.8306.3893.8 RRP $41.95
Packed with examples, photos and diagrams for every kind of circuit, this book will help you pin-point and fix almost any malfunction quickly and easily. Now also covers HDTV, stereo sound circuitry, modular chassis and large screen models. 605 pages 1991

TROUBLESHOOTING AND REPAIRING VCRs, 2nd edn
McComb 0.8306.3777.X RRP $34.95
Gordon McComb explains how to carry out preventative maintenance and supplies flowcharts for faultfinding and repair. He even includes problems not caused by your VCR (e.g. anticopying signals). 412 pages 1991
BESTSELLER

HOME VCR REPAIR ILLUSTRATED
Wilkins 0.8306.3711.7 RRP $37.95
Most VCR problems are caused by one component that is worn, loose, bent or dirty. Save money by doing the repair yourself—you don't need expensive tools or test equipment! Lots of detailed photos illustrate how to find and correct most common VCR problems. 383 pages
BESTSELLER

LENK'S VIDEO HANDBOOK: Operation and Troubleshooting
Lenk 0.8306.4072.X RRP $44.95
Includes chapters on colour and b/w monitors, Beta and VHS VCRs, cameras, camcorders and 8mm, featuring operating procedures, circuit theory, test and adjustment procedures, simplified circuit diagrams and a logical troubleshooting approach. 384 pages 1992
NEW

TROUBLESHOOTING AND REPAIRING CAMCORDERS
Davidson 0.8306.3337.5 RRP $42.95
Discover proven repair techniques for every tape format and major brand of camcorder! This book contains all you need to know about cassette problems, automatic iris, white balance and focus, servo circuits, motors, audio circuits - and much more! 533 pages 1990

TROUBLESHOOTING AND REPAIRING COMPACT DISC PLAYERS
Davidson 0.8306.3107.0 RRP $32.95
All the latest technology used in home, portable and car units is here. Manufacturers provided the literature and schematics used in this book, so you'll be able to repair servo control loops, remote control systems, lenses and laser assemblies, and the rest! 338 pages 1988

TROUBLESHOOTING AND REPAIRING ELECTRONIC MUSIC SYNTHESISERS
Horn 0.8306.3921.7 RRP $28.95
Part 1 deals with common problems in older analogue models, such as noisy, weak or missing output signals. Part 2 looks at modern digital systems, with a whole chapter on MIDI. Horn also shows how to modify or expand your existing system. 206 pages 1992
NEW

TROUBLESHOOTING AND REPAIRING AUDIO EQUIPMENT
Davidson 0.8306.2867.3 RRP $34.95
With scores of illustrations, the repair procedures in this book include probable causes of malfunctions. The book also gives tips on difficult-to-diagnose problems that often occur. Home and car CDs, 'boom-boxes', stereo systems and answering machines are featured. 325 pages 1987

TROUBLESHOOTING AND REPAIRING FAX MACHINES
McComb 0.8306.3778.8 RRP $31.95
A fax machine is a bundle of high-tech circuitry, but most faults are caused by dirty contacts, broken wires, dirty printing elements, worn belts and rollers, and damaged paper. Flowcharts help you diagnose and fix simple and complex problems yourself. 224 pages

TROUBLESHOOTING AND REPAIRING POWER TOOLS
Davidson 0.8306.3347.2 RRP $32.95
Step-by-step procedures for fixing 35 portable, cordless and stationary power tools! This book covers everything: care and maintenance, components, in-depth troubleshooting and repair procedures and special safety considerations for each tool. 243 pages 1990

TROUBLESHOOTING WITH YOUR TRIGGERED-SWEEP OSCILLOSCOPE
Goodman 0.8306.3891.1 RRP $31.95
Oscilloscopes have become far more sophisticated, but they are easier than ever to use—if you know how! This is an invaluable guide to getting the most out of your triggered-sweep oscilloscope, or to choosing one if you're thinking of buying. 309 pages 1992
NEW

TROUBLESHOOTING AND REPAIRING ELECTRONIC CIRCUITS, 2nd edn
Goodman 0.8306.3258.1 RRP $35.95
Block diagrams and schematics help you get it right first time as you use this book to fix circuitry in TVs, remote control units, stereo components and CD players, VCRs and more. 312 pages 1990

PROJECTS & GENERAL

THE ROBOT BUILDERS BONANZA: 99 Inexpensive Robotics Projects
McComb 0.8306.2800.2 RRP $29.95
A complete collection of modules you can mix'n'match to create a huge variety of intelligent and workable robots. You'll find all you need to build a typical robot—body and frame, power and locomotion, arms, eyes and ears, navigation and control. 326 pages 1987
BESTSELLER

HOME REMOTE CONTROL AND AUTOMATION PROJECTS, 2nd edn
Horn 0.8306.2196.2 RRP $31.95
Complete instructions and diagrams for 77 projects. Plans include intruder detectors, flood and temperature alarms and automated lighting. There are also sections on potentiometer ICs, stepper motors, timers and using personal computers for control. 301 pages 1991
BESTSELLER

MASTERING ELECTRONICS MATH, 2nd edn
Phagan 0.8306.3589.0 RRP $32.95
Phagan guides you through the calculations needed to design and troubleshoot circuits and components. Clear explanations and examples illustrate each concept, and there are problems and answers. 330 pages 1992
NEW

MAKE BETTER VIDEOS WITH YOUR CAMCORDER
Thomas 0.8306.2182.2 RRP $24.95
This well-illustrated, easy-to-follow guide will show you basic camera and lens operation, storyboarding and scripting, lighting, sound, directing and editing techniques, how to use graphics, special accessories — and a lot more. 170 pages 1991
BESTSELLER

* All books are softcover.
Prices and availability are subject to change without notice.
RRP = Recommended Retail Price.

MONEY-BACK GUARANTEE - ORDER FORM

Name: ______________________

Company: ______________________

Address: ______________________

______________ P/code: ____________ Ph: ______________

I enclose payment now by: ❑ Cheque ❑ Visa ❑ Bankcard ❑ Mastercard ❑ AMEX

Card Number Signature: ______________________

Expiry Date __/__/__

* If not completely satisfied, books can be returned in resaleable condition within 21 days of date of invoice for a full refund.

Qty	ISBN	Author	Title	RRP$

Postage & Handling	$6.00
TOTAL$	

MAIL or FAX TO: McGraw-Hill Book Company Australia Pty Limited
4 Barcoo Street Roseville NSW 2069 Telephone: (02) 417 4288 Facsimile: (02) 417 5687 92EA07

READER INFO NO. 5

Satellite fax decoder hardware and software:

LISTENING POST WESAT STATION - 2

In the first of these articles we gave an overall view of picture reception from polar orbiting weather satellites. This month we get down to the nitty-gritty: a detailed description of the Listening Post Wesat interface kit and the theory of its somewhat unusual operation. We'll also look at the software which produces full gray-scale or false colour photographs from space, on the screen of an IBM-PC or a Commodore Amiga computer.

by TOM MOFFAT, VK7TM

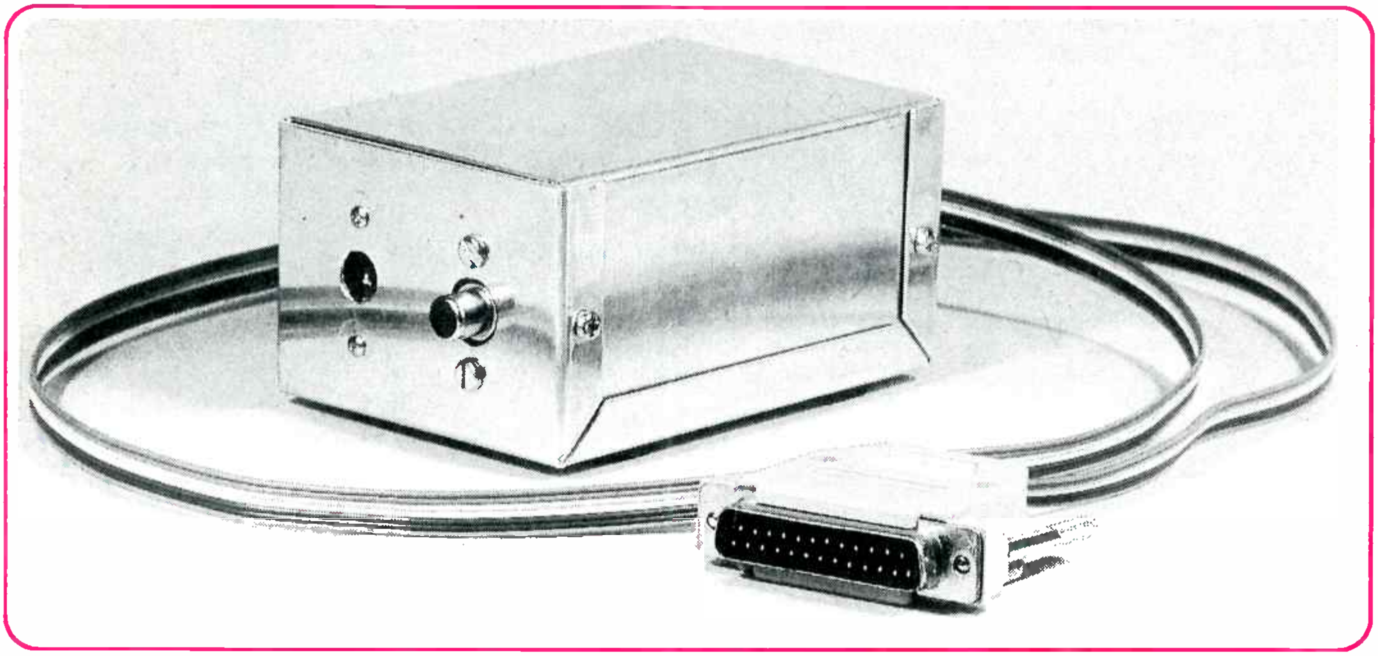
To understand the design of the Listening Post Wesat decoder, we should first look at the traditional method of doing things. The VHF signals from the weather satellites use FM on frequencies between 137 and 138MHz. The satellites' designers made life difficult for us by setting their transmitters for something like +/-15kHz deviation, instead of the 5kHz used by two-way radio services. So a 'normal' communications-type VHF receiver cannot be used, at least in its narrow-FM mode.

You can hear the satellites quite easily, but they sound very muddy and distorted, and correct picture demodulation is impossible.

You are really meant to purchase a special VHF receiver with a bandwidth of 50kHz or so, at considerable expense. This receiver is then fine for satellites, but it's really too wide for communications-grade FM, and too narrow for wideband broadcast-type FM.

It is possible to use a receiver with a 'wide' FM capability to receive weather satellites; but then it's too wide, officially. However there are ways to get around this, which allow the Listening Post Wesat unit to use any receiver that can operate in the 'wide-FM' mode on 137-138MHz. This includes most of the better 'scanner' type VHF receivers.

The audio that comes from the FM receiver is a 2400Hz tone, which is itself modulated in AMPLITUDE with video picture information from the satellite. The video signal also includes synchronising pulses, just like with normal television, as well as telemetry information and some handy gray-scale calibration signals that aid in decoding the pictures. Two lines of picture are transmitted each second, compared with 15,625 lines of normal television a second. The slow satellite line



The author's prototype Wesat decoder was built into a small aluminium utility box. The ribbon cable and DB 25 plug connect to the computer's printer port, while the RCA connector receives the audio from the VHF receiver. Along side the RCA connector is a small coaxial power connector used to accept 12V DC from a plug pack supply.

LISTENING POST

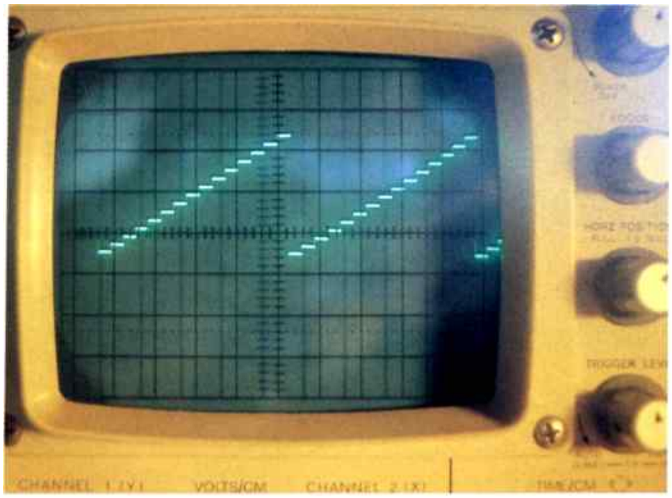


Photo 1: With the simplest kind of analog-to-digital converter, a 'stair-step' signal as shown here is compared with the input — a process that takes considerable time.

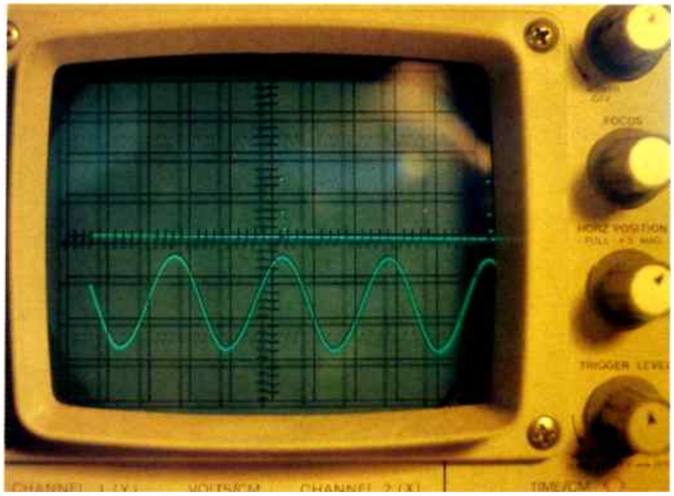


Photo 2: In the author's Wesat decoder, the amplitude of the signal is measured at the very peak of the sine wave. The timing is shown here by the small spike in the top trace.

rate is necessary so that high-definition picture information can be transmitted using an audio tone as a carrier.

To recover the picture information, the audio tone must be demodulated. That is, the video modulation must be stripped from the 2400Hz carrier. The trouble is, the picture itself contains components out to 1200Hz, so it is necessary to let everything up to 1200Hz come through, while totally removing the 2400Hz carrier.

This takes a whopper of a filter; the documentation for the NOAA satellites suggests a seven-pole filter containing four op-amps and numerous high tolerance resistors and capacitors. Such a filter alone would contain more components (and expense) than our entire Listening Post Wesat decoder circuit. One could scrimp on the filter, but then the picture quality would suffer.

There is a feature of all the American NOAA satellites, and the latest series of the Russian Meteor satellites, that lets us solve the demodulator and filter problems in a most direct and elegant way. The picture scanner is LOCKED to the 2400Hz tone, such that each line of modulated picture information contains exactly 1200 cycles of tone (remember two lines a second). With that fact in mind, consider how the Listening Post Wesat decoder achieves full-bandwidth pictures.

How it works

Our decoder circuit contains two main sections that are virtually independent — a phase-locked loop and an analog-to-digital converter. What we don't have is a demodulator filter. In fact we don't even have a demodulator. The phase locked loop, the 4046 IC, has been very carefully designed to latch onto the incoming 2400Hz tone and hang on for dear life. Remember that the amplitude of the tone is swinging madly with picture modulation, but the satellite is designed so that the tone can never go below 10% of maximum. So there is always SOME tone there for the PLL to lock onto.

The PLL has a very tight loop filter and a very slow time constant, set by the big 220uF capacitor (C1). So changes in its VCO frequency are purposely very sluggish. Just about all modulation, and noise, are filtered away here, and the PLL can follow a signal down through fades so deep your ears can't even tell the signal's still there.

The basis of a phase-locked loop is a square-wave oscillator, or VCO, which locks in frequency and phase to a signal fed to the input of the device. A useful characteristic of a phase-locked loop is that its VCO, when locked to an incoming signal, is EXACTLY 90° out of phase with that signal. So when the incoming signal is crossing through zero, the VCO signal is exactly halfway along the top or bottom of its square wave. More importantly, when the VCO square wave changes state, crossing through zero, the incoming audio sine wave is at EXACTLY the top or the bottom of its travel. It just so happens in the 4046 chip that when the VCO makes a high-to-low transition, the incoming sine wave is at its most positive.

Here comes the sneaky bit. If we feed the VCO square wave into a computer, we can arrange for the computer to take a 'snapshot' of the incoming sine wave at the exact peak of each cycle. In other words we have a PEAK DETECTOR — without actually having a 'detector' at all. This is where the second major part of the Wesat decoder comes into play, a 'successive approximation analog-to-digital converter'.

The hardware part of the converter is a 'binary weighted ladder network' of 4.7k resistors (R1 through R13), connected to the outputs of four sections of the 4050 buffer IC. The inputs to the buffers come from the lowest four bits of the computer's eight-bit parallel printer port.

When the input of one of the buffers is raised high by the computer, the output puts +5 volts onto the resistor connected to it. The 'output' of the whole resistor network is where R10 and R13 join with R14. The resistor network is arranged so that each of the data lines from the printer port has exactly half the influence on the ladder network output as the data line preceding it. If the line marked D3 is raised to logical '1', the output of the network will raise to 1/2 the maximum possible. If D2 is raised, the output will rise to 1/4. If D1 is raised, the output will rise to 1/8, and if D0 is raised, the output rises to 1/16.

The data lines can work in combination; that is, raising D3 and D2 together will raise the output to 3/4 maximum. Raising all four input lines will result in 1/2 + 1/4 + 1/8 + 1/16, or 15/16 maximum at the output. All of the inputs low, of course, results in a zero output. So with the four data lines it is possible to set the output to any one of 16 levels, between 0 and 15. Photo 1 shows this concept in action. I programmed the computer to send binary values incrementing over and over between 0 and 15 to the binary ladder network, via the lowest four lines of the printer port. The oscilloscope was connected to the output of the ladder network at the junction of R10, R13, and R14. The result is a 'stair-step' display; as you can see it's very linear and clean as a whistle.

Wesat - 2

Now enter upon the scene the comparator — the LM311 chip, IC3. This simple device has two inputs, and it gives an output indicating whether one input is larger than the other. Any old op-amp can be used as a comparator, but the LM311 was chosen because it can do its job very fast, and in this application speed is important.

The ladder network output is fed to one comparator input via a voltage divider, to bring the levels into the comparator's linear operating range. The 2400Hz sine wave from the satellite is fed to the other input and clamped with germanium diode D1, so that all its excursions are positive with respect to ground — again, to get it within the comparator's linear range.

If the ladder network was running with the stair-step wave of Photo 1, the comparator would send an indication back to the computer (via a printer port status line) when the amplitude of the stair-step wave became greater than the amplitude of the sine wave.

The computer could then look at which number it just sent and say 'That sine wave is 11 units high', or whatever. To be accurate the comparison would have to take place at the exact top of the sine wave. But 'climbing the stairs' takes time, and as well the instantaneous amplitude of the sine wave is always changing.

Here's where the 'successive approximation' part comes in. The stair-step technique would take between one and 16 steps to complete, depending on the amplitude of the sine wave. But there's another system we can use that takes precisely four steps each time.

If we first raise D3 on the ladder network and then look at the comparator, we can find out immediately if the sine wave at that instant is more than, or less than one-half maximum. If it is more, we hold D3 on. If it is less, we drop D3 back down again. Next we try D2.

If D3 had been held on, the comparator would then indicate if the sinewave height was more or less than 3/4. Or if D3 had been dropped again, this test would indicate if the sine wave was more or less than 1/4.

Going along the line to D1, we can then add in 1/8 and see what happens, and finally try D0 for 1/16. If we then look at which previous lines had been held high and which had been dropped, the four of them would form a 4-bit binary number describing the amplitude of the sine wave after four easy steps.

To understand this a little easier, imagine you wanted to find a short circuit in a piece of coaxial cable. If you

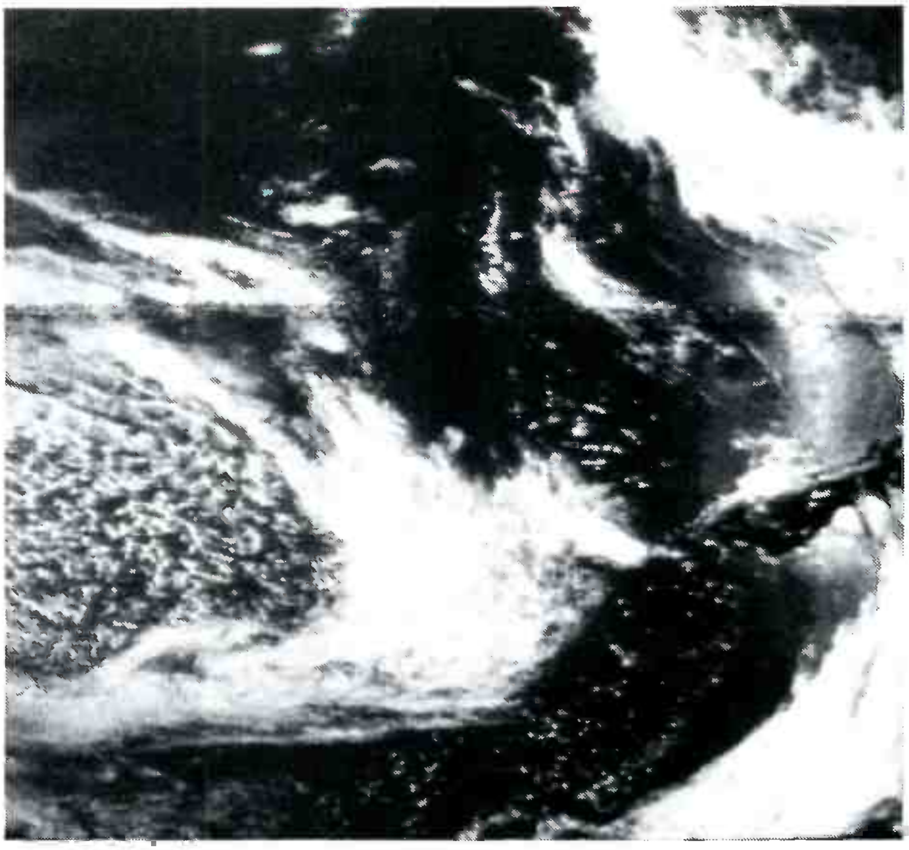
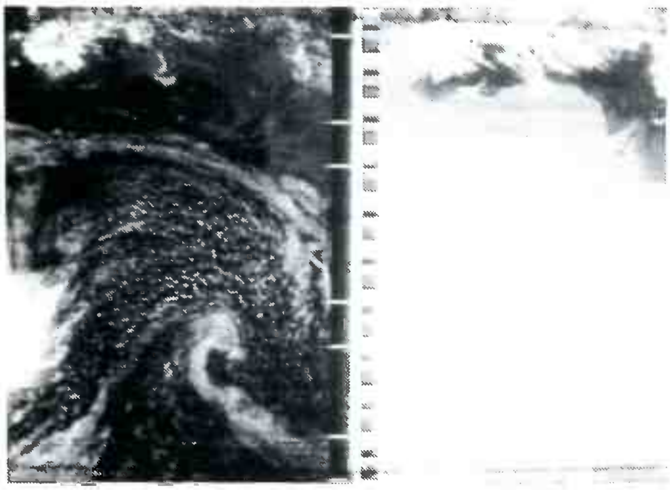
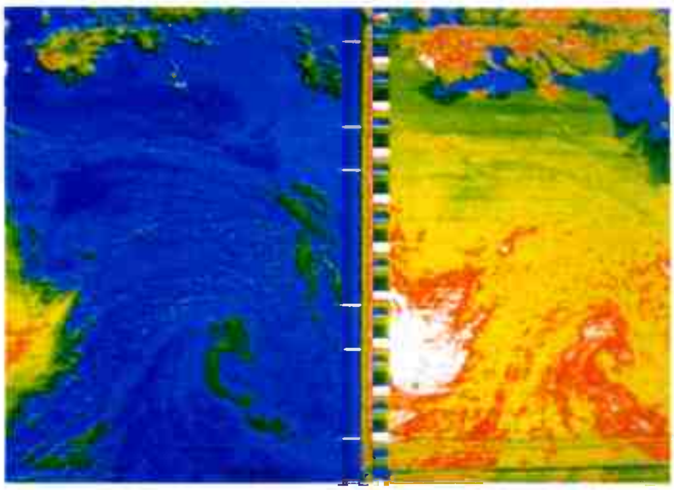


Photo 3: The kind of results you can expect from the Listening Post Wesat system. Here the Sun glints off New Zealand as a front approaches from the west. This picture came from a Meteor satellite.





Photos 3 and 4: A NOAA grey-scale picture of storms brewing south of Australia, compared with a false colour version of the same picture. The visible light image is on the left hand side of each picture, while the right hand side shows the infrared image. Note that the false colour version is more meaningful for the infrared images.

cut the cable in half, and then checked each half, you'd find the short in one of the pieces. If you then cut that piece in half and checked the resulting two halves of it, you'd isolate the short to one-quarter of the cable. If you then cut that section in half you'd isolate the short to one-eighth of the remaining cable. Another chop would finally isolate the short to 1/16 of the cable, after only four steps.

The computer routine that performs the successive approximation has been written in the fastest possible machine code, so the four 'tries' occur in the blink of an eye. The measurement is triggered by the downward edge of the VCO signal, so the sine wave is at its highest, almost stationary while the reading is taking place. In practice the results are very accurate.

Practical computer screens in this day and age do not allow 1200 picture elements (pixels) on each line; most are limited to 640 pixels or at the most 800. So our system takes 600 samples per line, at the top of every SECOND sine wave cycle. Photo 2 shows this taking place. The sine-wave being measured is on the bottom trace, and its 'snapshot' is being taken on the upper trace, right at the top of alternate cycles.

In the event some new graphics system comes along with 1200 pixel horizontal resolution, it would be a simple matter to use the existing Wesat decoder with new software to make use of every cycle, instead of every second cycle. But even with 600 pixels horizontally the picture resolution is very good — far better than a normal 'television' picture.

The only remaining part of the Wesat decoder to look at is the input amplifier, a 741 (IC2), set up as a 'gentle' active filter centred on 2400Hz. This gives some audio roll-off, particularly important for the higher audio frequencies where noise may be a problem. Using the filter lets us use a receiver in wide-FM mode while maintaining a reasonable signal-to-noise ratio in the PLL and A/D converter circuits.

So the Listening Post Wesat doesn't follow conventional practice at all. There is no demodulator and no video filter — but that means there's nothing to restrict the resolution of the recovered pictures. The tradeoff is that impeccable timing is required in the computer software to ensure that

(a) the satellite audio is sampled at the top of the cycle, and that

(b) processing of each sample is completed before it's time to get the next sample.

Software for both the IBM-PC and the Amiga have been written in pure machine code, directly controlling the hardware, to achieve this aim.

Photo 3 illustrates the kind of results you can expect from the Listening Post Wesat system. It's a nice, contrasty 'Meteor' picture of the sun glinting off New Zealand as a front approaches from the west. Note the pair of horizontal lines across the picture, caused by deep signal fades. The phase-locked loop easily held lock through them.

Assembling the kit

Anyone who knows which end of the soldering iron gets hot should be able to put one of the decoder kits together. There is nothing at all critical, no dire warnings other than to do your work as neatly as possible and try not to barbecue any components with too much heat. Be sure to correctly identify all components before beginning, particularly any metal-film resistors which have notoriously difficult markings.

You can now install the resistors in the appropriate places on the board, as shown on the overlay. Try to make the colour codes all run the same way. The diode can go in now too — the correct way around, please. Next you can install the capacitors, having carefully identified them first.

Finally comes the trimpot and then the IC's. Make SURE the IC's are the right way around, with the notches on their ends matching the markings on the overlay. This completes the circuit board proper.

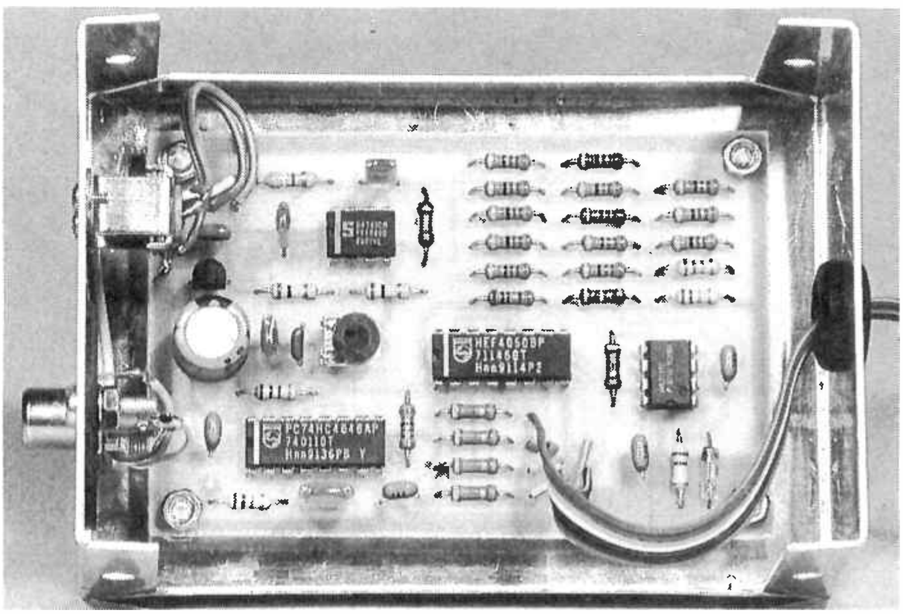
You must next make up the external connections, beginning with the cable from the decoder to the computer. There are seven wires, which all come together neatly on the one area of the board. Connect the 25-pin plug as per the diagram, not forgetting the jumper between pins 10 and 13. Wire an appropriate connector to the AUDIO and GROUND pads, to hook up to your receiver, and connect a nominal 12 volt DC supply to the +12 and GROUND pads. The supply can be a plugpack, as the unit doesn't draw much current, but it MUST be well filtered. Otherwise there may be hum bars in your pictures. If in doubt connect an extra 1000uF electrolytic capacitor across your power supply.

Testing and alignment involves nothing more than setting up the free-running frequency of the VCO to 2400Hz, using the trim pot. When you first apply power the VCO will not start oscillating until it is 'booted' by an external 2400Hz signal. You can feed it a satellite picture from your tape recorder, or 2400Hz from an audio oscillator.

Note that the Wesat audio input is low impedence — 600 ohms or less — so it must be connected to a speaker or earphone connection. As well the recorder's volume control must be in circuit so you can set the white level correctly.

If you connect a small earphone to the test point at the corner of the board you should hear the 2400Hz tone, somewhat faintly. Remove the external signal source and the tone will probably drift higher or lower in pitch.

You should adjust RV1 until the tone pitch remains substantially the same, with or without the external signal connected. This adjustment should be done carefully because it governs how well the PLL tracks during signal fades.



An inside view of the prototype decoder, showing where everything goes. Thanks to Tom's sneaky design, relatively few parts are required.

Wesat - 2

In operation

You must first tape record a satellite picture from a NOAA or Meteor satellite (see below). As this is being written there are four reliable NOAA satellites, and one Meteor that is constantly available. Frequencies are:

NOAA's 9 and 11:	137.62MHz
NOAA's 10 and 12:	137.50MHz
Meteor 3/4:	137.30MHz

Be sure to use wide-FM. The times to look for them can be worked out to the nearest minute or so, using something like the TRAKSAT program described below.

On your earliest attempts you will most likely get something, but don't despair if the signal is weak, noisy, and badly knocked around by local FM and TV transmitters. Methods to combat these problems will be described in the final part of this series. A ground plane antenna will work, but the Lindenblad antenna described next month will give much better results. You will most likely need a preamplifier as well; we'll have some suggestions about this next month too.

You will notice that NOAA and Meteor signals sound very different. NOAA's go 'tick-tock, tick-tock', while Meteors 'honk' like a goose. Their picture characteristics are very different too, so the software contains two versions of the decoding program — named, would you believe, TICKTOCK and GOOSE.

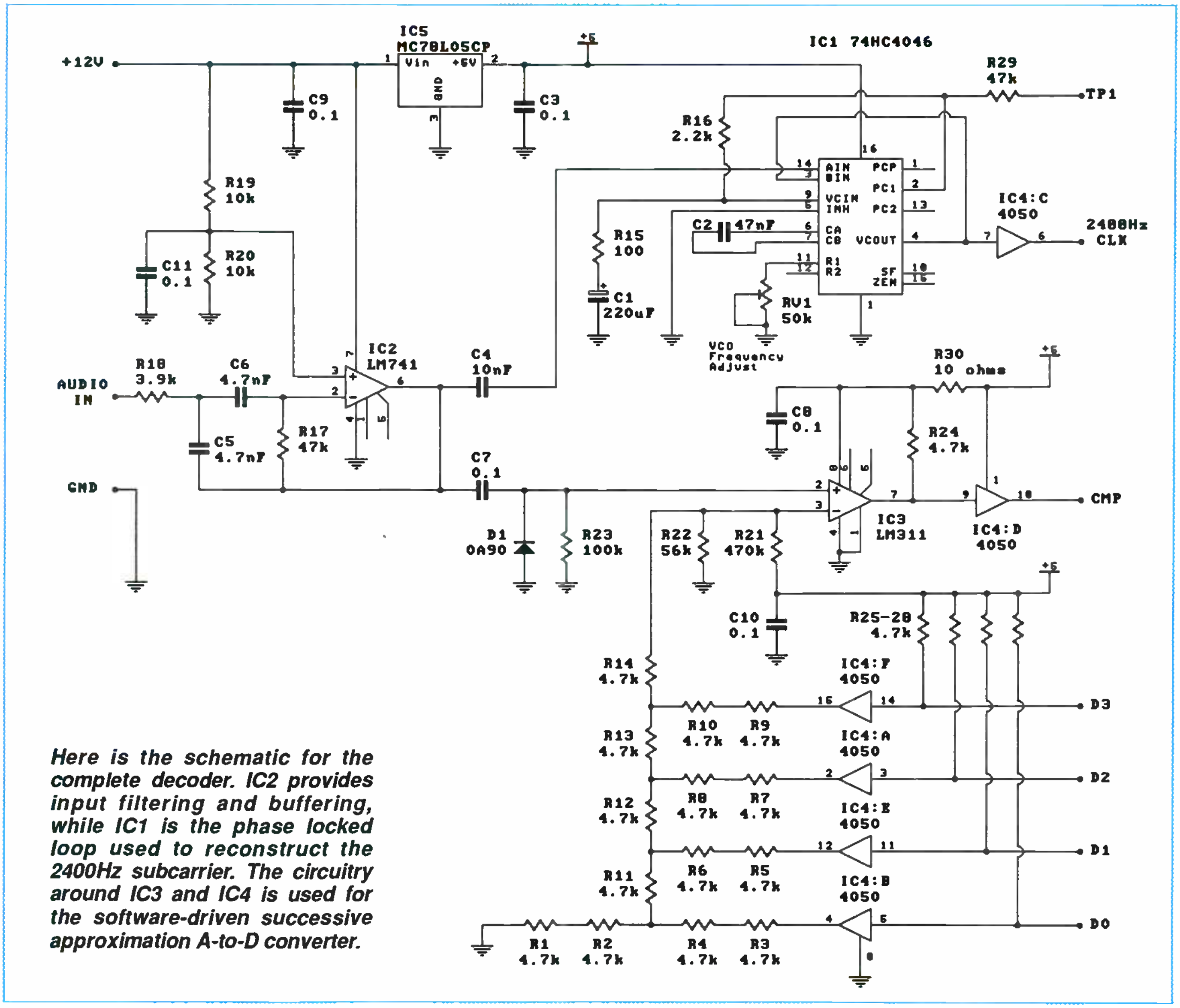
To begin decoding a picture, set the tape recorder to about half volume, connect it to the decoder, and run the appropriate program.

The screen will blank, and there will be a delay before anything happens as the program tries to lock up on the sync pulses at the edge of the picture. Once locked, the picture will appear on the screen line by line.

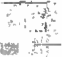
If nothing starts after 30 seconds or so, increase the volume on the recorder. In this case the picture may not be properly 'synced' and you may have to start the tape and the program again, after correctly setting the audio levels.

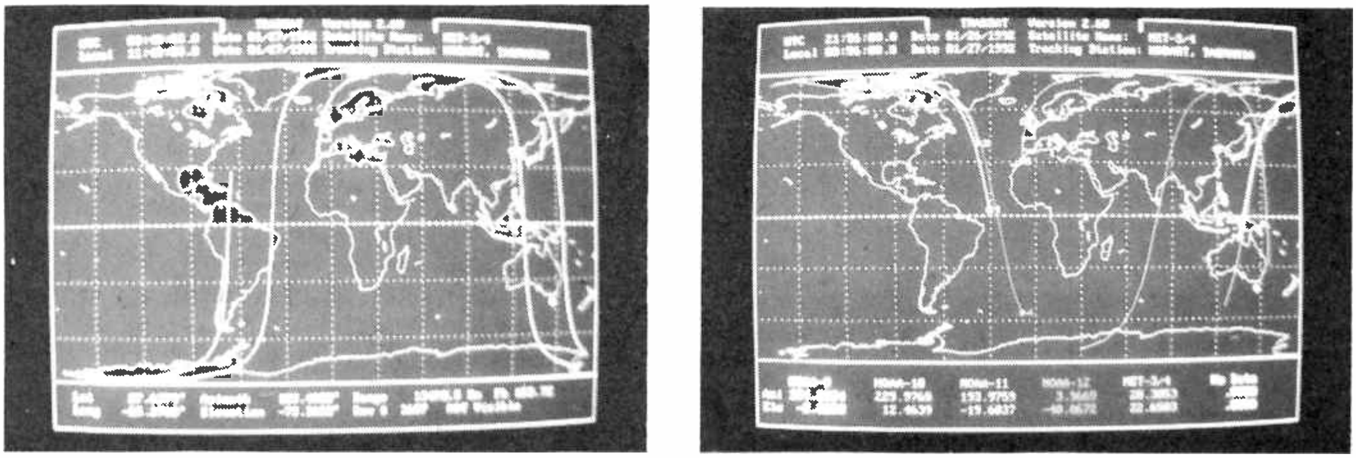
Since the video signal is AM, the amplitude of the output from the recorder determines how bright the image will be on the screen. You must carefully adjust the recorder's volume so that the picture just touches maximum white in its brightest parts. This where the gray-scales become useful. GOOSE pictures have a continuous strip of gray-scale running along next to the sync pulses. TICKTOCKs have small bursts of gray-scale at the picture edges that repeat regularly.

If you press F1 while receiving a pic-



Here is the schematic for the complete decoder. IC2 provides input filtering and buffering, while IC1 is the phase locked loop used to reconstruct the 2400Hz subcarrier. The circuitry around IC3 and IC4 is used for the software-driven successive approximation A-to-D converter.





***Photos 6 and 7:** The Traksat programme can plot the orbit of either one or a number of satellites, against a world map, in the form made familiar by NASA during manned spacecraft flights. It can also print out a list of satellite pass times.*

ture, the system will switch to false colour. This makes it easier to set levels since the only white on the screen represents peak white and all lower levels are gray or colours. With the GOOSE pictures the leftmost gray-scale bar should be white (with a perfect signal), and the others should work their way down through the colours. On NOAA pictures it is convenient to set the audio level so that the fat white bar to the right of the infrared image just becomes white. The rest of the shades will then fall into place.

Once the screen fills, the picture will begin to scroll upward — but it is only out of sight, not out of mind. The picture is still being held in memory and you can scroll up and down through it, once decoding has finished. With the scrolling feature the system should be able to display the l-o-n-gest satellite pass with ease.

While reception is in progress two keys are active. F1 flips back and forth between the gray-scale and false colour display. This allows you to set audio levels easily. The F10 key stops reception and allows you to study the received picture.

While you're in the hold-and-look mode, three keys are active. F1 again flips between colour and gray-scale. F2 turns the picture upside down or rightside up again, just like on the Listening Post II HF weatherfax system. This is handy when the picture is received upside down, which happens when receiving afternoon satellite passes which generally go south-to-north. F10 once again exits, saving the picture on the way.

The SHOW program assumes all pictures have the .PIC extension, so this must be used when renaming pictures. The SHOW program uses the same commands as the decoding programs to toggle false colour, invert, and scroll the pictures. F10 simply exits WITHOUT saving, so there's no way the SHOW program can mess up your picture files. You can keep a copy of SHOW on each diskful of pictures with complete safety.

I personally feel that the gray-scale pictures are aesthetically more pleasing than false colour. The ones from Meteor satellites in particular look like the very best black-and-white prints from photographers like Ansel Adams (see Photo 3). But false colour has its uses, particularly for temperature measurement in the NOAA infrared images.

Photo 4 is a NOAA gray-scale picture of storms brewing south of Australia. Photo 5 is exactly the same picture, displayed in false colour. In the visible side on the left, the gray-scale picture shows the scene as it really looks from space. The false colour version of the visible image doesn't add anything meaningful, it just turns most of the image blue.

But in the infrared image, a dull white mass on the gray-scale version becomes a dramatic indicator of storm activity in false colour. The south coast of Australia is clearly visible as blue, meaning the land there is fairly warm, around +25°C. Things start to cool down a bit south of Spencer Gulf, and the colour has turned to shades of green going into Victoria — indicating temperatures in the 15 - 20°C region.

Further south over the Southern Ocean colours range through the greens, yellows and reds, and through gray to pure white — which is the coldest temperature the system will measure, -75°C. Those clouds at the left probably contain ice, hail, snow, violent winds, and all other kinds of yucky stuff.

Moving back over central Australia, there are cloud buildups with some pretty cold temperatures, maybe -20 or -30°C, even though the ground temperatures are in the high +20's. This is the stuff thunderstorms are made of. There are a couple of white spots, one almost directly over Perth, which indicate cloud temperatures right down to -75°C.

The weather bureau people say these intensely cold thunderstorm formations are fairly common right up into tropical Queensland. They are caused by very hot air masses rising from the ground and being flung high into the atmosphere, where the temperatures are extremely low.

About tape recorders

It is normal practice to tape-record the incoming satellite pictures, which are later played into the interface circuit for decoding. This is because many computers generate RF interference, which ruins the tiny signal from the satellite. Most older receiving schemes needed a stereo tape recorder with one channel to record the satellite audio, and the other to record a tone from a local crystal oscillator which was used as the horizontal reference frequency during decoding.

Since the Listening Post Wesat unit derives its reference frequency from the satellite signal itself, only a single-channel tape recorder is needed, and a small dictation-style cassette recorder does the job nicely. All the satellite photos in this series were recorded on an ancient dictation recorder that should have been thrown out years ago.

A hint about cheap cassette recorders: most of them have automatic volume controls which attempt to turn soft input levels up and loud input levels down. If this AVC is allowed to work on amplitude modulated satellite video signals, it will attempt to push the blacks and whites toward each other, compressing picture contrast. This shows itself as solid black areas drifting toward gray as the picture scans from left to white.


A solution to the problem is to feed the audio from the receiver to the recorder via a voltage divider, so that the recorder's input circuit is just starting to compress when the picture content reaches maximum white. The divider required will be different for every radio/recorder combination.

Software versions

At the moment Listening Post Wesat programs have been written for the IBM-PC with CGA or VGA graphics. The VGA version produces full 16-level gray scale pictures with a resolution of 600 x 480 pixels on the screen, with the ability to scroll up and down beyond that.

The CGA version produces four-colour pictures in 320 x 200 pixel resolution. This is somewhat coarser than the VGA version, but it allows the reception of readable satellite pictures on a CGA laptop aboard a boat or in the field. There is no version for 'pure' EGA, since this mode is unable to produce usable gray-scale images. Both the VGA and CGA software will be included in an IBM-PC version of the kit.

The Amiga version uses 600 x 400 pixel graphics in the interlace scan mode. Because graphics are generated within the computer's main memory area, instead of on a separate graphics card as on the PC, the Amiga is only able to handle three bit-planes while maintaining the incoming picture's timing requirements. Consequently the pictures are eight-level instead of 16-level.

In practice these look just about as good as the VGA pictures on the PC, so good in fact that I considered reducing the PC's pictures to eight-level to try so save some memory space. But in the end I left it as is, mostly because the PC software was finished and I wasn't keen to do it again!

Satellite prediction

There are two ways to capture satellite pictures: wait around for a satellite to come by, or use a computer program to tell you exactly when a particular satellite will arrive.

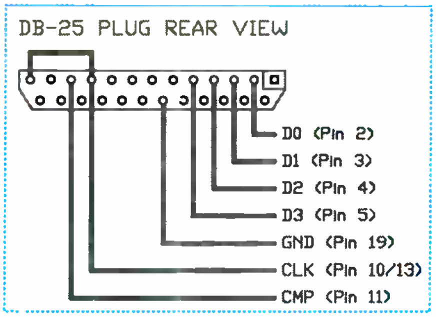
Computer programs use information such as the period of a satellite's orbit, its angle of inclination, and the rate of orbit decay to work out where it will be at any moment. Many of these programs are available, usually via computer bulletin boards. InstaTrak is one popular program, and the one I've been using is called Traksat.

This program can plot the satellite's progress against a world map, in the form made familiar by NASA during manned spacecraft flights. It can follow one satellite, as in Photo 6, or several of your favorite satellites, as in Photo 7. Traksat can also print out a list of satellite pass times, the highest angle they will rise above the horizon, the closest approach distance, and how long the pass will last. Times are given in both GMT and local time. The list can be used as a 'recording schedule' for your weather satellite activities.

Because of the decay factor, the orbital information used by satellite tracking programs is constantly changing, so it becomes inaccurate soon after it is compiled. In practice, a set of orbital elements for polar orbiting weather satellites is good for a month or so before it should be replaced. Fresh sets of elements are available on computer bulletin boards and via amateur packet radio.

The latest information, at least on the two newest NOAA satellites, is transmitted daily on radioteletype by the weather bureau's station AXM. This information can be received and stored as a disk file by owners of the Listening Post II radiofax/RTTY/Morse decoding system. However, the format used, called 'TBUS', is different from the format used by the tracking programs.

The IBM version of Listening Post Wesat includes a program 'TBUS-NASA.EXE' to convert a TBUS file into the NASA format used by the prediction programs. It's hoped to have an Amiga version as well, soon — which all depends on my finding a C language compiler for the Amiga that works instead of crashes!



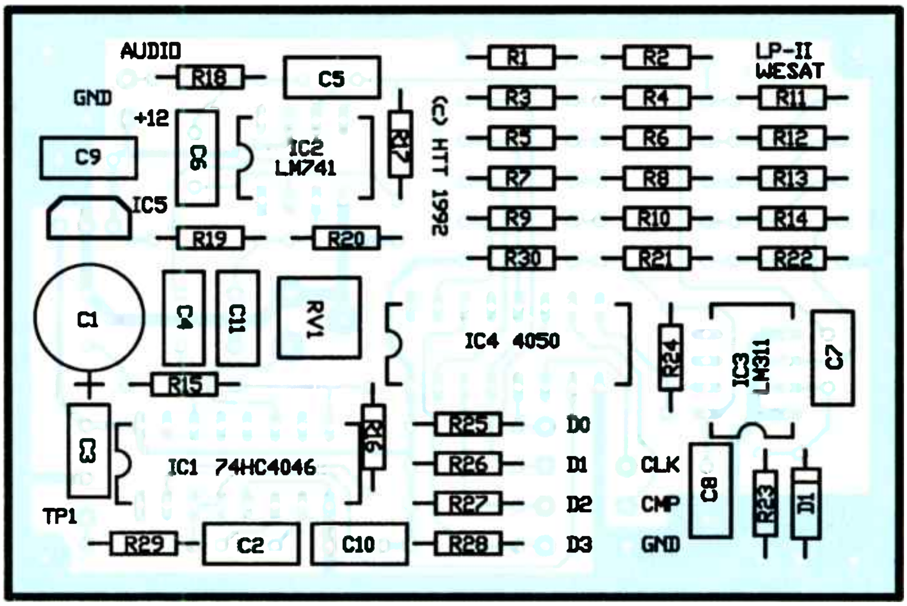
Here are the connections for the DB-25 plug used to connect to the computer's printer port.

Ordering the kit

The final article in this series will deal with the art of receiving VHF signals from the polar orbiting satellites. Starting from the front, we will look at some antenna designs, and describe the construction of a Lindenblad model that's a pretty hot performer. We'll also look at preamplifiers and suggest ways to acquire one. Finally we'll discuss how to optimise your whole system for best performance.

In the meantime, if you'd like to get started, the Listening Post Wesat kit is now available by mail-order only from High-Tech Tasmania, 39 Pillinger Drive, Fern Tree, Tasmania 7054. Please specify which version is required (IBM or Amiga) and include a money order or cheque with the order. The cost is $99 posted in Australia and the South Pacific. The kit includes the PCB and components to make the interface unit, software, and full instructions on disk.

(To be continued) ❖



Using this overlay diagram as a guide, along with the inside shot of the prototype, you should find it quite easy to assemble your own decoder.

[illegible]

OBIAT PTY LTD YOUR ONE STOP DISTRIBUTOR OF TEST & MEASURING INSTRUMENTS

Fluke 10 Series – The only thing Fluke skimped on is the price!

For high performance at the lowest price, get your hands on a Fluke 10 Series...

- New V Chek™ determines continuity/ohms. Most of the time it's the only setting you'll need!
- New Min/Max recording with relative time stamp and Continuity Capture™.
- Autoranging with manual option
- Sleep Mode shuts down automatically.
- Capacitance from 0.001µF to 9999µF.
- Safety to UL1244, IEC1010, CSA and VDE
- Fast and accurate to 600Vac or dc plus ohms to 40MΩ

Fluke 10

4000 count digital display • 1.5% basic Vdc accuracy • Fast continuity beeper • Diode test • Sleep Mode • Two year warranty

$89.00 ex tax
$105.00 inc tax

Fluke 11

Adds V Chek™ • Capacitance 0.001 to 9999µF • 0.9% basic dc volts accuracy

$115.00 ex tax
$134.00 inc tax

Fluke 12

Adds Min/Max recording with relative time stamp • Continuity capture™

$129.00 ex tax
$150.00 inc tax

Fluke 90 Series – 50MHz Bandwidth Digital Storage Scope plus...

- 25MS/s 2 channel digital storage
- 8-bit,25 levels/div vert. resolution
- 10ns/div to 5s/div timebase
- Store 8 waveforms (95 & 97) and 10 set-ups (97)
- Measuring cursors (95 & 97)

...Full 3000 count DMM

- Functions include Min/Max, Touch Hold™, Relative & %, Autoranging etc
- dBm, dBV and dBW (95 & 97)
- 5 Soft Keys/Pop-Up Menus
- 12cm 240x240pixel Super Twisted Nematic LCD screen
- Floating up to 600Vrms
- Optical RS-232 Port (97)
- Low Power (4 hr internal battery)
- Built-In component and baud rate testers and a sine, square and ramp signal generator (97)

Model 93 Basic instrument **$1460 ex tax $1752 inc tax**

Model 95 Adds measuring cursors and recording function **$1895 ex tax $2274 inc tax**

Model 97 Adds waveform and set-up memories, back-lit LCD, generator functions, RS-232 interface **$2350 ex tax $2796 inc tax**

Fluke 80 Series - the most popular Multimeter ever made by Fluke.

The Fluke 80 series is the first multimeter that can be truly called "multi".. it offers not only standard features, but special functions usually limited to dedicated instruments,plus innovations only Fluke can bring you. Like duty cycle measurement; or automatically store the highest, lowest and true average (mean) of readings for a few seconds or up to 36 hours; or record maximums and minimums for days; or the audible MIN MAX Alert™ that beeps for new highs or lows.

- ***Min/Max/Average recording stores highest, lowest and true average of all readings***
- ***Selectable response time to record turn-on surges or drift etc***
- ***1ms peak Min/Max hold on 87 to capture elusive transients or half-sine surges to 400Hz***
- ***Audible Min/Max Alert™ signals readings above or below previous limits***
- ***Splash and dust proof and impact resistant case***

83 **$399* ex tax $466* inc tax**

• Volts, Amps, Ohms, diode test, continuity, frequency and duty cycle, capacitance, Touch Hold™, relative, protective holster • 0.3% basic dc accuracy • 5kHz Vac • Analog bargraph with zoom • 3 year warranty

85 **$480* ex tax $560* inc tax**

• 0.1% accuracy • 20kHz Vac

87 **$580* ex tax $676* inc tax**

• High resolution analog pointer • True rms ac • 1ms peak Min/Max • 4 1/2 digit mode • Back lit display

* *includes FREE Soft Carry Case*

FLUKE
Made in USA

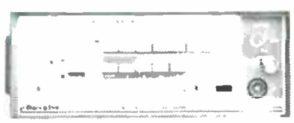
Black Star Video Monitor Tester 1410

• Checks MDA, CGA, EGA, Hercules, PGA, VGA, SVGA, 8514A, XGA and TV formats • Microprocessor controlled • Intelligent alpha-numeric display • Analog RGB, TTL-IRGB, Secondary RGB, Horizontal/Vertical/Composite syncs • Colour Bars, Test Card, Crosshatch, Dots, Ramp, Focus, Horizontal Lines, Vertical Lines, Raster and Checkerboard • Full control over output signals • 15.625 to 48.5kHz Line Frequencies • 49.9 to 87Hz Frame Frequencies • Inverse Video • Separate Analog and TTL Outputs • 1V and 0.7V Video • Easy Connection via 9-way and 15-way 'D' and BNC Connectors ***$1198.00 ex tax $1375.00 inc tax***

'TESTCARD' Easy-to-Use PC Monitor Test Software

• Choice of colours, backgrounds & Test patterns ***$115.00***

Orion PAL TV/Video Pattern Generator



• Tests TV, VCR, Monitors etc • PAL B, D, G, H, I, K • RF, Composite Video and IRGB Outputs • Separate or Mixed Syncs • Trigger Output • Colour Bars, Greyscale, Crosshatch, Dots, Lines, Focus, Purity etc. • Over 50 pattern combinations • 1V or TTL IRGB • 5.5, 6.0 and 6.5MHz Sound Carriers • Internal/External Sound • Mains Operated ***$775 (ex tax) $891 (inc tax)***

FREE 20 page Shortform Catalogue available.

Ask about our Account facilities and special arrangements for Education and Government Departments.

Express delivery throughout Australia and South Pacific

Detailed brochures and specifications available. We are factory trained to advise on your requirements for general purpose Test & Measuring Instruments

OBIAT PTY LTD

129 Queen Street, Beaconsfield P.O.Box 37 Beaconsfield NSW 2014
Tel : (02) 698 4776 Fax : (02) 699 9170

Call us for the name of your local stockist **READER INFO NO. 6**

bankcard VISA MasterCard

When I Think Back...

by Neville Williams

'Smithy' and the Southern Cross - 2
Radio essential for long distance flights

If the epic flights of Sir Charles Kingsford-Smith helped pave the way for today's national and international airlines, they also served to emphasise that reliable two-way radio and direction-finding facilities were not just an option; they were an essential adjunct to pioneering long-distance flights, and would be no less so for future intra- and inter-continental airline services.

Reminiscing in the NZ amateur radio magazine *Break-In* (March 1972) about the first-ever flight across the Pacific, described last month, Tom Clarkson ZL2AZ emphasises the key role played by amateur operators on that occasion. The on-board operator, Jimmy Warner, was himself a licensed amateur.

By way of interest, Tom Clarkson quotes excerpts from the logbook of NZ amateur station 1FQ, for June 4-5th, 1928 — examples of which appear in the accompanying panel.

For Kingsford-Smith and Ulm, the flight was a dream fulfilled against daunting odds. But back in Sydney, having attended to urgent matters and bidden farewell to Warner and Lyon, they faced the inevitable question: What next?

Both were convinced that the time was ripe to establish an Australian national airline. But before committing themselves to such a venture, they were keen to fly from Australia to Britain, thereafter crossing the Atlantic ocean and continental USA to California to become the first aviators to circumnavigate the globe.

At that juncture, however, Keith Anderson complicated matters by suing Smithy in the NSW Supreme Court, to recover expenses which he claimed to have incurred for the Pacific venture on the understanding that he was to be a member of the crew. It was a divisive issue which polarised the press and public and, while Smithy ultimately won the case, it was not a victory which gave him any pleasure.

According to Ward McNally, he met Anderson privately afterwards and insisted that he accept an ex gratia refund of $1000. Anderson reportedly accepted the cheque, with the stated intention of using it as a down payment on a Westland Widgeon aircraft, with which to earn a future living. Christened *Kookaburra*, the Widgeon was to haunt Smithy in the years ahead.

> **TYPICAL MESSAGES:**
>
> Hawaii-Fiji, June 4-5, 1928
>
> 4.55pm QST de KHAB — hr TR 6 p.m. position lat three deg thirty five north longitude one sixty nine and zero eight — sumthing made a sharp turn — banks of heavy cloud — altitude now six thousand smithy still making for altitude first right then left it's a great game dodging these dark clouds — a bit bumpy now.
>
> 5.35pm — hr we still trying to gain altitude to avoid storm clouds motors apparently OK there is our friend the moon peeking over a bank of clouds — our altitude now seventy-eight hundred feet but still clouds above us and all around us — that man Smith deserves credit he's a good pilot — one generator quit only three hours out and no chance to charge both batteries — a nice full moon.
>
> 6.50am hr wil ga for 5 mins on 700 metres pse get QTE QRX nw
>
> 7.30am — hr Southern Cross to westwards of course abt approx position now due north of Suva — Only about five hours at most left speed 75 knots may be able to make it to Suva but yet doubtful QRX.
>
> **(Excerpts from the log of 1FQ, from *Break-In* for March 1972)**

Taking advantage of the delay, Smithy and Ulm decided to set a record for a non-stop flight across Australia. Ignoring bad weather, they took off from the RAAF base at Point Cook, Victoria, reached and circled Adelaide in record time and completed the overall 3200km to Perth to an enthusiastic welcome. On their return, they registered themselves as Australian National Airways.

Then came the idea of flying the Tasman to New Zealand, which both regarded as a logical passenger/mail route for ANA. This was despite the fact that the Tasman was seen as 1425 miles (2300km) of treacherous ocean. To complete the crew, they chose M.A. Litchfield as navigator and T.H. McWilliams as radio operator.

It did indeed prove a hazardous, if ultimately successful, journey with storms and severe icing problems. (Which suggested a reason for the disappearance of Moncrieff and Hood, two young Australians who had previously attempted the crossing.) At the height of the storm, McWilliams reported that he could not contact either Australia or New Zealand by radio.

Following another warm welcome, the Royal New Zealand Air Force undertook to service the *Southern Cross* free of charge, while the fliers toured the country in a borrowed NZ Air Force Bristol. Ironically, while Ulm had proved himself a capable pilot, he was not officially certificated and this, too, was made good under NZ Air Force supervision.

Dark days ahead

Back again in Sydney, the same four-man crew set about preparing for the doubly delayed flight to Britain — one that was to result in a major setback for Smithy and Ulm.

Taking off from the Richmond RAAF base for what promised to be a routine trans-Australia flight to Wyndham, the

When I Think Back...

Fig.1: Smithy with John Stannage (left), one of the two men who found the 'Southern Cross' at 'Coffee Royal'. A Professional marine wireless operator, Stannage also helped guide the plane to a safe landing in Newfoundland. (Picture supplied by the Feature Bureau, John Fairfax & Sons Ltd., Sydney).

plane had been in the air for only half an hour when, taking a bearing on the Sun, Litchfield accidentally bumped the trailing aerial mechanism — causing the spool to unwind and the aerial to disppear into space.

Unable to receive incoming signals, McWilliams requested Smithy to return to Richmond for a replacement. But rather than dump 3000 litres of fuel to permit a safe landing, he decided to press on.

What Smithy didn't know was that the RAAF had just received news that the weather over the red centre had turned foul, and was trying desperately to warn him to return to Richmond to await better conditions. But the message was never received...

As a result, the Southern Cross headed straight into a deadly mix of wind, rain and dust, which coated it with red mud and reduced visibility to occasional glimpses through the windscreen and the prevailing murk.

Finally, unable to establish their whereabouts and with fuel virtually exhausted, Smithy decided to make an emergency landing at the first opportunity — which left the plane intact but bogged in thick mud. Desperate efforts to effect an emergency radio transmission were unsuccessful and, to make matters worse, they searched in vain for emergency rations which the RAAF had put aboard the plane the day before their departure.

Apparently, the food had been pilfered from the unguarded plane during the night by a hungry vagrant. As a result, the crew developed dysentry and headaches from a starvation diet of marsh mussels and coffee made on brackish water — fortified with a dash of brandy and baby food from a parcel destined for a chemist in Wyndham.

Smithy christened it 'Coffee Royal' — a term that was later picked up by the media and used to identify — and ridicule — the whole unfortunate episode!

Meanwhile seven planes based on Wyndham were searching for them in vain — one of them the *Kookaburra*, piloted by Keith Anderson with Bob Hitchcock as navigator. Forced down in the desert, without food or water, both were to die a lonely death before the Widgeon was finally located.

Reputation at stake!

Meanwhile, the rest of Australia was buzzing with allegations, attributed in part to the now-defunct Sydney *Guardian* newspaper and to *Smith's Weekly*.

The emergency was a 'put-up job', it was said, in collaboration with certain major Australian newspapers which had negotiated exclusive rights to the venture through John Ulm. Some even went so far as to suggest that Anderson was in on the deal, destined to become a national hero for finding the lost fliers. The scheme had come tragically unstuck, they reasoned, when he himself had become lost.

The *Southern Cross* was eventually found by pilot Leslie Holden and radio operator John Stannage (Fig.1) in the chartered *Canberra*.

Dragged from the bog and re-fuelled, the *Southern Cross* was flown back to Wyndham by Smithy and thence to Richmond. Once again he was greeted by a large crowd — but this time, they were booing rather than cheering.

I was only a schoolkid at the time, but I recall that to be 'for Smithy' put one in

the same dubious category as a 'teachers' pet'. Perhaps more than any other person I can remember, Smithy became a victim of Australia's infamous 'tall poppy' syndrome, to be honoured more after his death than during his eventful life.

Two days after the *Southern Cross* returned to Sydney, Prime Minister S.M. Bruce ordered a top-level inquiry into the affair by an expert committee — which was certainly not biased in Smithy's favour.

Having considered all points of view, the committee ruled that they could find no convincing evidence that the forced landing had been a hoax. Smithy and his crew were completely cleared, but to their dying day, both he and Ulm suffered at the hands of 'poppy cutters' who preferred their own 'gut feeling' to the verdict of an exhaustive inquiry.

Contemporary comment

Popular Radio & Aviation for May 1, 1929 carried an article by 'the well known radio experimenter' H.J. Asmus FRGS, entitled 'Searching the Air for VMZAB — The lesson of the Southern Cross'. From the context and the cover date, it is almost certain to have been prepared while the aircraft was still missing.

The writer says that he had listened to Warner's transmissions during the original trans-Pacific flight and found most helpful his practice of leaving the carrier run between messages. Receivers could be kept properly tuned to the transmitter and therefore instantly ready to receive the next message.

On the more recent flight, he heard McWilliams' message to VIS in Sydney indicating that the receiving aerial had carried away. Some time later, he heard a copyright message from Ulm for the Melbourne *Herald* and 'Sunflight' Sydney — presumably the Sydney *Sun*.

Throughout the day and into the night, Asmus continued to listen, noting that McWilliams did not normally leave the key down between messages.

For the listener there was therefore no carrier to indicate that the flight was progressing normally. Sometime after midnight he went to bed. Signals were heard again briefly on Sunday morning and then silence.

Asmus says that having personally monitored the plane across the Pacific and most of the way across Australia, he was left in no doubt that two-way radio communication was an essential adjunct to long distance flights.

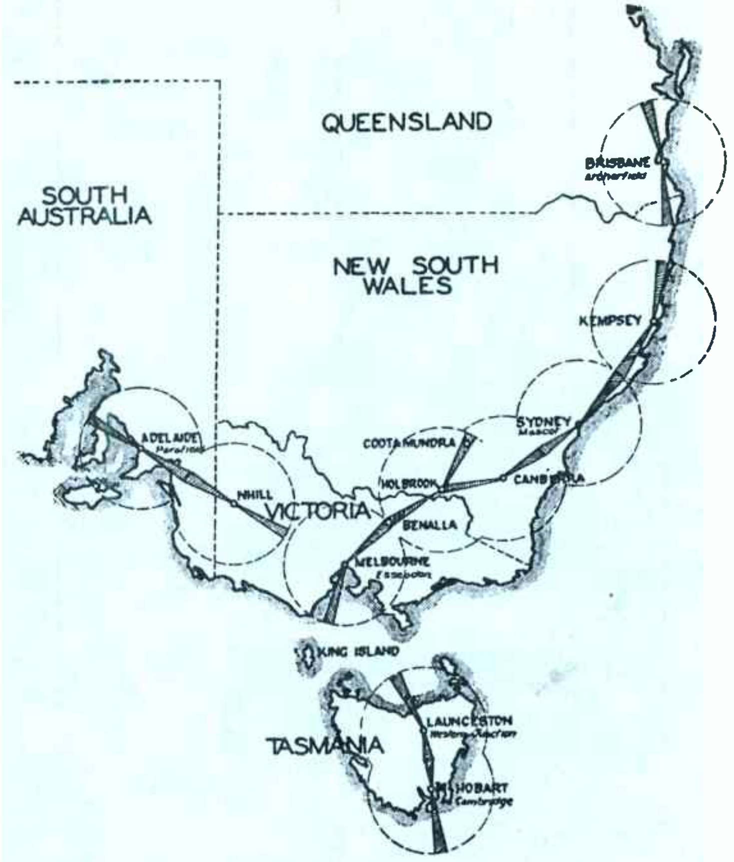


Fig.2: From D.L. Erben's 1938 IRE paper, this map shows the Lorenz type radio beacon system, then in the process of installation by STC to serve the main east coast routes.

The *Southern Cross* should either have been carrying sufficient spares to restore equipment in flight — or have returned to base when communication was impaired. Provision should also have been made for a possible forced landing.

By implication, he added, it was not appropriate either, for planes to have to rely on scattered coastal long-wave stations or even on amateur operators — helpful as they had undoubtedly been.

The Australian Government should immediately set up shortwave communication facilities, along with guidance and direction finding equipment to cope with the needs both of shipping and the coming era of inter- and trans-continental air transport.

In practice, the establishment of a national aeronautical communication and guidance network was much easier for *Popular Radio & Aviation* to suggest than for the government to implement.

As independent hobbyists, amateur radio operators can react to a new technique and assemble functional equipment within a matter of days or weeks.

To devise and install an official national aeradio network was a much more involved process, which could — and did — take years, as I was able to verify from professional radio engineering literature.

From radio engineers

For example, several of the technical papers contributed to the IRE World Radio Convention (Sydney, 1938) had to do with the evolution of Australian aeradio services to that date. One by AWA engineer H.M. Lamb provides useful contemporary comment.

In the paper entitled 'Radio Aids to Navigation', Lamb admits that:

In Australia, the development of aircraft radio services has tended to lag behind air transport itself.

Rightly or wrongly, he claims that this had come about not so much because of tardiness on the part of the authorities, but by reason of the rapidity with which private enterprise had established Australian commercial air services.

According to Lamb, the first dedicated aeradio station to be opened in Australia was set up 'as recently as April, 1935' at Melbourne's Essendon airport, with a

companion station following shortly afterwards at Western Junction in northern Tasmania.

Communication was on 324kHz, with D/F (direction finding) based on a Bellini-Tosi system. The two stations provided a valuable service to planes on the Bass Strait run — their only recourse, before then, having been to the Melbourne coastal radio station.

In another paper, an overview of 'Australian Radio Communication Services', L.A. Hooke (then General Manager of AWA) stated that aircraft providing scheduled services within Australia during calendar 1937 had flown nearly eight million miles (12.8 million km). By the end of that year, at least 24 intra-Australian planes had been fitted with wireless communication equipment, mostly using pilot operated telephony.

The Government's early response, much of it implemented by AWA, had been to arrange for coastal stations around Australia to communicate with aircraft — initially sharing the marine channels.

Over the two years preceding the Convention, facilities had been provided at the capital cities and key intermediate locations to service the internationally recognised aircraft channels on 900 and 930 metres. Most stations had D/F receivers installed by 1938.

The above arrangements offered reasonably good communication over the southern regions of Australia, but atmospheric noise was a major problem in the more northerly latitudes. A back-up service had been made available on 45 metres at Melbourne, Sydney, Brisbane, Darwin and Forrest as an interim measure.

However according to Mr Hooke, the Australian Civil Aviation Board had decided on 115 and 119 metres for normal working, with 45 metres for long distance communication. The 925-metre channel would be retained to provide access for overseas aircraft entering Australian airspace. Said Mr Hooke in April 1938:

Work is now in progress for the erection of a number of modern stations capable of working on these wavelengths.

He also indicated that the Civil Aviation Board had contracted for the installation of a chain of directional beacons operating on nine metres and servicing the major east coast routes.

The system would provide marker approach beacons, but would not extend to a blind landing facility. (This was probably a tender subject for Mr Hooke, as the relevant contract had been let to STC — a major competitor).

Approach beacons

In fact, a separate paper was delivered to the Convention by D.L. Erben, an engineer from C. Lorenz A.G. in Berlin, who had been seconded to Standard Telephones & Cables of Alexandria, NSW. Entitled 'Approach Beacon and Blind Landing', his paper detailed a system of aircraft beacons being currently installed in Australia, operating on nine and 9.05 metres (Fig.2).

In his introduction to the paper, Erben was conservative about the 'state of the art' in which he was involved, particularly in relation to neo-blind landing aids. I quote:

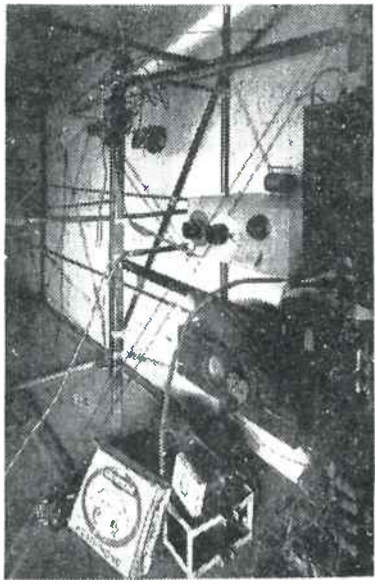


Fig.3: For the Sydney-London-USA flight, the 'Southern Cross' carried professionally built radio equipment, anti-shock mounted in a frame in the after cabinet. (From 'Wireless Weekly' for July 4, 1930.)

When we attempt to apply to the navigation of aeroplanes our existing knowledge of the high frequency field, we must realise that we are within the sphere of the two younger technical fields (radio and aeronautics), and that some of their main aspects are still in a rapid process of development. Therefore we must not expect to solve immediately the problems engendered by the application of high frequency to aerial navigation in a manner which will be satisfactory for all time. But there are hundreds of airlines working to extended schedules throughout the world which are in (urgent) need of improvements to their available radio aids in navigation. The industries concerned are therefore working along parallel lines.

According to Winston Muscio, who was working at STC at the time, Erben was subsequently killed in a road smash during the course of the installation. But by then, STC's own engineers had become sufficiently familiar with it to complete the work.

As if to emphasise that AWA did not lack expertise in this specialised area, a further three papers on radio navigation were presented by AWA engineers D.G. (Don) Lindsay, Dr O.O. Pulley and J.G. (Joe) Reed.

Reflecting on past practice, Don Lindsay pointed out that the mixed vertical/horizontal components from a low frequency trailing aircraft transmitting antenna could falsify the bearing indicated by a D/F loop by as much as 20 - 30° when the aerial was at right angles to the direction of the D/F site. The sense of the error (+ or -) depended on whether the plane was headed from left to right or vice versa.

In a companion paper sub-headed 'Ultra-High Frequency Beacons', Joe Reed (engineer, radio amateur and an active member of the WIA) claimed that AWA had been researching UHF beam technology since 1924. Against that background, he envisaged the way ahead for the aeradio industry.

Such was the situation in Australia in 1938 — the best part of 10 years after Smithy, Ulm and commercial pilots of their generation had had to navigate the hard way — which brings us back to 1929 and our central theme.

Off to London again

His name cleared in the 'Coffee Royal' affair, Smithy and his crew set off in June 1929 for Derby WA, en route to London. Decidely 'underwhelmed' this time around, he was farewelled from Richmond by a comparatively small group of well-wishers.

Fortunately for their peace of mind, the crew received an enthusiastic welcome at Derby, and were hailed by a wildly cheering crowd at Singapore. Apart from minor incidents, the flight to London went smoothly, in the official time of 12 days and 18 hours.

At this point, Anthony Fokker offered to arrange a complete factory overhaul of the *Southern Cross* at no cost. And since there was no special urgency about the Atlantic crossing, the crew returned home by ship, with Smithy and Ulm taking the opportunity to put more time and effort into their fledgling airline. After a few

months, Smithy left Ulm to carry on and headed back to Holland.

There, Anthony Fokker suggested that a Dutch test pilot Ewart van Dyke would make a capable co-pilot for the Atlantic crossing. Smithy completed the crew with Irish navigator Paddy Saul and Australian marine radio operator John Stannage, who happened to be in London at the time, between ships.

The Atlantic flight went smoothly at first, but half-way across they ran into bad weather which blocked all visibility and caused the compasses to malfunction by reason of condensation effects. Fortunately, Stannage was able to obtain directional fixes from shore stations and from ships in the area, and they were able to put down at Harbour Grace in Newfoundland before running out of fuel.

As it happens, our own ancestor *Wireless Weekly* covered the event in its issue for July 4, 1930. According to the article, before leaving Australia the *Southern Cross* had been fitted with a new Heinz and Kaumann transmitter designed to operate on 33.3 and 600 metres.

The receiver had been built by New Systems Telephones, in collaboration with the British General Electric Co. Using plug-in coils, it covered from 18 to 2900 metres and had provision to switch off the final audio stage if not needed.

As shown in Fig.3, the equipment was mounted in a framework in the after cabin of the *Southern Cross*, using elastic shock absorbers to protect the valves from vibration.

It was checked out before leaving Australia by operator McWilliams and a Mr Huckell, who was presumably a radio pioneer by that name well known in the Sydney area around that time. In Britain, the receiver was modified to use 2-volt rather than 4-volt valves.

A small map of Newfoundland in *Wireless Weekly* (Fig.4) shows the radio stations at Belle Isle (beam dotted) and Cape Race, with Harbour Grace in between. Earlier observations about the importance of functional on-board radio equipment are validated by a paragraph in the article:

While the fliers attribute their safety to the many radio devices which were brought into service, the most remarkable thing seems to have been the continued reception in the plane itself; everything depends on that.

Largely because of the intervening distance, along with interference from the American shortwave station WEC, Australian amateurs heard only snippets of the drama, enacted in Morse code. The one exception was Mr J. Duffy of Waverley, Sydney, secretary of Harrington's Radio Club.

Using a 'Super Wasp' receiver, he apparently managed to keep track of the *Southern Cross* throughout the Tuesday night (June 24, 1930) until 4.30am.

The final paragraph in the article may well have been written tongue-in-cheek — *Wireless Weekly* being, by then, a stablemate of the Sydney *Sun*:

The messages which Mr Duffy took down were printed in the 'Daily Guardian' on Wednesday morning.

Arriving in New York on June 26, 1930, they were greeted by the Mayor and a 6km tickertape parade, and taken to meet President Hoover.

There the team split up, with Van Dyke returning to Holland and Saul to Ireland — leaving Smithy and Stannage to complete the full circle to California. But, for Smithy, the end of his round-the-world flight was not to be a time for relaxation.

A few days later, stricken with appendicitis, he had to undergo surgery. While still recuperating, he learned from the papers that no less than four separate airmen were planning to challenge Bert Hinkler's record for a solo London-Australia flight.

London-Darwin solo

It was too much for Smithy. Convinced that the record should be retained by an Australian, he set up arrangements for a personal challenge using an Avro Avian IVA biplane to be called *Southern Cross Junior*.

Taking off from Heston airport in the UK on October 9, 1930, he maintained such a punishing schedule that he overtook the RAF's Lieut. Hill (who had left two days earlier) and reached Darwin in nine days 22 hours — cutting Hinkler's time by one third. The flight had been so meticulously planned and executed that Smithy was once again welcomed home as a genius and a hero.

In the meantime ANA, with a fleet of four tri-motor Avro 10's and a team of outstanding pilots, was setting up regular services between Sydney, Brisbane, Melbourne and Tasmania.

Ironically, Smithy and Ulm had earlier been criticised for selecting a Fokker plane with its distinctly German connotations. Ian Debenham of Sydney's Power House Museum confirms that the British '-10' airliner was a very similar tri-motor high wing monoplane built under licence to Fokker by Avro.

With provision for two pilots and up to 10 passengers, it was fitted with 7-cylinder Lynx radial engines. These were more powerful than the Wright 225hp 'Whirlwinds' on the *Southern Cross*, giving the Avro a speed margin of about 10mph.

No less to the point, Fokker's high wing tri-motor configuration found favour with quite a few of the American airlines being set up at the time, demonstrating the soundness of Smithy's original choice.

The ANA enterprise lasted only a few months, however. This was partly by reason of the great depression and partly because of the loss on March 23, 1931, of the ANA *Southern Cloud* in the Snowy Mountains, with Captain 'Shorty'

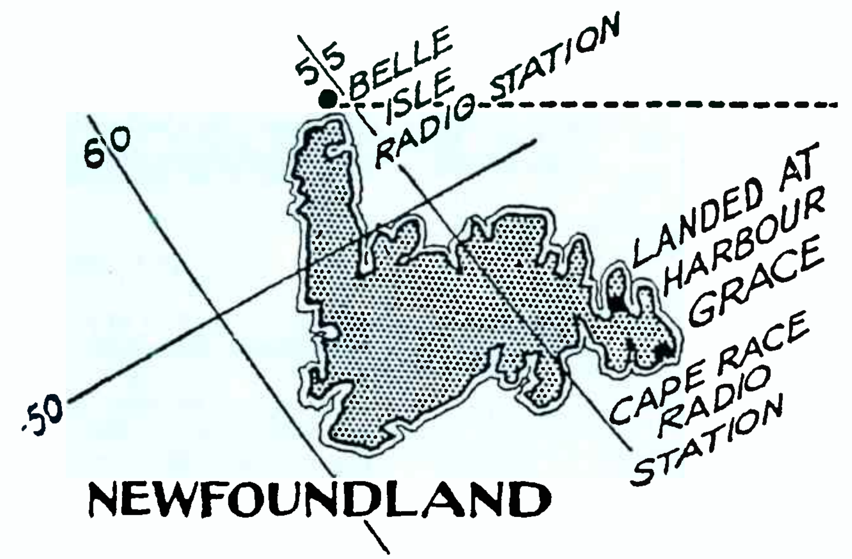


Fig.4: A sketch map of Newfoundland showing the two wireless radio stations which, along with ships in the area, provided critical guidance for the 'Southern Cross' to a landing at Harbour Grace. (Again from Wireless Weekly, July 4 1930.)

Fig.5: The ill-fated 'Southern Cloud' being checked and refuelled at a deserted aerodrome. Although manufactured in the UK by A.V. Roe, its resemblance to the original Fokker 'Southern Cross' is obvious. (Picture supplied by the Feature Bureau, John Fairfax & Sons Ltd., Sydney).

Shortbridge, co-pilot George Dunnell and six passengers. It resulted not from pilot or equipment failure but from late delivery of a message that would have warned 'Shorty' of wild storms over southern NSW.

Once again, the need for reliable on-board communications had been emphasised and the proposition was put to subsequent inquiries that all airliners should, in future, be required to carry effective two-way radio.

During the search there were reports of a tri-motor aircraft having been seen near Melbourne, leading to a theory that the *Southern Cloud* had overflown its destination and come down in the sea. Ironically the plane sighted had probably been another ANA airliner, being used by John Ulm to carry out preliminary tests of radio equipment in conjunction with AWA and General Electric.

In fact, the missing plane was only discovered in October 1958, by a workman from the Snowy Mountains scheme. It had crashed and burned in a depression on a mountainside, with passengers and crew being apparently killed instantly. For all practical purposes, ANA's operation as a passenger-carrying airline died with them.

As it happened, however, the British and Australian governments had been investigating the idea of a regular airmail service between the two countries, with a possible extension to New Zealand. Planning involved a number of overseas flights, including one by Smithy in ANA's Avro-10 *Southern Star* in December 1931 — carrying the first bulk mail delivery from Australia to Britain.

It was widely assumed that the Australian share of the UK mail service would be handled by ANA, but Prime Minister John Scullin directed the franchise be given instead to the fledgling Qantas group under Hudson Fysh, a man who had never flown beyond the borders of his own country.

Political decision?

It was suggested at the time that responsibility for the decision really rested with British PM Ramsay MacDonald. Keen for the UK to be the dominant partner, he felt that this might not be the case if the Australian operation was in the hands of someone with the experience and stature of Charles Kingsford-Smith — ranked by the RAAF as Air Commodore, recognised as the world's most notable long distance flyer and soon to be knighted by King George V.

The choice of Qantas was a body blow to ANA, which had to sell its Avro 10's to clear its debts. Smithy was left with his faithful 'old bus' as his only personal resource — by now fitted out to carry 12-passengers and two pilots.

Once again, he had to earn a living by barnstorming thoughout Australia and New Zealand, offering rides for 'ten bob' a time.

The situation recalled Smithy's retort to the accusations levelled at him following the Coffee Royal affair. He pointed out, and I quote: *that the Southern Cross was his sole means of earning a living, and that he was not likely to risk an aircraft worth £10,000 by playing silly bastards.*

About this time Smithy was offered a position by both Lockheed and Fokker. But although they must have been tempting, he was not finished with either records or Australia.

In October 1933, flying a Percival Gull *Miss Southern Cross*, he overcame extreme in-flight nausea to break Jimmy Mollison's solo UK/Australia record in a new time of six days, 17 hrs and 45 mins.

In August 1934, teamed up with P.G. Taylor, Smithy undertook a series of demonstration flights in a new Lockheed Altair, which he christened *Lady Southern Cross*.

In the process, the pair set new records between the Australian capitals. Then, when engine trouble forced them to abort their entry into the London to Melbourne Centenary Air Race, they headed out over the Pacific again to achieve the first crossing in a northerly direction.

In May 1935, back in Sydney and in the 'old bus', Smithy, Taylor and Stannage headed across the Tasman to New Zealand carrying special Jubilee Airmail. Some 900km out, a cowling failure damaged a propeller, rendering one engine useless. They managed to keep the aircraft airborne by dumping personal effects, then fuel and finally the mail.

When the remaining under-wing engine began to falter under the strain, P.G. Taylor in a display of incredible bravery, climbed five times out onto the struts to recover oil from the useless engine and·

Fig.6: The Lockheed Altair 'Lady Southern Cross' which featured in a number of record breaking flights, but which finally carried Smithy to his death in the Bay of Bengal. (Picture supplied by the Feature Bureau, John Fairfax & Sons Ltd., Sydney).

transfer it to the one that was still serviceable.

Meanwhile Stannage, operating new radio-telephone equipment which had previously been installed, kept the authorities and listeners in both countries informed of the plane's plight. They finally made it back to Mascot, climaxing a real-life radio drama that I still remember — eclipsed only by the unforgettable broadcasts many years later from the surface of the moon.

Sadly, Smithy realised that the 'old bus' had reached the end of its serviceable life. After negotiation with Prime Minister Lyons, it was patched up and flown to Richmond RAAF base for storage as a piece of Australian aviation history. The price, grudgingly offered and tardily paid, was £3000.

The final chapter in Smithy's life was bound up with an attempt to establish a new UK/Australia record in the *Lady Southern Cross.*

Accused of not wanting a new record to be set by an Australian crew in an American plane, the British establishment refused to allow extra tanks to be fitted to the Lockheed — even though they had raised no objection to such installations on earlier, much less powerful British planes.

As it was, Smithy and Tommy Pethybridge decided to fly the plane back to Australia anyway — as much as anything because tardiness of payment by the Australian Government had left them without the wherewithal to return with their plane by ship.

Their journey ended somewhere over the Bay of Bengal, with no radio to alert the waiting world of an impending crisis.

So Smithy passed on, but his imprint remained on Australian aeronautics.

In the year following his death, the initials which had identified Smithy and Ulm's airline, 'ANA', were recycled by another group comprising Holyman Airways, Adelaide Airways and West Australian Airways. It was acquired in 1957 to become Ansett-ANA.

According to Sir Gordon Taylor, Smithy was a perfectionist. QEA (Qantas) the company that inherited Australia's overseas passenger and mail services has built up a similar reputation, proudly carrying the Australian flag across the world.

Smithy demonstrated the wisdom of picking the best plane for the job, politics nowithstanding. Qantas, too, has pursued a policy of maintaining a fleet based on cost-effectiveness rather than country of origin.

As QEA began re-equipping with Lockheed 'Constellations' in 1952, the first was christened *Charles Kingsford-Smith.* Their first 'Super' model in 1954 was called *Southern Constellation.* Then followed *Southern Sky*, *Southern Aurora* and *Southern Zephyr.* The QEA service across the Pacific was publicised as the Southern Cross route.

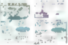
The legacy

Today Qantas' huge home base is sited adjacent to the one-time cow paddock at Mascot, now identified worldwide as Sydney's Kingsford-Smith airport. In Brisbane, his name identifies a scenic drive along the river. Every time we reach for a $20 note, we're faced with his portrait.

In the hundreds of passenger planes that fly in and out of our airports, the uniformed crews are surrounded by a mass of supportive devices and accommodated in a sound-proofed, air-conditioned flight deck, with provision for meals and refreshments as appropriate.

The planes can have access, as necessary, to an array of electronic systems — right through to satellite-based navigation aids which can pin-point their exact position at any time in terms of latitude, longitude and elevation. In some cases, computers even give effect to, and monitor, pilot control and intervene if a manoeuvre trangresses prescribed operational procedures.

How would Smithy and commercial pilots of his day react to the present scene? With interest, gratitude, amazement? Undoubtedly — but perhaps with a touch of concern about the native skill that they were said to have developed based on 'the seat of their pants'! ❖



FORUM

Conducted by Jim Rowe

Compact discs that 'rot', and people who claim to improve your player

As promised, we're continuing with the thorny topic we re-opened last month, concerning products and services which are claimed to improve the performance of your hifi system or components. In particular, we look at the people who claim to effect a dramatic improvement in the performance of a CD player, by replacing some of its components. But we also take a look at a subject of perhaps greater concern to many music lovers: just how long *will* your compact discs last?

Both of the letters that have prompted this month's discussion have been waiting in my bulging 'Forum' file for quite some time now, and before we begin I really must apologise to the readers concerned for the delay in tackling the matters they raise. I hope the wait will turn out to have been worthwhile, folks...

I think the one we'll look at first is that concerning compact disc longevity, because the reader concerned has been waiting longer. He's Mr Paul Proctor, of Whittington in Victoria, and his letter really doesn't need any introduction:

I wish to enter the 'Great CD Debate', on whether or not compact discs will 'last a lifetime'. Before starting, I am only a technical officer with a government organisation, and make no claims to be an expert in the field of compact discs. I have a reasonably large collection of discs, which when not being played are kept in their covers in protective drawers.

You will find enclosed a compact disc I purchased approximately two years ago, and recently tried to play on a portable player connected to a home stereo system. After listening for a short time, the disc started to jump erratically across tracks, and 'drop out' in certain areas.

At first I thought that the disc may need more of a clean than the usual wipe that I give them before playing. A closer inspection revealed what appeared to be small brown 'rust' spots in the aluminium coating, inside the disc itself. When the disc was held up to the light, it became apparent that these were holes completely through the coating in the disc. This same disc played perfectly on the very same player as it is now skipping on, and plays fine on a better quality player (read: higher priced).

When purchasing discs, I normally hold the disc up to a light to check for holes such as these, and admittedly on a few very rare occasions, I have asked for another disc where holes have been found. The disc in question is of German manufacture and to me, the German discs seem thinner and not as robust as the discs that Disctronics manufacture in Australia. Whether or not this has anything to do with the problem I won't enter into, but congratulations to the Australian manufacturer for what I consider to be a 'better' quality disc.

I have enclosed the disc so that you can look at it and make a judgement about the nature of these spots. I would have noticed the spots at time of purchase, and feel they have 'grown' since then. If I am wrong, I'll accept it and just turn the thing into a drinks coaster.

But if it is 'rust', or degradation of some form, is it a one-off? Just a bad batch? Or is it a problem that is going to arise in the future?

Just as a further note, this is not the oldest disc I own. The early discs purchased seem to have no problems such as this one.

As you can see, Mr Proctor has had direct experience of this subject, as opposed to the many 'hearsay' stories that seem to have been cropping up with increasing regularity in the last few years. The disc he sent in for examination carries the Warner Brothers label, and appears to have been pressed by Record Service GmbH in Alsdorf, Germany. It does indeed have a number of small dark 'spots' visible on the playing side, and when you hold it up to the light a much larger number of bright 'pin holes' become visible. In fact from this angle it looks a bit like the southern sky on a clear night — there are spots of light all over the place!

I must say the disc itself doesn't seem especially thin to me; it measures about 1.21mm thick, and many of the discs in my own collection are this thin or even slightly under. But I did notice that apart from the 'pin holes', the disc's reflective *aluminisation* does seem very thin — so thin that when you hold it up to the light, it seems almost transparent...

On the other hand, it seemed to play without any audible problems on both of the CD players I had to hand. Of course these were both a little more sophisticated than many compact portable players, and I suspect that portables probably have less effective error correction.

I don't think there's any doubt that Mr Proctor's disc has some kind of fault, and its aluminisation is gradually eroding away. Presumably it won't be playable even on more elaborate players, in another year or two.

But as Mr Proctor himself asks, how typical is this kind of problem? Is it only an isolated case, or are there serious shortcomings in CD manufacturing technology, which are going to make the real life of our CD's much shorter than we've been led to believe?

Well, from what I can gather it's more than just an isolated problem with the occasional disc. Or at least it *was*, until a year or two ago.

According to British technology writer Barry Fox, writing in a recent issue of *New Scientist* (April 4, 1992), a fairly serious situation occurred in Europe around the middle of 1988. There were reports of fairly significant numbers of discs in which air was able to leak into the aluminisation, causing progressive oxidisation and breakdown.

Apparently urgent meetings of disc manufacturers were called, and the phenomenon closely investigated. It turned

Forum

[illegible]

out that discs which had the aluminisation carried right out to the extreme outer edge were more prone to the problem, due to the likelihood of the protective lacquer being 'scuffed' away near the edge, allowing air and moisture ingress.

According to Barry Fox it was also discovered that some kinds of protective lacquer were more susceptible to etching by the inks used to print the disc labels. In particular, it seems that UV-hardened lacquers were more stable than the kind that are dried using hot air.

I gather that a series of meetings and investigations have taken place since then, and as a result of these there has been a considerable tightening-up of quality control and testing procedures for CD manufacturers. There is now an agreed 'accelerated life testing' procedure, and a system where the European factories test samples of each others' product in turn. The whole QC aspect is now apparently in the process of being drafted as a standard by the IEC, for incorporation into the *Red Book.*

In other words, since 1988 the CD manufacturing industry claims to have solved this kind of problem, and is now very confident that the product it sells has a very long life.

Barry Fox actually quotes a statement from Bert Gall, the General Manager of Optical Systems for Philips in Eindhoven:

"For average manufacturing quality and average use, we can now say that the life of a disc will be more than a thousand years. In the worst case, with the worst manufacture and the worst conditions of use, that life will reduce by a factor of between 20 and 50."

In other words, according to Philips you can now expect a disc life of 20 years as the absolute minimum, with most discs lasting much longer than this. A thousand years sounds an awfully long time, and I wonder how he can really justify such a figure. But even so, it sounds like Philips and the other manufacturers are now pretty sure that most of our CD's are likely to last longer than *our* lifetime, at least!

Laser damage?

Just before we leave the topic of compact disc life, at least for the present, in the last couple of weeks I've heard another theory — from two different sources. This is that supposedly CD's and LaserDiscs only have a lifetime of around 1000 *playings*, because the finely focussed IR laser beam causes slight damage to the internal reflective pits, and this damage slowly accumulates to cause the discs to 'wear out'.

One of the people who told me this suggested that it was supported by the fact that CD's are often warm, when you remove them from the player. He claimed that this showed the disc was indeed being heated by the laser beam, and that even a small rise in overall disc temperature could reflect a much higher rise where the heat was being applied, right at the micropits...

Could there be anything to this theory? Frankly I'm inclined to doubt it.

For a start, CD and LaserDisc players all contain a drive motor, apart from other heat-dissipating components like a power transformer, rectifier diodes and a regulator IC. So the fact that a CD or LaserDisc can be noticeably warm when you remove it from the player isn't really too hard to explain: generally it's just spent about an hour or so inside the player, with those components. In fact the drive motor is usually just below the revolving disc, so convection air currents would probably play a major role in disc heating, it seems to me.

But how much power is in that laser beam, and could it conceivably cause localised heating damage, as a result of being focussed into such a tiny scanning

spot? I doubt if the Philips and Sony engineers responsible for developing the CD system would have overlooked such a basic point, so it sounds unlikely. The scanning laser beam is indeed focussed into a very tiny spot, at the disc's internal reflective surface. Most references I can find quote a diameter of between 1.7 and 2.0um (micrometres), to ensure that it scans only a single track — with a track pitch of around 1.6um. But the beam power being focussed into this area (say 3 x 10^{-12} square metres) is very small, and in any case the disc is spinning quite rapidly in order to achieve the necessary scanning rate of 1.2 - 1.4 metres/second. This means that the beam is only incident on any particular spot on the reflective surface for less than 1.6us (microseconds).

Actual beam power?

As to the actual beam power in a typical player, the references I came across at first were a little confusing. Neville Williams in his book *HIFI: An Introduction* quotes a figure of 5mW for typical laser output, and this figure is also given in Ken Pohlmann's book *Principles of Digital Audio*. But data recently released by Kenwood for their upcoming CD recorders, using compatible CD-WO 'write once' discs with an organic dye layer, suggests that with normal players the incident power is always less than 0.7mW. The same data lists the power for recording on CD-WO discs as from 4 - 8mW, or about 10 times that of the playback power level.

I decided to go to Philips, to see if they could resolve this apparent confusion. After all, if anyone should know the official specification of CD's, it would be Philips. And local Philips expert Theo Laris was certainly able to help: he confirmed that the specified maximum laser power for reading CD's is indeed 0.7mW. Kenwood's range of 4 - 8mW for recording is also correct, too.

So it looks as if with a normal CD in a normal player, we have an incident beam power of less than 0.7mW. And although it's concentrated into an area of only 3 x 10^{-12} square metres, giving a relatively high power *density* (0.23 x 10^9W/m^2), this only occurs at any particular spot on the disc's aluminium layer for less than 1.6us. And considering that a high proportion of this radiation will be reflected straight back from whence it came, that doesn't sound to me like a situation where the aluminium layer is likely to be significantly degraded, cumulatively or otherwise. But perhaps I'm wrong. If so, I hope someone with more information will set the record straight.

Improving players

Now let's look at that other letter that has been waiting in my file for so long — the one about firms who claim to be able to improve the performance from a CD player, by replacing some of its components. The letter concerned comes from a reader in a northern suburb of Sydney, who supplied his full name and address but has asked for it not to be published. Here's what he wrote:

An article in AUSTRALIAN HI-FI (March 1991) caught my interest, because it claimed that the performance of many CD players is degraded because manufacturers use unsuitable components (capacitors and resistors) and inadequate design in the analogue amplifier stage of the player. A copy of the article is enclosed.

I decided to follow this up, even though I was a little surprised that the manufacturers would compromise performance to such an extent for the sake of a few cents. (I acknowledge the fact of carefully executed cost minimisation procedures.) I wrote to the author of the article, and a copy of his reply is enclosed.

The subject came up again when I was at a hi-fi shop, the manager of which I have found helpful and down-to-earth in the past. He mentioned a conversion for the Technics SL-PS70 CD player (which reviewed very well in EA's Challis Report, during 1990), in which the analogue amplifier was totally replaced, together with a separate power supply for this amplifier. The cost of this conversion was $700, and the performance was supposed to match top-line CD players in the $10,000 - $20,000 bracket.

I was told that Technics had withdrawn the SL-PS70 (after a relatively short model life) and that its D/A converter (?) was not available to any other manufacturers but is now reserved for use in future top-line players, because of its excellence. This story could be interpreted as confirmation of the benefits of the conversions mentioned above.

As you will see from Mr Werchola's letter, the performance claims are all subjective. I would appreciate your opinion on the truth of such claims — do they have a sound technical basis? If so, why don't the manufacturers include these basically low cost improvements in the first place?

What is the situation with your amplifier designs, such as the Playmaster 60/60? Can these be audibly improved by a similar approach?

I haven't been able to compare a converted player with the standard unit yet, but when I think about it, the whole situation seems like the old 'snake oil' approach — great claims, high cost and perhaps little benefit.

The component cost of the alterations, even for a new analogue amplifier and power supply, is likely to be quite low, and it appears to be a case of 'paying for what we know, not for what we do'.

Perhaps EA could publish a suitable, widely applicable design?

So that's our correspondent's quandary. The article he encloses is titled 'Modifying Your Compact Disc Player', and the author is a John Werchola. In the article Mr Werchola discusses perceived shortcomings in the analog circuitry found in certain CD players (particularly those using, or derived from the circuitry of earlier Philips players), and discusses ways to remedy these in order to achieve what he describes as 'more detail, greater dynamics and the overwhelming experience of re-discovering the true sound of your CD collection'.

Modification service

At the end of the article he also offers a modification service, for any readers who wish to have it done for them — perhaps because they're not confident about performing the required 'surgery' themselves.

The letter Mr Werchola sent to our correspondent is along much the same lines, but goes into greater detail about the results he claims to have achieved by modifying various models of CD player.

In both cases there are really no objective measurements to support the claims of improved performance; only a fairly liberal use of adjectives. Typical examples are 'the veiling characteristic normally found is lifted', 'the music flows better', and 'a more realistic re-creation of concert-hall space in which instruments are clearly discernible'.

I have to confess that this highly subjective approach, coupled with the author's endorsement of products such as disc dampers, 'magic green pens' and exotic interconnecting cables, made me pretty skeptical of the whole article. Like our correspondent, I also find it hard to believe that if the performance of many standard CD players could be improved significantly simply by replacing a few resistors, capacitors and op-amp chips with higher quality components, the manufacturers themselves wouldn't have done so. Not necessarily on their bottom-end players, of course (where minimum

cost is paramount), but surely on their mid-range and high-end models?

In fairness to Mr Werchola, though, I tried reading his article carefully to see if the technical side of his discussion of CD player shortcomings — and the offered solutions — made reasonable sense. I also asked Technical Editor Rob Evans to do the same, and we compared notes.

Earlier article

In the process, Rob was reminded of a somewhat similar article that had been published a year or so earlier, in the British magazine *Electronics and Wireless World*. We looked it up, finding it in the May 1990 issue. Written by a Ben Duncan, it was entitled 'Improved CD Electronics', and did indeed argue along very similar lines.

The main difference is that Duncan goes rather more deeply into a technical analysis of player shortcomings, and offers modifications that go rather further than those described in Werchola's article (although it seems that Werchola does make similar 'more extensive' mods, if customers wish).

But like Werchola, Duncan also doesn't really offer any hard evidence of the improvements to performance provided by his modifications. He too falls back on a somewhat subjective and airy-fairy summary:

The upgrade circuit presented here has developed over four years and has already been tested by over 200 audiophiles, many of them professionally involved in audio. The most upmarket oversampled CD players (e.g. Sony's 337-ESD) have benefited no less than the humblest Philips or Marantz. There has been a distinct consensus on what the improvements to sonic quality are: there is none of the stridency and 'metallicity' associated with bad CD players; the sound is more 'open'; it is much easier for the ear to focus on specific instruments; and most of all, it is possible to listen for long periods without the fatigue or boredom that is the hallmark of poorly executed audio.

Even if classic steady-state analysis of audio signals fails to see the difference, the results are very real and also make sense in the bigger chaotic and statistical scheme of things.

Now perhaps the improvements offered by these modifications *are* relatively subtle, and easier to hear than to measure using currently available instruments. But when their protagonists start falling back into this kind of pseudo-technical waffle, well laced with impressive jargon, it's hard not to smell at least a faint whiff of snake oil.

By the way, Duncan's article also refers to earlier articles by himself and others, on the same general topic of enhancing CD player performance by modifying the analog output and power supply circuitry.

On the whole, though, both Duncan and to a lesser extent Werchola seem to provide some evidence that at least from a theoretical point of view, *some* CD players — particularly some of the earlier models — may have a few shortcomings in their analog section, and could conceivably respond to a few not-too-drastic (in relative terms) substitutions and other modifications.

What shortcomings?

What sort of shortcomings are they talking about? Well, things like the output from the DAC in earlier players having an effective DC offset, so that the following op-amps are not swung evenly about the mid-supply point; supposedly inadequate filtering provided for the DC bias used to correct this imbalance, in later players; supposed interaction between the two halves of dual op-amp devices like the frequently-used NE5532, and general 'weaknesses' in

other areas of this device's performance; distortion supposedly introduced by electrolytic coupling capacitors, either because of inherent limitations or inadequate applied biasing; supposedly inadequate power supply filtering, which allows noise from the digital section of the player to creep into the analog output signals; and distortion supposedly introduced by the use of bipolar and JFET devices for de-emphasis switching and signal muting.

Compromises inevitable

As you have probably gathered from this, there's a certain amount of technical plausibility in each claim. Most electronic components and circuit configurations have their limitations, and there's almost always a way to get around at least some of these limitations — if you're prepared to go to the necessary trouble and expense. The fact is that in most practical situations, you have to stop at some point and say 'right, that's a good compromise between price and performance'.

I guess it's inevitable that there will always be arguments about where that kind of compromise is drawn. Some people will be happy with relatively modest performance, providing the price is right; others (probably most) will want somewhat better performance, but still at the best possible price; while others are prepared to pay almost any price, in a search for what they perceive as 'perfection'. No doubt that's why there's a huge range in models and prices, not just in CD players but in all kinds of product — from electric toasters to motor cars.

So in the case of CD players and the above claims, it's certainly possible that the performance of some of the circuit areas concerned might be capable of improvement, at least theoretically, if one is prepared to go to the necessary trouble and expense. But are the results likely to be worth the effort? That's the crucial question, I suspect, and inevitably different people are going to give different answers...

The fact that neither Duncan nor Werchola can really provide any hard objective evidence of performance improvements suggests to me that the improvements achievable are basically pretty subtle. And I'm not too surprised at that, because let's face it: considering the average hifi system overall, the CD player is really one of the *best* links in the chain. The performance of even fairly modest CD players is already much better, in relatively easy to measure objective terms, than 'weak links' like the speaker system.

So it stands to reason that modifications to a CD player, even if they're based on sound theory, are unlikely to achieve much in the way of dramatic and audible improvement — let alone results that are measureable. If you want this kind of dramatic benefit, it's always going to be a better proposition tackling improvements in things like the speaker system.

At this stage I can almost hear the objections of the platinum-eared brigade, which are by now probably reaching fever pitch. What if you have already invested in the best available speaker system, they'll be saying, and your amplifier and other system components are already of a very high quality — and yet you *really can* still hear an edginess on CD's? Won't these modifications *then* be likely to produce a small but audible improvement?

Perhaps so; but it's hard to say. Obviously people like John Werchola and Ben Duncan will say yes. You'll get the same answer, I expect, from people who have invested either money or effort to have these kind of modifications done. After all, if you can't hear the improvement, that's tantamount to admitting that you either have cloth ears, or you've been conned into wasting your money. No-one likes to admit to either.

Just a con?

Am I saying, then, that it is all just another con job, with benefits that are purely in the ear of the beholder? No, not really. What I *am* saying is that this kind of thing is currently in a kind of technical 'grey area', where theory and snake oil and a certain amount of self-deception are often mixed up in a way that's surprisingly hard to untangle.

I don't know if this helps our shy correspondent who raised the subject, but it's about the best I can do.

If you ask me directly whether I'd be bothered to modify my own CD players along the same lines, I have to say no. On a personal basis, I'd far prefer to put the effort and/or money in improving my speaker systems...

Well, that's about all we have space for this month, so I'd better draw things to a close. I hope you'll join me again next time, because there's no shortage of interesting topics to discuss — including more on dubious products, and dangers from various kinds of radiation. ❖

[illegible]

CHEAP BULK DISK PRICES!

5.25" from 35¢ — 3.5" from 60¢

NO BRAND DISKS

ALL DISKS INCLUDE WRITE PROTECTS & ENVELOPES
BOXES OF TEN DISKS — LIFETIME WARRANTY

	1-9+	10+	50+	100+	500+
5 1/4" DS/DD	$4.50	$4.40	$4.30	$3.25	$3.50
5 1/4" DS/HD	$8.50	$8.25	$8.10	$7.50	$6.60
3 1/2" DS/DD	$7.90	$7.70	$7.50	$7.00	$6.00
3 1/2" DS/HD	$14.95	$13.75	$13.50	$12.00	$10.00

MEMOREX DISKS

	1-9 boxes	10+
3 1/2"DD	$19.95	$18.95
3 1/2"HD	$45.95	$42.95
5 1/4"DD	$14.95	$12.95
5 1/4"HD	$23.95	$22.95

VERBATIM DATALIFE

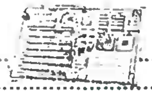
	1-9 boxes	10+
3 1/2"DD	$23.95	$22.95
3 1/2"HD	$44.50	$42.50
5 1/4"DD	$17.95	$16.95
5 1/4"HD	$24.95	$22.95

VERBATIM VALUELIFE

	1-9 boxes	10+
3 1/2"DD	$21.95	$19.95
3 1/2"HD	$39.95	$37.95
5 1/4"DD	$11.95	$10.95
5 1/4"HD	$18.95	$16.95

NEW CATALOGUE OUT NOW!

MOTHERBOARDS



286-16/21	$129.00
386SX-16	$230.00
386SX-25/31	$295.00
386-25	$495.00
386-33 64K CACHE	$545.00
386-33 WITH 128K CACHE	$595.00
486SX-20	$795.00
486-33 256K CACHE	$1195.00

HARD DRIVE SPECIALS

Prices are without paddle cards

52M QUANTAM DRIVE	$495.00
85M HD 17ms ACCESS VOICE COIL 2 YEAR WARRANTY	$495.00
105M HD 19ms ACCESS	$595.00
126M HD 16ms ACCESS VOICE COIL 2 YEAR WARRANTY	$695.00
180M HD 2 YEAR WARRANTY	$995.00
200M HD 12ms ACCESS VOICE COIL 2 YEAR WARRANTY	$1095.00

SUPA VGA COLOUR MONITOR 3 YEAR WARRANTY

This stylish & reliable monitor has been designed for Australian conditions and comes with a 3 year warranty.
Specs: CTR: 14" 90° delection, dark tint, non glare.
Display Size: 245+/5mm x 180+/-5mm x 180+/-5mm
Resolution: (max): 1024 x 768
Dot Pitch: 0.28" $469.00

IBM* CARDS

XT HD CONTROLLER	$129
AT HD CONTROLLER	$149
RS232/SERIAL CLOCK	$49
MONO COLOUR CARD	$76
MULTI I/O CARD	$99
PRINTER CARD	$29
EGA CARD	$179
DIAGNOSTIC CARD	$795
TTL PRINTER	$89
6M AT EX/EXP	$325
FAX CARD	$595
4PORT SERIAL CARD	$199
2 WAY FDD CONT (360)	$39
RS/232 SERIAL CARD	$39
GAMES CARD	$29
AT S/P/G 2 S/P/G	$49
4 WAY CONTROLLER (360-1.44M)	$129
2 WAY FDD CONTROLLER (360-1.44M)	$89
CLOCK CARD	$39
SMART DRIVE ADAPTOR IDE/FDC	$49
SMART DRIVE ADAPTOR IDE I/O FDC	$89
512K/576K RAM CARD	$99
VGA CARD 16 BIT 250K	$89
VGA CARD 16 BIT 512K	$129
VGA CARD 16 BIT (1MEG)	$199

NEW SUPA QUICKSHOT JOYSTICKS

AVIATOR 5

Authentic Aircraft control yoke
- Automatic centering
- 4 positive reponse buttons
- 6 Foot cable with 15 Pin connector.
- Suction Cups

C14250......................$89.95

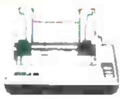
INTRUDER 5

- Omnidirectional Grip
- Compatible with IBM PC, XT, AT and 386. Automatic Centering
- 2 Positive Response Fire Buttons
- Pop-up Fire Button Cover
- 6 Foot cable

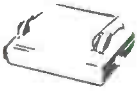
C14240........................$79.95

386 & 486 systems need an additional games card...$49.00

SAVE ON OUR GREAT RANGE OF EPSON PRINTERS



LX-400 80 Col, 9 Pin Dot Matrix, 180 Cps Draft 30 Cps NLQ, Pull Tractor
C22054..................$249

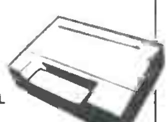


LX-850 80 Col, 9 Pin Dot Matrix, 240 Cps Draft 48 Cps NLQ, Push Tractor, Smart Park Feature
C22074..................$365

FX-850 80 Col, 9 Pin Dot Matrix, 264 Cps Draft 54 Cps NLQ Push Tractor Smart Park Feature
.... $750

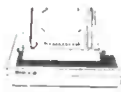
FX-1050 136 Col, 9 Pin Dot Matrix, 264 Cps Draft, 54 Cps NLQ, Push Tractor, Smart Park Feature.
..................$925

SQ-850 80 Col, 24 Nozzel ink jet, 600 Cps Draft, 198 Cps LQ, Push Tractor, Smart Park Feature
.... $1,225

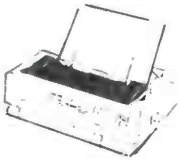


LQ-200 80 Col, 24 Pin Dot Matrix 200 Cps Draft, 72 LQ, Friction paper feed, 6 resident fonts, Very compact
C22070..............................$475

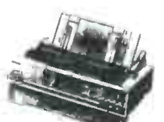
SQ-2550 80 Col, 24 Nozzel ink jet, 600 Cps Draft, 198 Cps LQ, Push Tractor, Smart Park Feature,
................................$1995



LQ-400 80 Col, 24 Pin Dot Matrix, 180 Cps Draft, 60 NLQ Pull Tractor
C22070..................$439



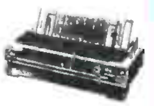
LQ-570 80 Col, 24 Pin Dot Matrix, 252 Cps Draft, 84 Cps, NLQ Scalable Fonts 8 to 32 points, 11 LQ Fonts 360 x 360 DPI, Top, Rear, Bottom and Front paper feed paths, Convertable Push/Pull Tractor.
................................$575



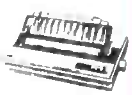
LQ-870 80 Col, 24 Pin Dot Matrix,330 Cps Draft, 110 Cps NLQ, Scalable Fonts, 8 to 32 points, 11LQ Fonts, 360 x 360 DPI, Top, Rear, Bottom, & Front paper Feed paths Convertable Push/Pull Tractor.
................................$895

LQ-860 80 Col, 24Pin Dot Matrix' 295 Cps Draft,98 CPS LQ, Colour Standard,Push Tractor Smart Park Feature..................$1095

LQ-1070 136 Col, 24 Pin Dot Matrix, 252 Cps Draft, 84 Cps NLQ, Scalable Fonts, 8 to 32 point, 11 LQ Fonts, 360 x 360 DPI, Top, Rear, Bottom, and Front Paper Feedpaths, Convertable Push/Pull Tractor
..................$775



LQ-1170 136 Col, 24 Pin Dot Matrix, 350 Cps Draft, 110 Cps NLQ, Scalable Fonts, 8 to 32 point, 11 LQ Fonts, 360 x 360 DPI, Top, Rear, Bottom, and Front Paper Feedpaths, Convertable Push/Pull Tractor
..................$1,149



LQ-1060 136 Col, 24Pin Dot Matrix' 292 Cps Draft, 98 Cps LQ, Colour Standard,Push Tractor, Smart Park Feature.
..................$1,395

LQ-2550 136 Col, 24Pin Dot Matrix' 400 Cps Draft,133 LQ Colour Standard,Push Tractor, Smart Park Feature.
..................$2,049

ROD IRVING ELECTRONICS Pty. Ltd. ACN.005 428 437
HEAD OFFICE: 56 RENVER RD, CLAYTON. PH: (03) 543 2166. FAX (03) 543 2648
CITY 48 A'BECKETT ST. MELBOURNE. PH. 663 6351 / 639 1640. FAX: 639 1641.
OAKLEIGH: 240C HUNTINGDALE RD, OAKLEIGH. PH: 562 8939
NORTHCOTE 425 HIGH ST. NORTHCOTE, PH. 489 8866. FAX: 489 8131.
SYDNEY:74 PARRAMATTA RD, STANMORE. PH: (02) 519 3134. FAX: (02) 519 3868
BLUESTAR COMPUTERS: 271 MAROONDAH HWY. RINGWOOD. PH: (03) 870 1800

Postage rates

$1 - $9.99	$3.00
$10 - $24.99	$3.50
$25 - $49.99	$4.50
$50 - $99.99	$6.00
$100 - $199	$7.00
$200 - $500	FREE
$500 PLUS	FREE

These postage rates are basic postage only up to 5Kg. Road freight, bulky & fragile items will be charged at different rates

TOLL FREE MAIL ORDER HOTLINE: 008 33 5757
(ORDERS ONLY)
ENQUIRIES: (03) 543 7877

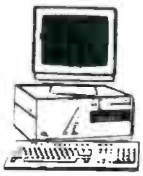
ROD IRVING ELECTRONICS

MAILORDER HOTLINE: 008 33 5757

[illegible]

RITRON QUALITY 3 year warranty!

RITRON



286-21

80286-16 CPU
1 MEG RAM EXPANDABLE TO 4 MEG
21Mhz LANDMARK SPEED TEST
1.2M JAPANESE BRAND F.D.D
85M HARD DISK DRIVE 28ms ACCESS
101 EXTENDED "CLICK" KEYBOARD
JAPANESE KEYBOARD SWITCHES
MINI CASE & 200W POWER SUPPLY
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
2 SERIAL, PARALLEL, GAME PORTS
3 YEAR PARTS & LABOUR WARRANTY
256K VGA CARD. IBM* COMPATIBLE
SPREADSHEET, WORDPROCESSOR & DATABASE
SOFTWARE INCLUDED.
DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.

$1449 TAX INC.
$1,229 TAX EX.

RITRON

DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.

386SX-21

80386SX-16 CPU
1 MEG RAM EXP TO 8 MEG
21Mhz LANDMARK SPEED TEST
1.2M JAPANESE F.D.D. 512K VGA CARD
85M HARD DISK DRIVE,
101 EXTENDED "CLICK" KEYBOARD
MINI CASE & 200W POWER SUPPLY
SUPA VGA COLOUR MONITOR 1024x768 Res 0.28"DP
SERIAL PARALLEL GAMES PORTS
3 YEAR PARTS & LABOUR WARRANTY IBM*
COMPATIBLESPREADSHEET, WORDPROCESSOR &
DATABASESOFTWARE
INCLUDED.
* SHAREWARE SOFTWARE
ASSEMBLED & TESTED
IN AUSTRALIA.

$1,499 TAX INC.
$1,269 TAX EX

OPTIONAL EXTRAS

ADD PRICE TO BASE SYSTEM COST.

512K VGA CARD..$50 1M VGA CARD..$150

TO CHANGE A 85M HARD DRIVE TO A

126M HD add $175 105M HD..$105
200m HD add $575 180M HD..$475

EXTRA RAM

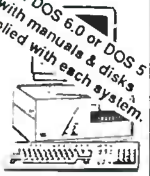
1 MEG add..$65 2 MEG add..$130
WINDOWS 3.00.$69 WINDOWS 3.1.$179

SOUND CARDS

SOUND COMMANDER....................$149
THUNDER BOARD.........................$199
SOUNDBLASTER II........................$249
SOUNDBLASTER PRO....................$389
FLOPTICAL DRIVE add..................$849
21 M/BYTE DISC TO SUIT...............$39
CD ROM DRIVE.............................$599

RITRON

DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.



386SX-31

80386SX 25M CPU
1 MEG RAM EXP TO 8 MEG
31Mhz LANDMARK SPEED TEST
1.2M JAPANESE F.D.D. 512K VGA CARD
85M HARD DISK DRIVE,
101 EXTENDED "CLICK" KEYBOARD
MINI CASE & 200W POWER SUPPLY
SUPA VGA COLOUR MONITOR 1024 x 768 Res 0.28" D.P
SERIAL PARALLEL GAMES PORTS
3 YEAR PARTS & LABOUR WARRANTY IBM*
COMPATIBLESPREADSHEET, WORDPROCESSOR &
DATABASESOFTWARE INCLUDED.
* SHAREWARE SOFTWARE
ASSEMBLED & TESTED
IN AUSTRALIA.

$1,549 TAX INC.
$1,299 TAX EX

RITRON EXECUTIVE

DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.

386-57

80386-33 CPU 64K CACHE ON BOARD MEMORY
1 MEG RAM EXP TO 16 MEG
57Mhz LANDMARK SPEED TEST
85 MEG HARD DISK
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL PARALLEL GAMES PORTS
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
MINI CASE & 200W POWER SUPPLY
512K VGA CARD (256 COLOURS) IBM* COMPATIBLE
3 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPROCESSOR & DATABASE
SOFTWARE INCLUDED.
*SHAREWARE SOFTWARE
ASSEMBLED & TESTED
IN AUSTRALIA.
386-33 128K.....$1899

$1,799 TAX INC.
$1,525 TAX EX

RITRON EXECUTIVE

DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.

386-65

80386-40 CPU 64K CACHE ON BOARD MEMORY
1 MEG RAM EXP TO 16 MEG
65 Mhz LANDMARK SPEED TEST
85 MEG HARD DISK 12ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS 512K VGA CARD
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
MINI CASE & 200W POWER SUPPLY
3 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPROCESSOR & DATABASE
SOFTWARE INCLUDED. *SHAREWARE SOFTWARE
ASSEMBLED & TESTED IN AUSTRALIA.

$1,899 TAX INC.
$1,595 TAX EX.

WITH 200 MEG DRIVE
$2,475 TAX INC.
$1,995 TAX EX.

RITRON EXECUTIVE

DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.

486-75

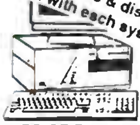
80486SX-20 CPU
1 MEG RAM EXP TO 32 MEG
75Mhz LANDMARK SPEED TEST
85 MEG HARD DISK
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS, 1MEG VGA CARD
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
MINI CASE & 200W POWER SUPPLY
3 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPROCESSOR & DATABASE
SOFTWARE INCLUDED. *SHAREWARE SOFTWARE
ASSEMBLED & TESTED IN AUSTRALIA.

$1,999 TAX INC.
$1599 TAX EX.

WITH 200 MEG DRIVE
$2,579 TAX INC.
$2,299 TAX EX.

RITRON EXECUTIVE

DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.



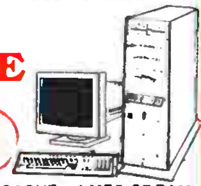
486-157

80486-33 CPU
256K ON BOARD CACHE. 1 MEG OF RAM
157Mhz LANDMARK SPEED TEST
85 MEG HARD DISK
1.2M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS
512K VGA CARD. IBM* COMPATIBLE
SVGA COLOUR MONITOR (1024 x 768 Resolution) 0.28"DP
MINI CASE & 200W POWER SUPPLY
3 YEAR PARTS & LABOUR WARRANTY
SPREADSHEET, WORDPROCESSOR & DATABASE SOFTWARE.

$2,449 TAX INC.
$1,945 TAX EX.

WITH 200 MEG DRIVE
$2,995 TAX INC
$2,500 TAX EX

RITRON EXECUTIVE



486-157

80486-33 CPU 256K ON BOARD CACHE. 4 MEG OF RAM
157Mhz LANDMARK SPEED TEST
200 MEG HARD DISK 12ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
3.5" 1.44M JAPANESE BRAND F.D.D
101 EXTENDED "CLICK" KEYBOARD
SERIAL, PARALLEL, GAMES PORTS
1 MEG VGA CARD. IBM* COMPATIBLE
SUPA VGA COLOUR MONITOR (1024 x 768 Res) 0.28" DP
TOWER CASE & 220W POWER SUPPLY
3 YEAR PARTS & LABOUR WARRANTY
SPEADSHEET, WORDPRCESSOR & DATABASE SOFTWARE.
ASSEMBLED & TESTED
IN AUSTRALIA.
IDEAL CAD MACHINE!
DR DOS 6.0 or DOS 5
with manuals & disks
supplied with each system.

$3,295 TAX INC.
$2,795 TAX EX.

ROD IRVING ELECTRONICS Est. 1977.

MAIL ORDER HOTLINE: 008 33 57 57. ORDER FAX LINE: (03) 543 4871 ENQUIRES (03) 543 7877
HEAD OFFICE: 56 RENVER RD, CLAYTON. PH: (03) 543 2166. FAX (03) 543 2648
CITY 48 A'BECKETT ST. MELBOURNE. PH. (03) 639 1640. FAX: 639 1641.
OAKLEIGH: 240C HUNTINGDALE RD, OAKLEIGH. PH: (03) 562 8939 FAX: (03) 562 8940
NORTHCOTE 425 HIGH ST. NORTHCOTE, PH. 489 8866. FAX: 489 8131.
SYDNEY:74 PARRAMATTA RD, STANMORE. PH: (02) 519 3134. FAX: (02) 516 5024
BLUESTAR COMPUTERS:
MELBOURNE: 271 MAROONDAH HWY, RINGWOOD, PHONE: (03) 870 1800 FAX: (03) 879 3027
SYDNEY: 115 - 117 PARRAMATTA RD CONCORD. PH: (02) 744 5526 FAX: (02) 744 5405

FREIGHT CHARGE BASED ON 35KG COMPUTER SYSTEM

Melb-Metro.$12.00	Vic country....$19.00
Sydney....... $17.00	NSW country.$39.00
Adelaide..... $17.00	S.A country...$39.00
Bribane...... $24.00	QLD country.$55.00
Canberra.... $18.00	W.A country..$74.00
Darwin........ $40.00	Insurance:-
Perth........... $31.00	$1 / $100 Value.
Tasmania.... $53.00	

All sales tax exempt orders
to : RITRONICS WHOLESALE
56 Renver Rd, Clayton, Victoria .
Ph: (03) 543 2166 Fax: (03) 543 2648
MAIL ORDER & CORRESPONDENCE
P.O BOX 620, CLAYTON, VICTORIA. 3168.

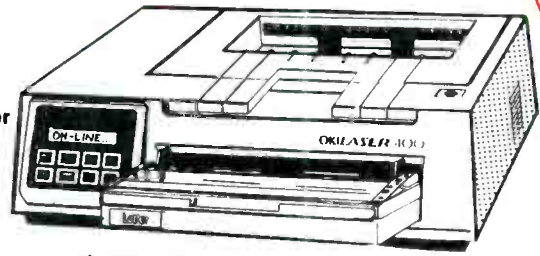
Errors & ommissons excepted. Prices & specifications subject to change. *IBM, PC, XT, AT, are registered trademarks of International Business Machines. PRICES AT AUS $ = US $0.74

NEW "BLUESTAR COMPUTERS" STORE NOW OPEN: 115-117 PARRAMATTA RD, CONCORD.

[illegible]

OKILASER 400 IT'S LOWEST PRICE EVER!

It's the cheapest it has ever been! The famous OKILASER 400 Laser printer at only $1299! Reliable and compact, it fits neatly into the smallest of offices. Highly reliable due to its latest LED imaging technology. The OL400 offers excellent print quality, superior paper handling, and a variety of fonts which rivals some of the more expensive laser printers on the market



$1,299

Only $1095 Tax Ex.

5 year warranty on LED system head.

No moving parts (LED SYSTEM HEAD) recycles its own toner! Approx. 1.8 ¢ per copy.

Toner Cartidge to suit only $59.00

GET INTO THE PICTURE WITH THE MAESTRO 9600XR FAX / DATA MODEM

SPECIFICATIONS V29 / V27 ter / V21 Ch.2 Fax modes V22 bis V22 / Bell 212A 103 Data modes Auto dail, Auto Answer, Pulse and Tone Dialing, Hayes "AT" compatible, TR.29 fax mode compatible (industry standards), Fax group 3 compatible (send and recieve), Auto Baud select, All new dsp technology, External modem-RS232 compatibles and Apple Macintosh.

MAESTRO 2400ZXR MODEM

This is our biggest selling external modem that features - V22 bis, V22 , V23 (with auto BRC), V21- (2400bps, 1200bps, 1200/75bps, 300bps) Auto Baud Select, Hayes "AT"commands set, Auto Answer, auto Dial, Auto Disconnect. This modem will suit almost any computer with a RS232 serial port. Telecom approved.

2400bps for only $399.00

MAESTRO 2400XR MODEM

This has to be the cheapest and easiest way into high speed data communications with features only found in some modems of at least twice the price. Features include-2400bps (V22bis), 1200bps (V22), Auto answer, Auto dial, Auto disconnect, Hayes "AT" commands set compatible, Non volatile memory (for configuration storage), Synchronous and Asynchronous operations Telecom approved

$299.00 full price incl. tax

AUVA / RITRON NOTEBOOK

The Ritron 945/20 takes up less space than your old desktop when you're working and can be stored in the drawer of your desk when you're finished. The 945/20 uses less than one third of the space of your desktop SX and is at least as powerful. Don't stretch your arms to their limit walking back to the office. The Ritron 945/20 won't drag you down when you need to be on-the-go Relax over a cup of coffee and do some power computing in a more elegant setting than your office. The Ritron 945/20 lets you work in your favorite places without intruding on everyone around you.

$1995 Tax Ex.

Microprossor
•CPU 80386SX-20

Memory
•Fitted with 4MB

BIOS
•128KB ROM Pheonix BIOS

Storage Devices
•One 1.44MB 3.5" Floppy disk drive
•One 60MB 2.5" Hard Disk Drive

Display
•VGA compatible display
•640x480 pixel resolution
•32 gray scales
•Backlit Paper White LCD

INCLUDES DOS 5 OR DR DOS 6.0 ALL FOR ONLY

$2395 Inc. Tax

"MegaRAM" Memory board

This new generation memory enhanced board offers 0 wait state high speed operation. It takes up to 6MBytes of 4 x 256K or 1 x 1M DRAM chip. Up to seven cards can be used together (42MB EMS). It is 100% EMS 3.2 & 4.0 compatible, and best of all it can be used in an XT, AT or 386 because it is 8 bit, 16configerable. So get yourself a Mega for the price of a mini.

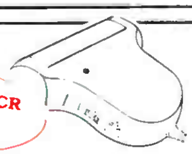
X18051.........................*SAVE $100.00*...........$199.00

4 PORT SERIAL CARD

(Software Output Cables included)
The PE-514 has 4 port serial ports for asynchronous communication. These ports can bve used to connect your PC with a serial printer, MODEM, Serial mouse or serial devices which use an RS232C Interface. The interface is a DTE type with a male DB25P for 4 serial port output. It supports DOS & XENIX.

X18155.........SAVE $50 Only $149.00

GeniScan



WITH FREE OCR SOFTWARE!

The GS-4500 is a hand held scanner that can transfer graphic images such as photographs, drawings, text and clip art directly to your computer screen. It is capable of scanning up to 105mm in two different modes, Letter or Photo. The GS-4500 also has a resolution control switch to select the amount of brightness to be used. It also can control the amount of colour shade. The letter mode scans black and white This mode can be used for artwork and scanning text to a text file using OCR software. X19935...............................$279.00

ULTRA 15C 16MB CACHING IDE CONTROLLER CARD

TURNS A 20mS ACCESS TIME HARD DRIVE INTO EFFECTIVLY A 0.2mS DRIVE.

The ULTRA 15C provides intelligent caching up to 16 MBytes of cache memory to make the drive "invisible" when a cache hit is achieved providing multiple increases in I/O performance. It is AT register & BIOS compatible. It supports two high transfer IDE drives. It supports the largest selection of hard drives in the market today. The ULTRA 15C also supports any mix (5.25" and 3.5") of up to three floppy disk drives or floppytapes. In addition to the special support to break the support to break the 1024 cylinder and the 528MB partition limits of DOS and OS/2, the ULTRA family of caching controllers will also co-reside with any other controller to support dual channels and/or duplexing/mirroring in popular network operating systems. $649.00

ROD IRVING ELECTRONICS Pty. Ltd. ACN.005 428 437
HEAD OFFICE: 56 RENVER RD, CLAYTON. PH: (03) 543 2166. FAX (03) 543 2648.
CITY 48 A'BECKETT ST. MELBOURNE. PH. (03) 663 6151 / (03) 639 1640. FAX: (03) 639 1641.
OAKLEIGH: 240C HUNTINGDALE RD, OAKLEIGH. PH: (03) 562 8939. FAX: (03) 562 8940.
NORTHCOTE 425 HIGH ST. NORTHCOTE, PH.(03) 489 8866. FAX: (03) 489 8131.
SYDNEY:74 PARRAMATTA RD, STANMORE. PH: (02) 519 3134. or (02) 565 1458. FAX: (02) 516 5024.
BLUESTAR COMPUTERS: (COMPUTER PRODUCTS ONLY) 271 MAROONDAH HWY. RINGWOOD. PH: (03) 870 1800. FAX: (03) 879 3027.
OPENING 6th OF APRIL: BLUESTAR COMPUTERS CONCORD. (COMPUTER PRODUCTS ONLY)
GROUND FLOOR 115-117 PARRAMATTA RD, CONCORD. PH: (02) 744 5526. FAX: (02) 744 5405.
TOLL FREE MAIL ORDER HOTLINE: 008 33 5757. FAX ORDERS: (03) 543 2648 (STRICTLY ORDERS ONLY)

ROD IRVING ELECTRONICS SUPPLIES THE BEST QUALITY COMPUTER PRODUCTS

COMPUTER CASES

TOWER CASE
Give your computer that professional look
X11105.....$199
220W Power supply to suit X11102......$199
BOTH FOR ONLY $295

MINI TOWER CASE WITH 200W P.S
X11100............$199

RITRON EXECUTIVE CASE
Includes P.S X11089.............$119

NEW STYLE MNI CASE WITH POWER SUPPLY
X11103............$149

COPY HOLDERS

COPY HOLDER
YU-H33
- Copy area 9 1/2" x 11"
- Sliding line glide
- Flat metal base

C21060...... $39.95

COPY HOLDER
YU-H32
Adjustable arms allows easy positioning
- Copy area 9 1/2" x 11"
- Sliding line glide
- Clamping Mounting

C21062..................$39.95

GRIP CLIP COPY HOLDER
- Attaches to the top your monitor
- Put your copy right where you need it.
- Spring clip to hold paper
- Velcro at mount for easy removal

C21065...................$14.95

MONITOR MOVER ARM

MONITOR MOVER ARM
Position your monitor exactly where yuo want int
Maximize desk space.
- Solid steel structure
- Height Adjustment
- Span 33cm
- Maximum load 50kg

C21079.......................$199.00

- Sturdy Steel construction
- Can rotate 360°
- Lifts monitors up to 22 Kg.
- Locks in place with monitor on tray.

C21082.....................$199.00

POWER SUPPLIES

Power Supply for IBM *, PC/XT & compatibles.
DC Output :+5/13A -5.0 5A +12V/4.5 -12V 0.5A
X11096.....................$139
200W Switch Mode Power Supply for IBM* AT* & Compatibles DC Output: +5/16A -5.0.5A +12V/4.5 -12V/5A -12/0.5A
X11097.....................$109

COMPUTER PAPER

Introducing ComPstat!
High quality 70 gsm, convieniently packed continuous fan- fold computer paper. Comes in packs of 250 or 500 sheets in two sizes. 279mm x 241mm and true A4. Very useful for photocopying computer print-outs without having white space on the top or bottom of the page.

279mm x 241mm
250 sheets
C21006...................$9.95
279mm x 241mm
500 sheets
C21007.................$16.95
True A4
296mm x 210mm
250 sheets
C21008.................$14.95
True A4
296mm x 210mm
500 sheets
C21009...... ..$19.95

MEMOREX RECYCLED COMPUTER PAPER 2000 SHEETS
C21002............$29.95

BULK COMPUTER PAPER
Quality paper at a low price!
- 60 gms bond paper
- 11 x 9 1/2" 2000 sheets

C21001................$39.95
- 15 x 11" 2000 Sheets

C21011................$64.95

ANTI GLARE SCREEN

Relieve eye strain and headaches and increase production with these anti glare screens.
14" screen
X99990..................$39.95
12" screen
X99995..................$14.95

COMPUTER ACCESSORIES

HEAD CLEANER DISKS
It only takes a minute amount of dust, dirt or magnetic oxide particles on your drive heads to cause problems: errors, downtime or an expensive service call. Regular use of a head cleaner will keep your drive free of trouble causing dirt and help keep your system up and running. These disk cleaners are simple to use, and include cleaning solution and instructions.

	1-9	10+
• 3 1/2"		
C12560......	$6.95	$5.95
• 5 1/4"		
C12555.....	$6.95	$5.95

DISK NOTCHER
Converts 5 1/4" single sided floppy disks to double sided, by placing an appropriate notch in the floppy disk jacket.
C21070...............$7.95

PLASTIC DISK HOLDERS

3 /12" PLASTIC DISK HOLDER
- Holds 5 disks

Comes in 6 different colours

C16050 Red	C16054 Yellow
C16052 Orange	C16056 Green
C16058 Blue	C16060 Grey

Only ....$3.50 Each.

5 1/4" PLASTIC DISK HOLDER
- Holds 6 floppy disks

C16030.....$3.50

5 1/4" DISK STORAGE CASES
- Made of Sturdy black flexible plastic.
- Holds 10 or more 5 1/4" disks.
- Display positions

	1-9	10+	100+
C12820..........	$3.95	$3.50	$3.00

MEMOREX
3.5"Plastic disk holder
- Holds 10 Disks

C12840.....$3.95

3 1/2" DISK STORAGE
- 40 x 3 1/2" disk capacity
- High impact plastic lid & base

C16040............................$6.95

GENDER CHANGERS

DB9 GENDER CHANGERS
X15640 Male to Male..........$9.95
X15641 Male to Female......$9.95
X15642 Female to Female...$9.95

DB15 GENDER CHANGERS
X15645 Male to Male $9.95
X15646 Male to Female........$9.95
X15647 Female to Female...$9.95

RS232 GENDER CHANGERS
X15650 Male to Male..........$12.95
X15651 Male to Female......$9.95
X15652 Female to Female.$12.95

RS232 MINI PATCH BOX
- Interfaced RS232 divices
- 25 leads with tinned end supplied

X15653.................................$12.95
X15654.................................$12.95
X15655.................................$12.95

CENTRONICS GENDER CHANGERS
- All 36 pins wired straight through

X15663 Male to Male.
X15664 Female to Female
.............$29.95 each

RS232 MINI TESTER
- Mail to Female connections
- Dual colour LED indicates activity and direction on 7 lines.

X15656................$23.95

RS232 NULL MODEM ADAPTORS
- Pins 2 & 3 reversed
- All 25 pins connected

X15657 Male to Male
X15658 Male to Female
X15659 Female to Female
...............................$12.95 each.

INLINE SWITCHING BOX
- 25 pin "D" plug to 25 pin "D" socket (RS232) • DIP switch allows easy switching of internal wiring.

X15662...............$19.95

PRINTER RIBBONS

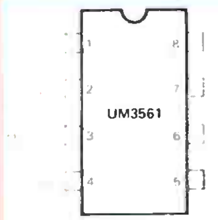
	1-9	10+
MX100, FX100, RX100, LX1000 C22002	$12.95	$10.95
CP80, SX80, DP80, SP80 C22036	$12.95	$10.95
LX850, MX70, MX80, RX80, FX800, LX800, LX400 C22031	$10.95	$9.95
EPSON LX80, GX80, LX86, C22003	$9.95	$8.95
EPSON LQ500, LQ200, LQ500, LQ570, LQ400, LQ800, LQ850, LQ870. C22004	$11.95	$10.95
EPSON LQ1000, LQ1050, LQ1010, LQ1070, FX1050. C22011	$12.95	$11.95
EPSON LQ1500 C22009	$14.95	$13.95
STAR NX 1000 C22048	$11.95	$9.95
STAR NX 1000C COLOUR C22040	$29.95	$27.95
CANON 1080/115A H80 A40 C22039	$16.95	$15.95
STAR NX 1500 STAR LC 2410 STAR NX 2410 IBM 5538 C22047	$14.95	$12.95
COMMODORE 4023 C21180	$12.95	$10.95
OKI 380/390 C21105	$14.95	$12.95
TOSHIBA P1350 C22027	$23.95	$22.95
APPLE IMAGE WRITER CITOH 8510 - 1550 C22051	$13.95	$12.95
QUME IV MULTI-STRIKE C22023	$14.95	$13.95
MT85 MANNESMAN TALLY S2-72 COPAL RIBBON FOR KAITEC C21190	$19.95	$15.95
OKI 172 C22104	$12.95	$11.95
KXP 1080 / 1081 / 1082 NATIONAL PANASONIC KXM110, SUPER 5 C22034	$11.95	$10.95
NATIONAL PANASONIC KXP1124, KXP1180 C22024	$11.95	$10.95

ROD IRVING ELECTRONICS

MELBOURNE: 48 A'Beckett St. Ph: (03) 663 6151.
Computer sales: Ph 639 1640.
NORTHCOTE : 425 High St. Ph: (03) 489 8866
OAKLEIGH: 240C Huntingdale Rd, Ph: (03) 562 8939
SYDNEY: 74 Parramatta Rd. Stanmore. N.S.W.
Ph: (02) 519 3134
MAIL ORDER: 56 Renver Rd, Clayton Vic. 3168.
Ph: (03) 543 7877
Mail Order Hotline: Ph: 008 33 5757.
DEALERS: BLUESTAR COMPUTERS
(Computer Products only)
MELBOURNE: 217 Maroondah Hwy, Ringwood. Ph: (03) 870 1800
SYDNEY: 115-117 Parramatta Rd, Concord. Ph: (02) 744 5526
MAIL ORDER & CORRESPONDENCE
P.O BOX 620, CLAYTON, VICTORIA, 3168.

[illegible]

THREE SIREN SOUND GENERATOR UM3561



Features:

- Four sounds can be selected.
- Typical 3V operation voltage.
- RC oscillator with an external resistor is built in. (mask option.)
- A magnetic speaker can be driven by connecting an NPN transistor.
- Power on reset.

The UM3561 is a low cost, low power CMOS LSI designed for use in toy applications. Since the intergrated circuit includes oscillator and selector circuits, a compact sound module can be constructed with only a few additional components. The UM3561 contains a programmed mask ROM to simulate siren sounds.

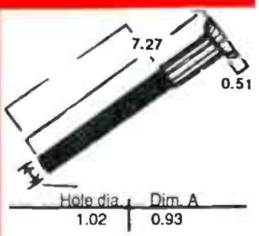
TYPICAL APPLICATION

FOUR SOUND APPLICATION

1. Police Siren
2. Fire Engine Siren.
3. Ambulance Siren.
4. Machine Gun.

1-9	10+
$3.95	$3.50

PROTOTYPING HALF PIN.

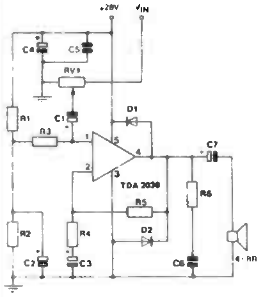


These pins are ideally suited to the take-off points or flying leads from a PCB. The solder is soldered to the copper track with pin protruding ont he component side of the board. These are made for 1.02mm holes.

H11618 Pack of 20.....$2.95
H11619 Pack of 100...$6.95
H11620 Pack of 1000.$59.95

TDA2030

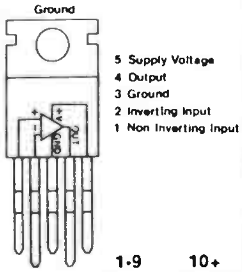
A high quality audio amp in a 5-pin To220 package that does not require insulating washers between the metal tab and heatsink in single rail supply applications. The amp will operate with single or split supplies. The distortion up to 12 W into 4Ω is less than 0.2% typically (less than 5% up to 14W) and up to 8W into 8Ω is less than 0.1% (less than 0.5% up to 9W).



Typical application with single rail power supply.

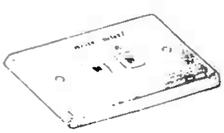
PARTS LIST.

R1,2,3:	Min Res 100k
R4:	Min Res 4k7
R5:	Min Res 150k
R6:	Min Res 1Ω
RV1:	Pot Log 22k
C1:	Axial 1uF 63V
C2:	Axial 22uF 25V
C3:	Axial 2.2uF 63V
C4:	Axial 100uF40V
C5:	Polyester 0.1uF
C6:	Polyester 0.22uF
C7:	Axial 2200uF 25V
D1,2:	1N4001



	1-9	10+
TDA2030	$3.95	$3.50

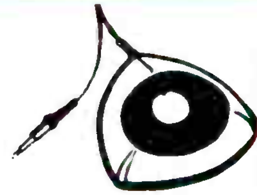
AUDIO ACCESSORIES



SPEAKER TERMINAL PLATE

Standard size wall plate for speaker outputs. Each wall plate has dual polarised 2 pin DIN screw terminating sockets for left and right speaker connections. Supplied with all hardware.

A16061................$6.95



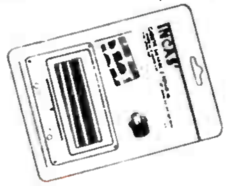
PILLOW SPEAKER

Ideal for private listening. Slimline cabinet for placing under pillow

SPECIFICATIONS:

Speaker:	2" fullrange
Impedance:	8 ohm
Cord:	1.5 metres
Plug:	3.5mm phone plug
Colour:	Black

C12117............$11.95



CASSETTE SALVAGE/REPAIR KIT

Mylar splicing/repair tape. Complete kit with everything needed to repair damaged cassette tapes and cases Included in each kit are:

- Complete cassette parts including case.
- Tape spicing bar and razor blades.

A10009................$2.95

MINI / MICRO CASSETTE ERASER

Erase recordings instantly from mini and micro sized cassette tapes. Simply pass the tape through the slot in the centre of the magnetic fields in this unit and the tape is erased. The job is finished in seconds.

- No external power or batteries are required.

............................$6.95

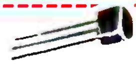
HEAVY DUTY JUMPER LEADS

Five colour coded jumper leads.

- 560mm long with alligator clips on each end.
- Alligator clips are insulated with vinyl boots
- Conductors 5 x 20/ 0.20 mm

W12005.............$5.45

NEW TRANSISTORS



SWITCHING TRANSISTORS

		VCBO V	VCEO V	Ic a	hFE	Package
2SC2625	NPN	450	400	10	10	TO3P

1-9: $10.95 10+: $9.95

Above Transistor will replace 2SC2555, 2SC3306, 2SC4138 etc.

2SC4242	NPN	450	400	7	10	TO3P

1-9: $7.95 10+: $6.95

Above Transistor will replace 2SC3039, MJE1007, MJE1008, etc.

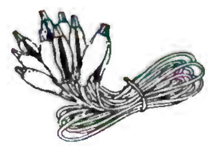
DRIVER TRANSISTORS

2SC945	NPN	60	50	0.1	20-400	TO92

1-9 $0.35 10+: $0.30

Above Transistor will replace 2SC1815, 2SC2320, etc.

	1-9	10+
TDA2002 8 WATT CAR RADIO AUDIO AMPLIFIER	$2.95	$2.50

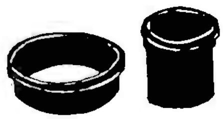


JUMPER LEADS

Ten colour coded jumper leads.

- 450mm long with alligator clips on each end.
- Alligator clips insulated with vinyl boots.
- Conductors: 10 x 11/0.18mm

W12000..............$6.95



SPEAKER PORTING TUBES

Black plastic speaker tubes designed for finishing off breathing or porting outlets on speaker cabinets. Porting tubes are also ideal for finishing off desk and furniture that need holes cut into the surface for passing telephone, computer and electrical cables through.

- R60 Inside Dia: 51mm, Length: 65mm
- R89 Inside Dia: 82mm, Length: 33mm

....$1.45
....$1.95

SIMM SOCKETS

SINGLE
P10536.......................$5.95

DOUBLE
P10538.......................$6.95

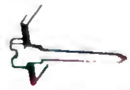
These are good quality SIMM Sockets with metal clips at the ends and not the plastic ones which break.

WIRE WRAP PINS

These pins are not gold plated so they are much cheaper.They are suitable for wire wrapping and fit holes of 1mm (0.04in) diameter. Two types are available Single-sided and Double-sided

DOUBLE SIDED

Packet of 20
H11680......................$3.95
Packet of 100
H11681.....................$18.95
Packet of 500
H11682.....................$85.95



SINGLE SIDED

Packet of 20
H11690......................$3.50
Packet of 100
H11691.....................$17.95

ROD IRVING ELECTRONICS

MELBOURNE: 48 A'Beckett St. Ph: (03) 663 6151.
Computer sales: Ph 639 1640
OAKLEIGH: 240C Huntingdale Rd, Oakleigh. Ph: (03) 562 8939
NORTHCOTE : 425 High St. Ph: (03) 489 8866
SYDNEY: 74 Parramatta Rd. Stanmore. N.S.W.
Ph: (02) 519 3134
MAIL ORDER: 56 Renver Rd, Clayton Vic, 3168.
Ph: (03) 543 7877
Mail Order Hotline: Ph: 008 33 5757.
All sales tax exempt orders & wholesale inquires to:RITRONICS WHOLESALE,
56 Renver Rd, Clayton, 3168.
Ph. (03) 543 2166. (3 lines) Fax: (03) 543 2648.
MAIL ORDER & CORRESPONDENCE
P.O BOX 620, CLAYTON, VICTORIA, 3168.

Errors & omissions excepted. Prices & specifications subject to change. IBM*, PC*, XT*, AT*, are registered trademarks of International Business Machines.
*Apple is a trademark of Apple Corporation.

[illegible]

THE SERVICEMAN

A cure for the blues, reds or greens — and fuses that open, but don't blow...

I have a mixed bag for you this month. There's a story about an unusual but 'routine' repair job from my own workshop, which explains how to keep an old CTV going despite the development of a heater-cathode short in the tube. Then there are some comments on a very elementary subject — fuses, and particularly those that go open-circuit without 'blowing'. Finally, there's an amusing anecdote told to me by a friend, about his accidental invention of a very high powered amplifier.

We begin on my own well-worn bench, with the story of a quite routine fix. (Experienced servicemen can stop reading right now, because they have probably done this same job themselves, on several occasions; but others may find the story both interesting and helpful.) In fact, I didn't consider this job to be in any way unusual, until the customer began singing my praises to everyone he met. I still don't think I did anything remarkable, but then...

It all began when the customer rang me and asked if I would care to hazard a guess as to what was wrong with his set. He explained that it was a big 26" National, and it had a bright blue screen with white lines diagonally across it.

I had no hesitation in diagnosing his trouble. I've seen it on numerous occasions. The screen is often blue, but is sometimes red. I haven't seen a green screen National, but I don't doubt that they exist. The trouble is that the tube is faulty. It has developed a short circuit between the heater and the blue cathode (or red cathode, if the screen has gone red.)

I think that telling a customer that his (or her) picture tube has failed is almost as bad, for me, as it would be for a vet to tell someone that a favourite pet has to be put down...

It only takes some money to get a new television, yet people react as though a much-loved relative was about to leave for ever. And so it was in this case.

The set was a model TC2620 and the owner had bought it new, just after colour TV began. He had looked at it and loved it all through the years, and now his dear friend was about to depart from his life. Please, couldn't I do something — anything, to give it a new lease of life?

I explained that I could always fit a new tube, at a cost of several hundreds of dollars. Or I could fit a reconditioned tube, for perhaps $200. But the owner could see the futility of this. He agreed that this kind of money would be better spent in getting a new set.

I must admit, I played the story for all the drama I could wring out of it. Then I suggested that I just *might* be able to effect a modification that could get the set working again, well enough to watch even if it wasn't as good as it used to be.

At this news, his face lit up with hope and excitement. Yes, please — anything! Anything to get the old set working again. I suggested that he bring the set in and let me have a look at it. I would see what I could do for him.

There was no point in explaining the problem to the customer, but briefly, this is what had happened. The tube heater is normally earthed on one side.

Sometimes this is done in the power supply, but in the case of this National, it was done right at the picture tube socket. On the other hand, the cathodes are at somewhere between 100 and 150 volts above earth. This puts a constant strain on the insulation around the heater and as in the case of this National, a short eventually develops.

As a matter of interest, in many black and white TV's and a few CTV's, the heater was not earthed but was returned to HT via a one megohm resistor. This allowed the heater to float at close to the cathode voltage, and removed the strain on the insulation. Heater/cathode shorts were virtually unknown in sets wired in this way.

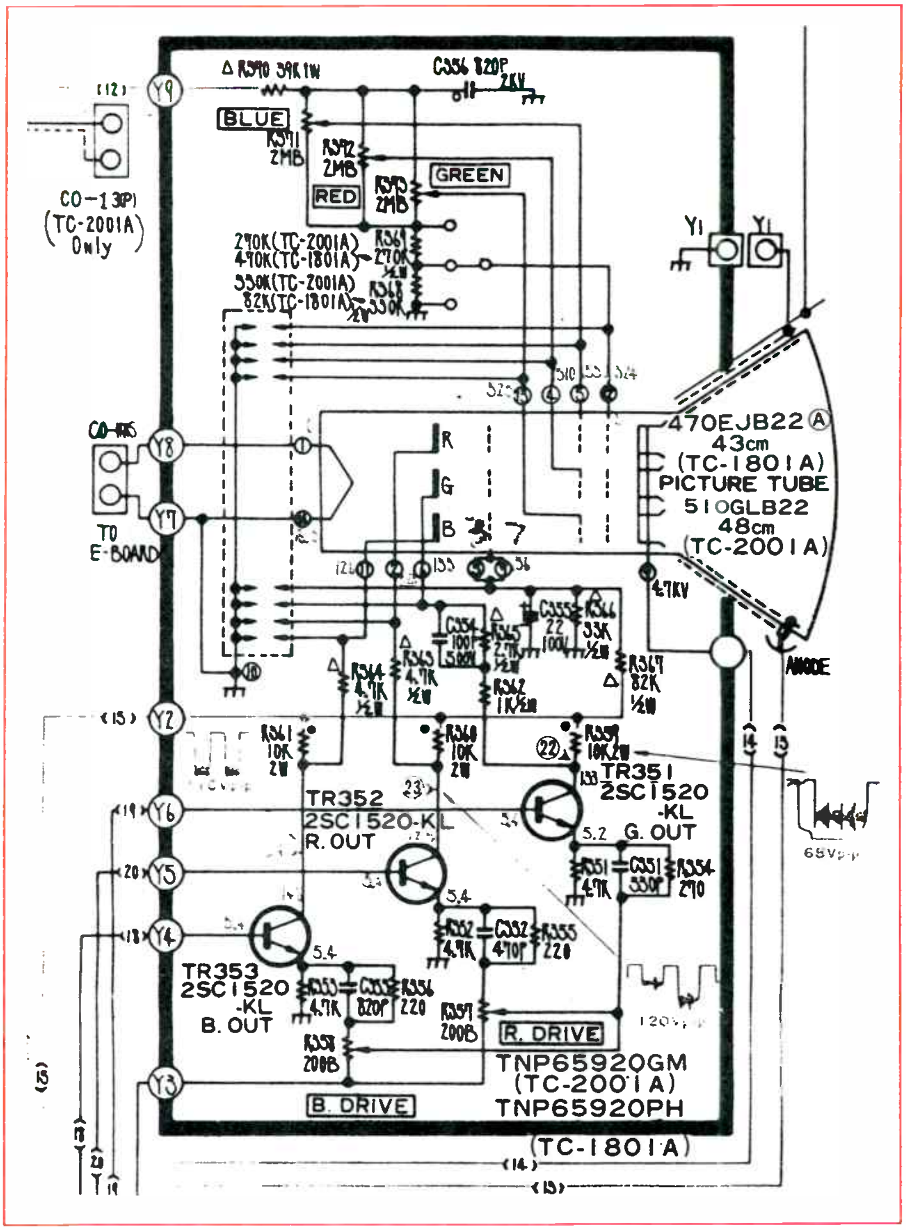
But back to the National. On the bench it was exactly as the customer had described. And when I had the cabinet back removed, I could check the blue cathode voltage on pin 11. As I expected, it was zero.

For those who cannot remember their vacuum tube characteristics, the grid has to be kept below the cathode voltage. In other words, negative with respect to the cathode. When the grid and cathode are at the same voltage, the grid has no control over the beam current and the screen is flooded with that particular colour.

It is relatively easy to regain control of the cathode voltage. All that is needed is to remove the earth connection on the heater supply. Unfortunately, that is only half of the story.

In normal operation, the tube cathodes are being fed with video information containing all frequencies from DC up to

[illegible]



This is the circuit schematic for the picture tube base board of a National CTV with a smaller tube than the model TC2620, but the schematic is almost identical. Note the link between one side of the heater and earth.

nearly 4MHz. When the heater/ cathode short occurs, all the circuit capacitance associated with the heater wiring is added in parallel across the output of the final video amplifier.

The end result of adding this capacitance is to destroy the high frequency response of that particular colour. Only the low frequency signals can get through, and the colour is blurred and smeared accordingly. If the set is going to be restored by isolating the heater, then steps must be taken to minimise the capacitance in the heater wiring.

In the past, I have done this with some success by mounting a small 240/6.3V power transformer right on the tube neck. This called for very short leads with correspondingly low capacity, and the small transformer added very little more to the circuit. However, there is an even better way to do this job — run the heater off the line output transformer.

Early colour televisions of the vintage we are talking about here were pretty evenly divided between those whose heaters were powered from the mains transformer or the primary power supply, and those whose heaters were powered by the line output transformer.

If the heater was fed from the mains or the primary power supply, there was a possibility that taking the supply from the line output stage could upset the operation of the stage, to the detriment of set reliability. But this possibility seems to have been pretty remote, and I never had any trouble in this respect.

Some of my patch-ups were still working reliably five or six years later. On the other hand, if the heater was originally powered from a winding on the line output transformer, then all I had to do was to disconnect one winding, and replace it with another that wasn't grounded.

In detail, the job is quite easy. It is necessary to determine exactly where the heater is earthed and with any luck this connection can be cut out of circuit. In other cases, the operation is less straight forward, but still offers no great problems.

The heater in the National TC2620 connects to pins 1 and 14 on the tube baseboard. The supply comes in on pin 1 via lead Y7 from plug CO19, and exits on pin 14, which just happens to be in the middle of a long track linking all the earth points on the board.

So, if I had cut the track on the side toward the earth connection, I would also have isolated a number of resistors and capacitors that should be grounded. The answer was to make two cuts, one each side of pin 14, and then to link the now separated parts of the earthy track with a wire bridge. The board pattern diagram printed here shows where the cuts were made, and the link that rejoined the tracks.

In the National's case, I also removed the original supply lead Y7 and cut it back to prevent accidental shorts. In fact, I could have simply unplugged the supply at CO19 but this would have left a long length of unnecessary wire to add its capacity to the blue output. By removing the surplus wire right at the tube baseboard, I minimised the resultant degradation of the picture.

Having isolated the heater, it remained to arrange for powering it in a manner that introduces the least possible capacity to the cathode circuits. I usually do this by taking a one metre length of stranded hookup wire. It needs to be reasonably heavy duty, as it has to carry up to an amp of current.

I often take a length of 'figure eight' flex and use just one side. This wire is wound a number of times around the core of the line output transformer, and the ends brought out and soldered on to the heater pads on the base board. As for the number of turns around the core, this can only be found by experiment. The voltage induced into the wire depends on the flux in the line output transformer core, and this can vary widely.

Clearly, too many turns will supply too much voltage and the heater will run the

risk of being damaged. Similarly, too few turns will not supply enough voltage and a dark picture will result.

The way I go about this job is first to note very carefully just how bright the heaters are when operating from their original power supply. Then I wind two turns around the core and make the connection to the heater.

When the set is switched on, the heaters may or may not glow. I haven't struck a set yet which would work on just two turns. But two turns will give some idea of how many will be needed in the end. If there is no heater glow, then another two turns will be needed. A dull glow will suggest one more turn. So unsolder one end of the wire from the base board and add the extra turn or turns to those already around the core. Reconnect the wire to the heater and switch on. (Philips used this system in their early K9 chassis, and those transformers carry four turns...)

Unfortunately, it isn't practical to fit only half a turn, so you might find that three is not enough and four is too many. In that case, you will have to make a judgement as to which number to leave.

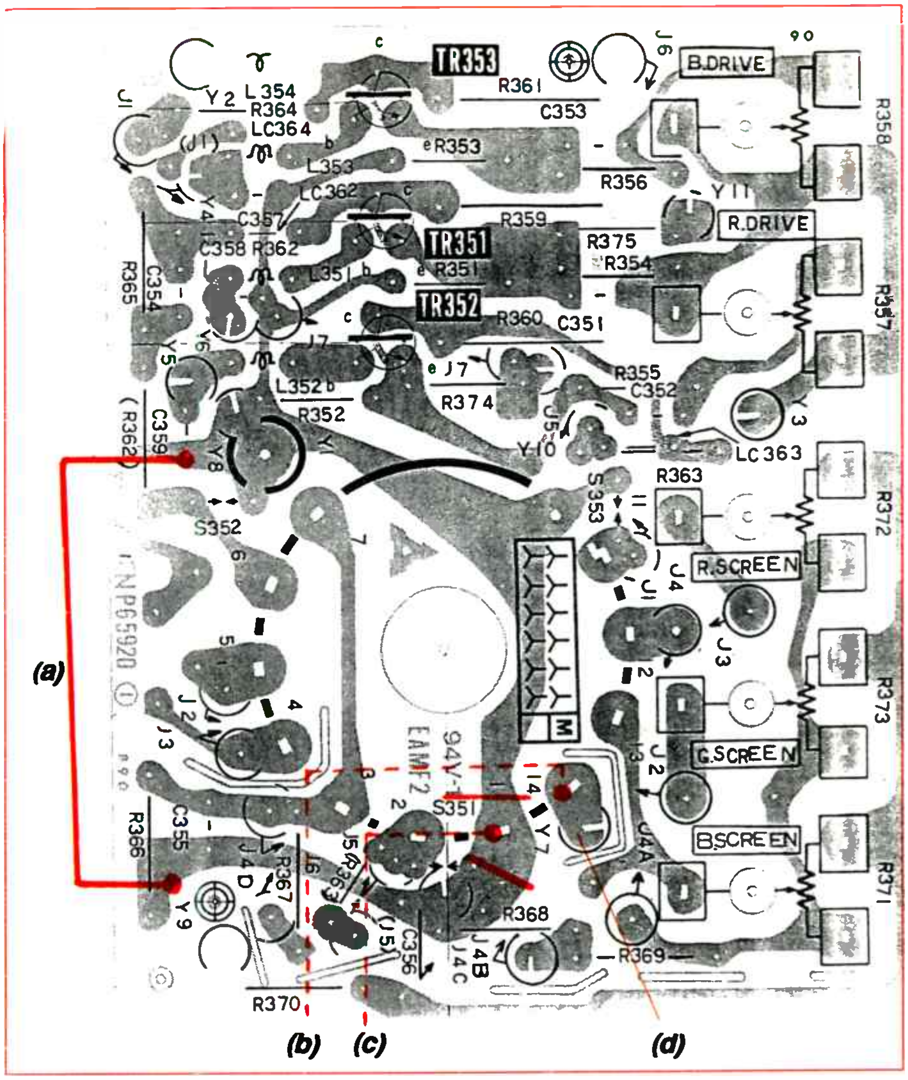
If the set has a reserve of brightness — that is, if the brightness control can be set well back from full on — then under-running the heater will ensure maximum service life from the tube.

On the other hand, if the tube is aging and the brightness control is usually run full on, then over-running the tube with an extra turn on the core may brighten the picture and give the owner a better result — even though the tube life will be shortened.

The old National that started this story took four turns to light the heater to what I judged to be normal brightness. The picture was really over-bright with the control set full on, so perhaps I could have got by with only a three-turn winding.

In this case, the modification was so successful that I couldn't detect any smearing caused by degradation of the blue output. I would have expected this to show up as a hazy blue halo on the right of blue subjects. There may have been something there, but it certainly wasn't enough to spoil the owner's enjoyment.

Sometimes, when the heater/cathode short is intermittent, you can see the picture changing as the video response changes. The way to cure this problem is to tie the now isolated heater to the appropriate cathode. In other words,



Shown here are the modifications that the Serviceman performed in order to power the National's picture tube heater from a winding added to the horizontal output transformer. Link A is needed to restore ground continuity when the track is cut on either side of tube pin 1. B and C are the new heater wires, while D is the old heater wire which is removed from PCB connection pin Y7.

make the short permanent. That didn't seem to be necessary in the case of the National, but I did it just the same — as a precaution in case the short chose to become intermittent in the future.

This kind of modification can be performed on most television sets. Some are easier than others, but all depend on being able to isolate the heater wiring from chassis ground. Of course, if a second cathode shorts to its heater, the tube really is a write off — there's no way of separating the heaters in the different cathodes.

In this case, the owner got his TV back, at a cost only a fraction of what he would have paid for a new set or a new or reconditioned tube.

He can't see any fault with the picture, so he's going round town telling his friends what a clever fellow I am!

I found out later that he had hawked the set to several other technicians who all told him the same thing — his tube was u/s. The implication was that he should junk it. It seems that none of them was interested in helping him to solve his problem, which seems to be a rather telling commentary on some tradesmen.

It would appear that the economic recession doesn't exist for some people.

Fuses that puzzle...

I sat down to write a story about fuses. But then, it's hard to make an interesting tale about something as prosaic as fuses. Let's face it — fuses are just bits of wire, aren't they? Yet two things have happened recently that make me wonder if fuses are as simple as they appear.

The first event followed a call from a colleague. He asked me to drop into his workshop next time I was in the vicinity.

He said he had something unbelievable to show me.

A few days later I was in his shop and he pulled a plastic bag from a drawer. He handed it to me and asked if I would hazard a guess at what was wrong with the contents.

The bag contained two glass fuses. Both were 'slow-blow' types, one 2AG and one 3AG. They were both of spring type construction, and both appeared to be in as-new condition.

He told me that they had been taken from different pieces of equipment, after many years in service, and both had failed. Replacing the fuses had restored the gear to service, yet he defied me to explain what was wrong with the fuses.

Spring type slow-blow fuses have a small coil spring holding one end of the fusible element under tension. When the fuse blows, the spring pulls the broken ends apart. The end result is visually unequivocal.

Yet in the case of the fuses shown to me, both had failed in some way that did *not* result in the spring retracting. The fuses were definitely open circuit, but the fusible wire was intact and still apparently under tension.

Later, I crushed the glass tube of the larger of the two fuses, and as the glass collapsed, the end caps sprang together as though they had been under some tension. In fact, that is just what I would have expected with the fuse wire still physically intact. I picked up one end cap and the other followed, dangling on the unbroken fuse wire. I can't explain why the fuses were open circuit, but they were!

The second of these two incidents occurred in my own workshop only yesterday. The customer brought in a big Hitachi colour TV and complained that the picture had just faded slowly away, although the sound was still normal.

I didn't like the sound of 'just faded away'. That sounded suspiciously like a tube heater failure, and I always hate having to tell a customer that his tube is dead. I wasted no time in getting the cabinet back off, and sure enough, the heater was not glowing.

Sure, there are several reasons why the heaters are not glowing, but the most dramatic is an open circuit heater. It's the one we fear most and it's always the first test I make when the heaters are not glowing.

In this chassis it is easy to isolate the heater from the power supply. There are two small, two-pin plugs at the top of the bridge rectifier board, which connect the line from the power transformer to that going to the tube baseboard. Between the two plugs, in one side of the line, is a 1A delay action fuse.

Fault of the Month

NEC N-3430 CTV

SYMPTOM: No sound, and no control of volume. Volume control buttons will change channels, but have no effect at all on the volume. The channel change buttons work normally.

CURE: One or more buttons have broken off the button tree, and attached to the inside of the cabinet. The buttons cannot fall out, because of the way they are held in the cabinet, but they can effectively jam the wrong function switch.

This information is supplied by courtesy of the Tasmanian Branch of The Electronics Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

I pulled one of the plugs and checked for heater continuity at the baseboard. The heater appeared to be OK, and I confirmed this by patching a 6.3V AC supply across the heater pins on the socket. The set came up with a first class picture. So, if it wasn't the tube, it had to be the heater supply voltage. And therein lay the problem. There wasn't any!

I restored the plug to the bridge board, then removed the tube baseboard and checked the continuity back to the power transformer. It seemed quite normal, yet still there was no sign of 6.3V AC.

I pulled the plug from the transformer side of the bridge board and there I measured the missing voltage. It seemed to be disappearing in the short tracks between the two plugs — or in the fuse.

I pulled the fuse and measured it with the multimeter. Perfect — about five ohms, as I have come to expect with slow blow fuses. I checked the board and the plug connections for broken tracks or dry joints, but found nothing.

For the want of something better to do, I clipped a jumper lead across the fuse holder clips — and suddenly I had the missing voltage back. I removed the jumper lead and replaced the fuse. I have known fuse holders to develop a layer of insulating verdigris and this could have accounted for the symptoms I had with this set. But the set was now back to the No Go state.

It seemed that the fuse, although intact physically and electrically to the low voltage and current from my multimeter, was nevertheless open circuit to either the higher voltage or the higher current found in normal service. I fitted a new fuse and the set worked like a charm.

So there it is. It's not a fairy story.

[illegible]

THE SERVICEMAN

Three fuses, all physically intact but electrically unserviceable. I leave it to you to work out what kind of fault could cause the symptoms.

(Would you believe, the day after I finished writing the story above *another* set came into the workshop, with a similar unsprung delayed action fuse. This one had a small fusible resistor attached to the spring, rather than the more usual piece of wire.

This fuse was really open circuit but it was physically intact — the spring was still under full tension. Which just goes to show that you can't judge a fuse by appearances.)

Megawatt amplifier

To finish off this month, here's a short story as told to me by one of my colleagues. He once worked for the Tasmanian Hydro Electric Commission as a Control technician, and has a wealth of stories to tell of what goes on in power distribution in the 'Island State'.

One of them is good for a laugh whenever it is told. He relates the story thus:

A state-wide power network such as they have in Tasmania is a monster to control. The load can be required anywhere in the State, and has to be supplied from one or more generators in other parts of the island.

Although the main control room is in Hobart, there are subsidiary control rooms located in other centres. The signals to control the generators, to put them on line and on load, are generally in digital format and represent only a few milliwatts. This miniscule power is able to control megawatts after suitable processing, so it is vital that metering is precise and is accurately displayed wherever it is needed.

One of my maintenance engineering tasks was the periodical testing of meters in the control room. The instruments involved in this story were combination moving iron galvanometers and photoelectric relays.

Exact description would take more space than is available here; but put simply, the galvanometer displayed the state of the control signals passing from the control centre to the generator hall.

The photoelectric section relayed the position of the galvanometer pointer back to the control centre in Hobart. This gave the Hobart operators proof that the remote readings were the same as they were seeing on their local meters.

My job was to disconnect the remote meter from the generator, then feed in current using a 1.5 volt dry cell and a small potentiometer. As the meter moved, its position was relayed down the line and a corresponding meter in Hobart should have read the same position. Only this time I disconnected the wrong side of the meter...

Back in Hobart there were no return signals coming through, and much time was taken up testing lines and meters — but no fault could be found anywhere in the system. Then it was lunch time and we decided to pursue the problem after we had eaten.

When I came back from lunch I noticed great activity over by the power station. Engineers were running around all over the place and seemed to be almost in a panic. Curiosity got the better of me and I went over to have a look. A quick description of the problem made every thing clear, at least to me.

It seems that one of the fifty megawatt generators had been running quietly, off load, when it suddenly came up to full power and just as suddenly slowed down again.

It went through this cycle several times at irregular intervals. Then just before lunch, it stopped playing up and had been perfect ever since. The engineers had the machine stripped down to a skeleton, but could find nothing wrong with it.

I raced back to the control room and looked behind the panel. Sure enough, the meter I had been testing before lunch was the one connected to the baulky generator and confirmed that I had taken off the wrong connector — leaving the line to Hobart open and my 1.5 volt dry cell connected to the generator. So I had inadvertently been driving the generator in and out of operation. About 10 milliwatts from my battery was controlling an output of 50 megawatts at the generator!

When I left the HEC the engineers ceremoniously presented me with a battery mounted on a polished wooden base. The engraved brass plate reads 'To Eric, inventor of the world's largest Direct Coupled amplifier'.

Well, that's his story and he's sticking to it! Without doubt, that must have been the biggest amplifier ever built. What would the Rolling Stones give to have one of those?

Personally, I've often wondered two things: what happened to all the power his battery caused to be generated, and how many dB of gain did that amplifier have?

That's all for this month. I'll be back next time, if the fates be willing ❖

TECS TECS TECS TECS TECS TECS

SUPER SPECIAL

PRIME SPEC
INTEL BRAND
27512-25
UNBELIEVABLE
$5.00 EACH
'TILL STOCKS LAST

COMPUTER MEMORY CHIPS

	1-9	10+
4164-10 (64Kx1)	$3.25	$3.00
4464-08 (64Kx4)	$2.95	$2.75
41256-08 (256Kx1)	$2.95	$2.75
44256-08 (256Kx4)	$8.50	$7.95
411000-08 (1Mx1)	$8.50	$7.95
1Mx9 SIM/SIP	$59.00	$55.00
4Mx9 SIM/SIP	$250.00	$235.00

TECS
ELECTRONICS & COMPUTER SUPPLIERS

QUALITY

100% GUARANTEED

HITACHI MOSFETS

2SJ49	$8.00	2SJ56	$13.50
2SK134	$8.00	2SK176	$13.50

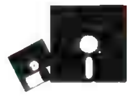
THESE POPULAR MOSFETS ARE NOW BACK IN STOCK. WHOLESALE ENQUIRIES WELCOME.

QUALITY JAPANESE BRAND FLOPPY DRIVES

3.5" 1.44M	$99.00
5.25" 1.2M	$125.00

NO BRAND DISKS

5.25" DSDD	$4.50
5.25" DSHD	$8.50
3.5" DSDD	$7.90
3.5"DSHD	$14.95



SEMI CONDUCTOR BARGAINS

DIODES

	1-9	10+
IN4148	$0.04	$0.03
IN914	$0.06	$0.05
IN4004	$0.08	$0.06
IN4007	$0.10	$0.08
IN5404	$0.20	$0.16
IN5408	$0.25	$0.20

BRIDGES

WO4	$0.50	$0.45
BR64	$1.50	$1.30
BR104	$2.50	$2.10
BR108	$2.75	$2.35
BR254	$3.50	$3.00
BR2510	$3.75	$3.45
BR354	$3.95	$3.50
BR3510	$4.20	$3.75

LED'S

3mm RED	$0.15	$0.12
3mm GRN	$0.20	$0.18
3mm YLW	$0.20	$0.18
5mm RED	$0.15	$0.12
5mm GRN	$0.25	$0.20
5mm YLW	$0.25	$0.20

7 SEG. DISPLAY

HDSP 7301	$2.75	$2.50
HDSP 7303	$2.75	$2.50
HDSP 5301	$2.75	$2.50
HDSP 5303	$2.75	$2.50

TRANSISTORS

BC547/8/9	$0.15	$0.12
BC557/8/9	$0.15	$0.12
BC327	$0.25	$0.10
BC328	$0.25	$0.20
BC337	$0.25	$0.20
BC338	$0.25	$0.20
BC639	$0.50	$0.45
BC640	$0.50	$0.45
BD139	$0.45	$0.40
BD140	$0.45	$0.40
BD681	$1.20	$1.00
BD682	$1.20	$1.00
BF469	$0.90	$0.75
BF470	$0.90	$0.75
BFY50	$1.20	$1.00
BU208A	$3.95	$3.50
BU326A	$3.95	$3.50
BU406D	$2.95	$2.60
BU407D	$2.95	$2.60
BUW12A	$6.95	$6.00
MJ15003	$6.50	$5.50
MJ15004	$6.50	$5.50
MJ2955	$2.50	$2.10
MJ802	$7.00	$6.30
MJE13007	$3.95	$3.50
MJE2955T	$1.90	$1.60
MJE3055T	$1.90	$1.60
MJE340	$1.50	$1.25
MJE350	$1.50	$1.25
TIP122	$1.50	$1.25
TIP127	$1.50	$1.25
TIP31C	$0.80	$0.70
TIP32C	$0.80	$0.70
TIP41C	$1.00	$0.90
TIP42C	$1.00	$0.90
2N2222A	$0.50	$0.45
2N2646	$1.95	$1.70
PN2907A	$0.40	$0.35
2N3055	$1.50	$1.20
PN3645	$0.40	$0.35
PN3771	$4.50	$4.00
2N3772	$4.50	$4.00
2N3773	$5.50	$5.00
2N3904	$0.35	$0.30
2N3906	$0.35	$0.30
PN4250A	$0.40	$0.35
2N6027	$1.00	$0.90
2N6123	$1.75	$1.50

VOLTAGE REGULATORS

7805T	$0.50	$0.45
7812T	$0.50	$0.45
7815	$0.50	$0.45
7905T	$0.60	$0.55
7912T	$0.60	$0.55
7915T	$0.60	$0.55
317T	$1.00	$0.90
337T	$2.10	$1.90
723	$0.80	$0.75

74LS

74LS00	$0.50	$0.45
74LS02	$0.50	$0.45
74LS04	$0.55	$0.50
74LS08	$0.50	$0.45
74LS10	$0.50	$0.45
74LS14	$0.60	$0.55
74LS32	$0.50	$0.45
74LS74	$0.75	$0.65
74LS85	$0.65	$0.60
74LS112	$0.65	$0.60
74LS123	$1.00	$0.90
74LS138	$0.75	$0.65
74LS139	$0.75	$0.65
74LS151	$1.00	$0.90
74LS153	$0.90	$0.80
74LS157	$1.00	$0.90
74LS161	$0.90	$0.80
74LS164	$1.20	$1.00
74LS173	$1.00	$0.90
74LS174	$0.90	$0.80
74LS193	$1.00	$0.90
74LS221	$1.20	$1.00
74LS241	$1.00	$0.90
74LS244	$1.50	$1.25
74LS245	$1.50	$1.25
74LS257	$1.00	$0.90
74LS273	$1.50	$1.25
74LS293	$0.90	$0.80
74LS373	$1.50	$1.25
74LS374	$1.50	$1.25

74HC

74HC00	$0.55	$0.50
74HC02	$0.55	$0.50
74HC04	$0.60	$0.55
74HC08	$0.55	$0.50
74HC10	$0.55	$0.50
74HC14	$0.65	$0.60
74HC32	$0.55	$0.50
74HC74	$0.75	$0.65
74HC85	$1.00	$0.90
74HC112	$0.90	$0.80
74HC123	$1.00	$0.90
74HC138	$0.90	$0.80
74HC139	$0.90	$0.80
74HC151	$1.00	$0.90
74HC153	$1.00	$0.90
74HC157	$1.00	$0.90
74HC161	$1.20	$1.00
74HC164	$0.80	$0.70
74HC173	$1.40	$1.20
74HC174	$0.80	$0.70
74HC193	$1.50	$1.25
74HC221	$1.20	$1.00
74HC241	$1.75	$1.50
74HC244	$1.50	$1.25
74HC245	$1.50	$1.25
74HC257	$1.20	$1.00
74HC273	$1.50	$1.25
74HC373	$1.00	$0.90
74HC374	$1.00	$0.90
74HC393	$1.50	$1.25
74HC4017	$2.00	$1.75
74HC4020	$2.00	$1.75
74HC4040	$1.50	$1.25
74HC4049	$1.00	$0.90
74HC4051	$2.00	$1.75
74HC4060	$2.00	$1.75
74HC4066	$1.50	$1.25
74HC4075	$0.90	$0.75
74HC4514	$3.50	$3.00
74HC4515	$3.50	$3.00
74HC4518	$2.50	$2.10
74HC4520	$2.50	$2.10
74HC4538	$2.50	$2.10

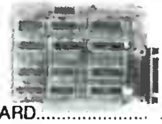
CMOS

4001	$0.35	$0.30
4011	$0.35	$0.30
4013	$0.60	$0.50
4017	$0.90	$0.75
4024	$0.90	$0.75
4026	$0.90	$0.75
4027	$0.60	$0.50
4040	$0.90	$0.75
4046	$0.80	$0.70
4049	$0.50	$0.45
4053	$0.90	$0.75
4060	$0.60	$0.50
4066	$0.60	$0.50
4069	$0.40	$0.35
4070	$0.35	$0.30
4071	$0.35	$0.30
4081	$0.35	$0.30
4093	$0.60	$0.50
4174	$0.90	$0.75
4511	$1.20	$1.00
4514	$2.30	$2.00
4518	$1.20	$1.00
4520	$1.20	$1.00
4584	$6.00	$0.50
40106	$0.60	$0.50

QUALITY IC SOCKETS

	1-9	10+
8 PIN	$0.20	$0.15
14 PIN	$0.25	$0.20
16 PIN	$0.30	$0.25
18 PIN	$0.35	$0.30
20 PIN	$0.40	$0.35
24 PIN	$0.50	$0.45
28 PIN	$0.55	$0.50
40 PIN	$0.60	$0.55

PERIPHERAL CARDS FOR COMPUTERS



XT CLOCK CARD	$24.50
XT/AT GAMES CARD	$24.50
XT/AT PARALLEL CARD	$24.50
XT/AT SERIAL CARD	$24.50
XT/AT MULTI I/O (2S, 1P 1G)	$39.00
XT/AT MONO/CGA CARD	$49.00
16 BIT 256K VGA CARD	$89.00
16 BIT 512K VGA CARD	$110.00
IDE/FDD CONTROLLER CARD	$29.00
IDE/FDC MULTI I/O CARD	$49.00
6M MEMORY EXP. CARD	$210.00

STILL USING SCREWDRIVERS TO REMOVE IC CHIPS?

AVOID DAMAGING EXPENSIVE IC'S WITH

8-40 PIN DIL IC EXTRACTOR $2.95

PLCC EXTRACTOR $19.50

HARD DRIVES

IDE

80M	$550
120M	$650
170M	$795
200M	$1150
360M	$2200
500M	$2450

SCSI

100M	$650
200M	$1200
500m	$2550

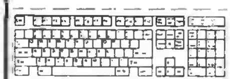
COMPUTER CASES WITH POWER SUPPLY

FLIP TOP	$99.00
MINI TOWER	$120.00

COMPUTER MOTHERBOARD

286-16MHz	$135.00
386SX-16MHz	$235.00
386SX-25MHz	$295.00
386DX-33MHz	$475.00
486DX-33MHz	$1150.00

KEYBOARD



$59.00

OFFICE: *1ST FLR., 289 LATROBE ST., MELBOURNE, VIC. 3000*
SHOP: *GRD. FLR., 289 LATROBE ST., MELBOURNE, VIC. 3000*
PHONE: *(03) 670 6474* ***FAX:*** *(03) 670 6006*

FREE PRICE LIST RETAIL & WHOLESALE

MAIL ORDER HOTLINE
(008) 335 901 TOLL FREE

ALL MAJOR
CREDIT CARDS WELCOME

SHOP HOURS:

MON.-THURS.:	8.30-5.30
FRI.	8.30 - 6.30
SAT.	9.00 - 1.00

Normal Prices charged, unless ad prices quoted.
Errors & Omissions excepted.

POSTAGE RATES:

$1.00 - $9.99	$3.00
$10.00 - $24.99	$3.50
25.00 - $49.99	$4.50
$50.00 - $99.99	$6.00
$100.00 - $199.99	$7.00
$200.00 PLUS	FREE

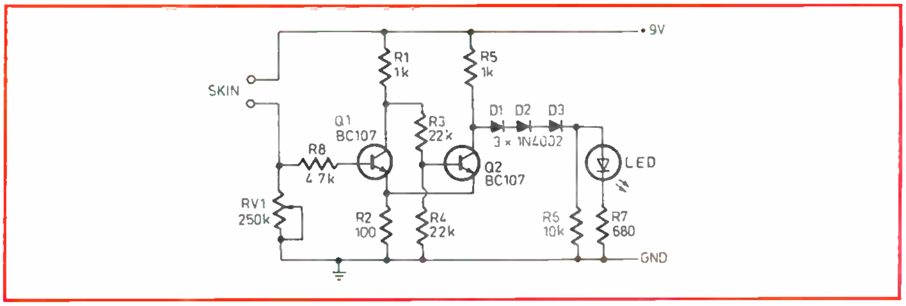
TECS TECS TECS TECS TECS TECS

[illegible]

Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

Acupuncture point finder



Unless you are a trained acupuncturist, you might find this instrument handy to locate your acupuncture points. It works because the skin resistance at an acupuncture point is considerably lower than the value of a neutral skin point.

Of course, skin resistance varies for many reasons; young or old, changing moods, nutrition, weather conditions, time of day and year, etc.

My experiments have shown that the skin resistance of a healthy middle-aged person at room temperature, away from the influence of electrical fields, is of the order of about 300k ohms. The resistance of an acupuncture point is about one third to one quarter of that value.

It boiled down to designing a circuit which indicated the difference between those two values, and would still function correctly when the conditions have changed considerably. The circuit should be inactive while the resistance of the skin is high — while no acupuncture point is touched. But it should show a response as soon as the resistance drops at an acupuncture point.

Consequently, the input bias had to be adjustable. Transistors Q1 and Q2 form a Schimtt trigger, with the input bias controlled by a potential divider made from the skin resistance being measured and the variable resistor RV1. For neutral skin points, transistor Q1 will remain off, with Q2 on. This means that nearly all the voltage drop will occur across resistor R5 (the voltage at the collector of Q2 was about 1.6V). The addition of the three diodes, D1-D3, removes any possibility of the LED being on under these conditions.

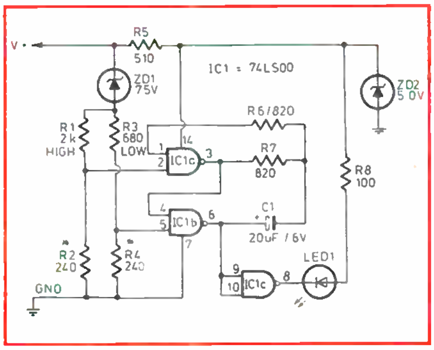
When contact is made with an acupuncture point, Q1 turns on, Q2 off, and the LED will glow. The 10k resistor, R6 was included in the original circuit which I modified, to stabilise the output when nothing was connected to the diode chain. Because it has a comparatively high value, I left it where it was.

Since skin contact is influenced by factors like sweat, grease, dirt and moisture, clean the skin surface before making measurements. Tape one electrode to the skin (round a finger, for instance), and mount the other electrode in an insulated holder like a discarded biro. The protruding tip of this electrode should be about 2mm diameter, as acupuncture points can have a diameter up to 4mm. Place a small piece of gauze dampened with saltwater between the skin and electrodes to provide better contact.

Set the variable resistor to about 100k. Then touch the electrode to a neutral skin spot — try several to make sure that an acupuncture point has not been chosen accidentally — and the LED should glow. Now adjust RV1 (decreasing its value) until the LED just turns off. When you search for an acupuncture point, the LED should begin to light up in the fringe area (up to 4mm from the centre). Move the electrode slightly about to determine the centre of the point.

Ted Allison,
Newborough, Vic. **$40**

Car voltage monitor



This simple voltage probe is capable of displaying three voltage levels for a 12V car battery, via one LED. If the voltage falls below the 'low' level (11.6V) then the LED glows, and if it rises above the 'high' level (14.5V) then the LED blinks with a frequency of about 1Hz. Between these two voltage levels the LED is off.

The battery voltage is first dropped by 7.5V (ZD1), then further lowered by two voltage dividers R1/R2 and R3/R4. The 'high' threshold level goes to pin 2 of IC1a (74LS00), while the 'low' level goes to pin 5 of IC1b. Obviously R1 must be greater than R2, so that the 'low' threshold is reached first.

When the battery is low, inputs to pins 2 and 5 are both logic low, so their outputs both go high. (The connection via R7 and R6 means that pin 1 is also high, though this has no effect until pin 2 eventually goes high.) This means that pins 9 and 10 of IC1c are also high, so pin 8 goes low. Current can therefore flow through LED1 causing it to glow continuously.

Once the probe voltage rises above the low threshold, but is still below the high value, pin 2 will remain low, but pin 5 will go high. The output of IC1a will not change, but that of both IC1b and IC1c will — pin 8 now goes high and blocks LED1. The LED is now off.

And at long last, when V+ is greater than 14.5V, pin 2 will also go high. IC1a and IC1b are now configured as an astable flipflop, with the oscillator frequency set by the values of C1 and R7. LED1 will now blink.

Due to chip tolerances, the values of resistors R2 and R4 might need to be adjusted. Remember that neither value can exceed 1k. After making these adjustments, the long term stability of the voltage thresholds will remain within 4-5% in the 20-30°C temperature range. This should be quite enough for most domestic and car appliances. I used a red LED, as this colour is the most 'alarming' when it needs to attract your attention.

Dr Alex Belousov,
Sumgait, Azerbaijan, USSR **$45**

[illegible]

[illegible]

Automatic scanning for CBs

Cheap Citizens Band radios are good fun and an inexpensive radio introduction (as a precursor to Amateur Radio of course!), but they have their limitations. One of these is the annoyance of having to manually step through the channels looking for activity. A way around this is to install a channel scanning circuit, a device which is provided on almost all of the high-end radios.

A good percentage of the bottom-line radios use up/down buttons for channel selection, as these are cheaper than installing a 40-position rotary switch. So it becomes a simple matter to wire a scan circuit in parallel with either the UP or DOWN button, to allow the radio to automatically change channels.

Since the radio itself takes care of 'rolling-over' between channels 40 and 1, the new circuitry only has to control the starting and stopping of scanning. That is what this circuit does. It uses only two ICs and a handful of discrete components to implement a simple scanner. A START button causes the radio to start scanning, and a STOP button will manually stop it.

A pickup from the radio's squelch line is used to indicate whether there is any activity on the channel. If there is, scanning stops, and should activity cease for more than a set time, the scanning will automatically recommence. The circuit operates as follows. U1 (555) produces a square wave of approximately 50% duty cycle at 5Hz. Note the somewhat unusual 555 configuration, with the output (pin 3) alternating between power and ground to charge and discharge the capacitor C1 via R2. This square wave is fed into the NOR gate U2:B which allows or prevents it from switching the output transistor Q2.

A set/reset flipflop is constructed from gates U2:C and U2:D. In the absence of squelch (discussed in a moment), when SCAN is pressed the output of the flipflop goes low, and so U2:B feeds the square wave through to Q2. If the STOP button is pressed, the flipflop output goes high, and hence U2:B no longer passes the square wave. Instead the output of U2:B goes low, and so Q2 is switched off. On the flipflop, C3 is used to provide a power-on pulse to the STOP input, to ensure that upon power-up the unit does not automatically start scanning.

Squelch monitoring is implemented with Q1, U2:A and associated components. On my radio (a Pearce-Simpson Super Lynx 3), the squelch line goes to about +3V when there is activity on the channel, and to ground when there is none. When the squelch line goes high, Q1 is turned on, which discharges C4 and causes the output of U2:A to go high. This in turn forces the control input (pin 6) of U2:B high, stopping scanning as before.

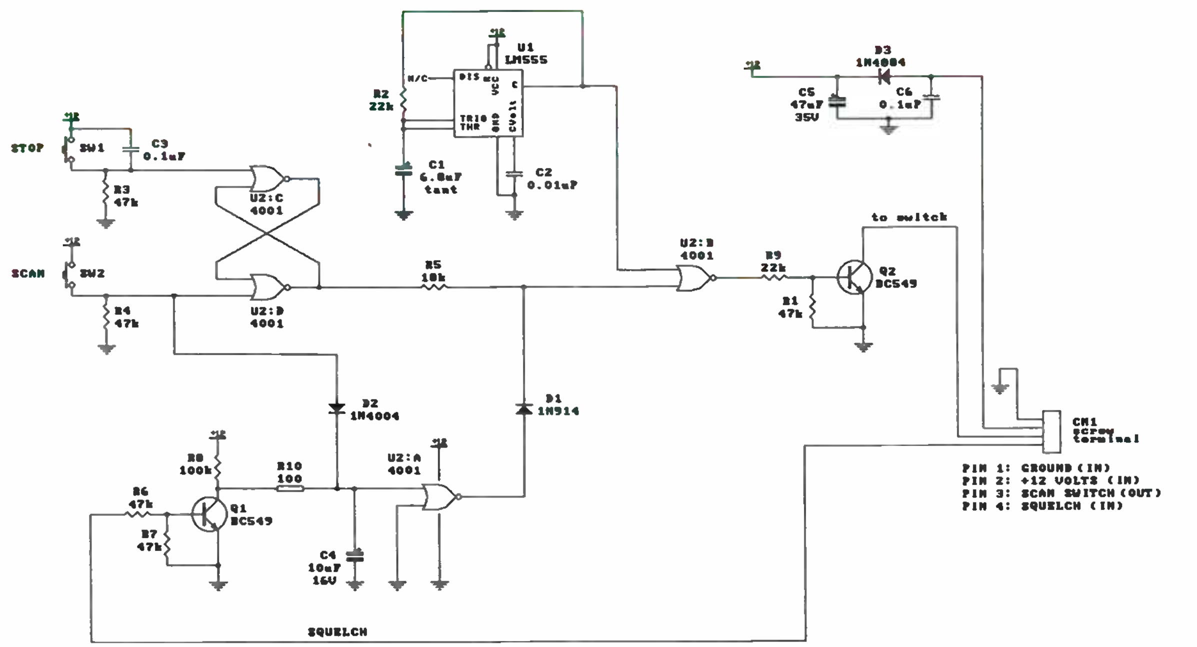
Possible conflicts between U2:A and the flipflop are prevented by R5 (which gives the squelch circuit priority over the flipflop), and diode D1 which stops U2:A from initiating scanning when the output of U2:A goes low. When channel activity ceases and the squelch line goes low, Q1 turns off. However the capacitor C4 is still discharged and so holds the input of U2:A low (and thus pin 6 of U2:B high) until it recharges via R8. This provides a delay of a few seconds, to prevent the unit from scanning again during brief pauses in conversation.

Diode D2 forces C4 to quickly recharge, should the SCAN button be pressed while the squelch line is high (i.e. active channel). This permits scanning to be continued even if the current channel is active. Perhaps the conversation became a little boring! Capacitors C5 and C6, plus diode D3, provide some supply voltage filtering, along with reverse-voltage protection.

Installation is simple, provided a circuit diagram of the radio is available. Determine which of the two UP/DOWN switches closes to ground (in my case the DOWN), and connect the collector of Q2 to this. Locate the output of the squelch circuit and connect the base of Q1 to it. As a guide to finding this output, the squelch generally becomes a DC voltage input to the audio amp IC, so that the amp is disabled when little or no RF is being received (the exact threshold being defined by the squelch knob on the front of the radio). Being a DC voltage, this point should have a capacitor or two to ground to remove any stray AC.

Provided that you can find the squelch output, the only other problem that may occur is that the squelch has the wrong polarity, i.e. it goes to ground rather than +V when there is activity on the channel. In this case, simply add another transistor before Q1 to invert the polarity. Aside from these potential problems, the circuit should go together quite easily.

Frank Van Hooft,
South Perth, WA **$45**



[illegible]

Beginner's project:

Easy to build low cost intercom

Need a three-way intercom where any station can call and talk to any other? No 'master' and 'slaves' with this design — each unit is 'active', and is built around two 8-pin ICs. So, with more than two units, there is no limitation on who can talk to whom.

by PETER MURTAGH

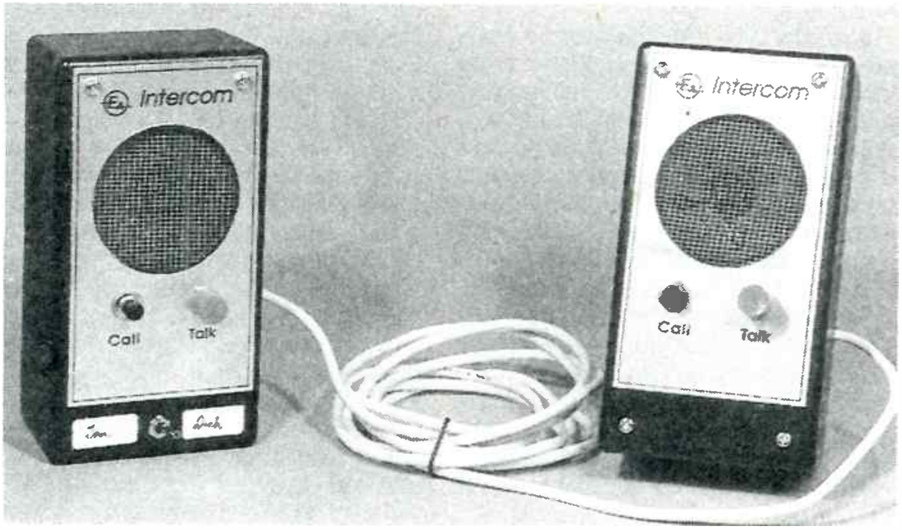
Previous designs for intercoms published by both *EA* and other magazines have all tended to suffer from the problem of interference. This occurs because the low-level signal from the 'passive' unit (the slave) must travel all the way along the connecting wires, where it is subject to radio frequency (RF) signals, before being amplified (by the master).

Or the interference can be caused by positive feedback, which occurs when parallel wires in close proximity carry the input and output signals from the amplifier.

Elaborate filters, or costly shielded audio cable are the normal solutions to these problems.

We have decided to try a different approach — by building a complete amplifier in each intercom station. This is economically feasible nowadays because of the existence of the LM386 audio module, which costs less than $2 and needs only a few components to make a suitable amplifier. A second low-cost IC, the 555, is used to provide an attention-demanding buzzer.

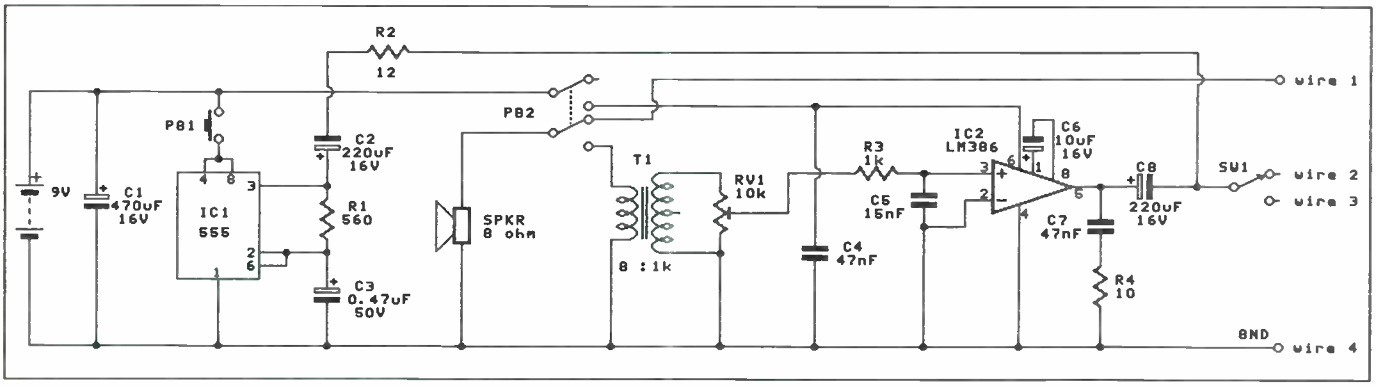
For simplicity, we decided to use the usual intercom approach where each speaker acts both as microphone and loudspeaker, depending on whether you are talking or listening.



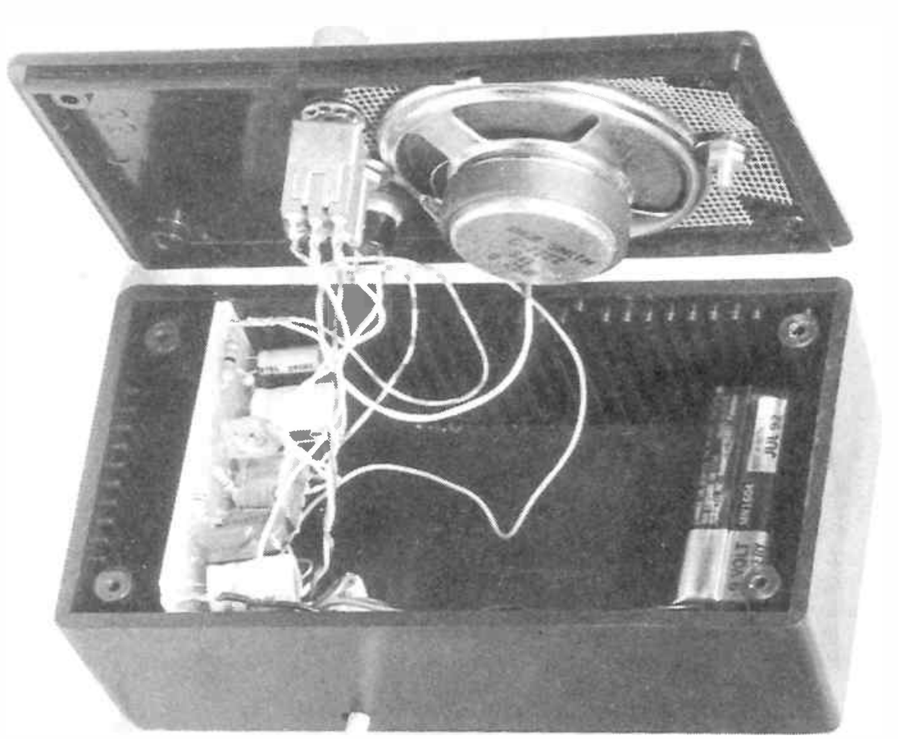
Shown are two variations of our intercom unit. The model on the left shows the optional privacy switch, and also the hole (lower left panel) to allow external adjustment of the amplifier gain.

So what are the main features of our new intercom? In addition to its flexibility as outlined above, each station is automatically powered up by pressing the 'talk' button. The amplifier draws quite a low current, so a standard type 216 9V battery can be used in each unit. Because this current flows only when you are talking, you can't forget to turn the power off and accidentally flatten the battery.

Also complete privacy is assured. Un-



The schematic shows the circuit inside each intercom unit. Each is active, i.e., a 'master' unit, with a 555 to produce the 'call' tone and an LM386 to amplify the voice. Switch SW1 is the optional privacy switch.



Looking inside the box shows the space at the right for the battery, and at the left for the privacy switch. The PCB slides into the slots on the sides of the zippy box.

less you press your 'talk' button, no-one can hear any signals from your unit — no-one can eavesdrop.

And your outgoing conversation only goes to the station which you have selected with your selector switch (SW1), so only the person you have chosen hears what you have to say. The wiring diagram in Fig.1 shows how to connect three stations, to give this privacy.

Another advantage of this design is that low cost, telephone-type wiring can be used — no need for expensive shielded cable.

Simple modifications can easily be made to this setup, to suit different needs. For example, you may not require the privacy function — this obviously is the case for a two-station intercom. Or you may wish to extend the number of stations to more than three. See the section on 'Modifications' for the details on how to do this.

To reduce the cost when building the intercom with brand-new parts, we decided to use 57mm speakers mounted in medium-sized zippy boxes (41 x 68 x 130mm).

While this definitely lowered the cost, the price we paid (pardon the pun!) is that the output of the intercom isn't terribly loud, and you must stand fairly close to the speaker when you wish to talk.

More about this aspect later on.

How it works

To alert another station, the caller pushes PB1, which activates the IC1 circuit, producing a buzzer signal. When PB1 is first pressed, the voltage at the trigger (pin 2) < 1/3 of the supply rail, so the 555's internal flipflop is turned on, and its output (pin 3) goes high. Capacitor C3 then begins to charge via resistor R1 until the voltage > 2/3 of the supply rail, when the threshold (pin 6) turns the flipflop off, and pin 3 goes low. C3 now discharges via R1 and pin 3, until its level drops enough to again trigger the circuit.

The charging and discharging times are each approximately 0.7RC, which gives a full cycle time (for 560 ohms and 0.47uF) of about 0.4ms, which means a frequency of about 3kHz.

This signal is fed via switch SW1 to whichever station has been selected. If your intercom does not have the private setup, then all loudspeakers will be buzzed, including the caller's.

The 555 draws about 50mA when producing this signal, so it should not be overused with a battery supply. Resistor R2 is provided to reduce the signal volume, and its value could be increased if you find the sound too loud.

This could easily be the case with the non-private setup, when the signal goes to several speakers connected in parallel, which decreases the load on the 555.

When the person called comes to their intercom unit, they press PB2. This powers up their audio amplifier IC2 (LM386), as well as connecting the speaker to the chip's input. With the button depressed, their voice is transmitted to the station selected by their selector switch SW1.

But how does the person at the other end know who has called them (so that they can switch SW1 to the correct sta-

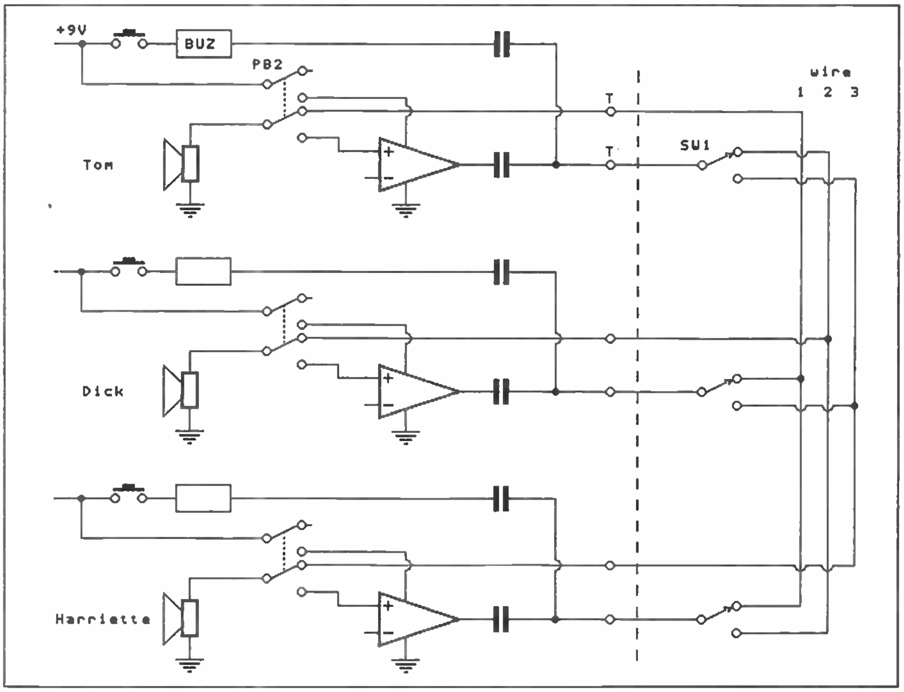


Fig.1: The wiring diagram to interconnect three units with full privacy. For non-privacy, one wire replaces everything shown to the right of the dashed line.

tion)? There are several ways around this problem. The caller can buzz with one, two or three bursts to indicate whether it is station 1, 2 or 3 calling.

Or, if you wish, the calling frequency of each unit can be altered by changing the R1/C3 combination, so that each station produces a different sound. Or the caller can simply announce him(her)self.

If you look at the wiring diagram in Fig.1, you can see that the caller can talk to the station they have selected, even if that station is not switched back to them.

Suppose Harriette wants to talk to Tom. As shown, she has selected station 1, so she can both buzz and talk to Tom.

A simple message like "Harriette here" can be heard by Tom — provided of course that he is in the room! He can then select station 3 to be able to talk back to Harriette. Dick (at station 2) can still buzz and be heard by Tom, but he cannot hear either Tom or Harriette unless they alter their selector switches. Complete privacy is maintained.

Now, back to explaining the circuitry in each unit. Transformer T1 is an audio type, with an 8 ohm primary (to match the 8 ohm speakers used) and a 1k secondary. The secondary has a centre-tap, which makes that winding easy to identify. The output of T1 (which gives a voltage gain of about 10) is fed through trimpot RV1.

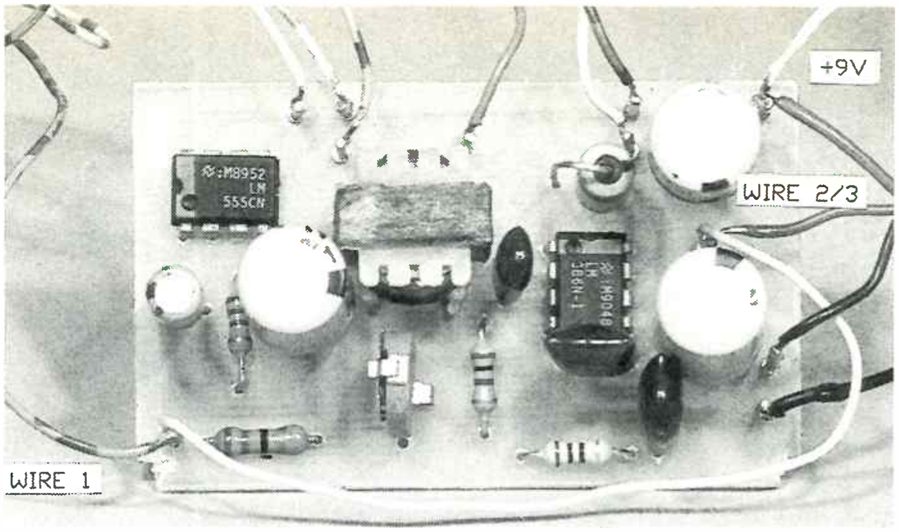
This controls the input signal to IC2, which allows you to adjust the output volume. Because we regarded this as a once-only adjustment, we used a trimpot instead of a more expensive potentiometer and knob.

As mentioned before, our small speakers need as much gain as possible. IC2 can give a gain of between 20 and 200. So, to achieve the upper limit, capacitor C6 is connected between the two 'gain control' pins (1 and 8) of the chip, effectively bypassing an internal 1.35k resistor between them.

(Our measurements on an oscilloscope showed that the overall gain — T1 plus IC2 — was close to the predicted value of 2000: 10 x 200.)

If less gain is needed — for example, if you intend using larger speakers — then add a resistor in series with capacitor C6. If C6 were removed altogether, then the gain would only be 20; so the resistor-capacitor combination can adjust the amplifier chip's gain to any value in the range 20-200.

Capacitors C4 and C5 have been added for stability. Notice on the PCB that they are attached as close as possible to the IC pins. C4 stabilises the supply voltage (the LM386 surprisingly did not like any variations in this voltage level), and the low value C5 provides a bypass for any high frequencies, from about 10kHz up.



Note that this intercom is wired for non-privacy — wire 1 from PB2b is joined by the loop wire to the output from C8, wire 2/3. It is also wired for a shared battery — the extra +9V wire at the top right sends power to the second unit. Also, the tight fit of some components, as shown on this prototype PCB, has been corrected in our final version.

Capacitor C7 also provides a high frequency bypass at the output. Resistor R4 is added in series with C7 to prevent an effective shortcircuit across the amplifier's output for very high frequencies.

Finally, the voice signal passes across capacitor C8, which provides DC isolation between the audio amplifier and both its own signal generator and other intercom units.

Construction

Start your construction by soldering on to the PCB the more rugged components like the resistors, trimpot, coil and capacitors. Make certain that the electrolytic capacitors are inserted with the correct orientation (see Fig.3).

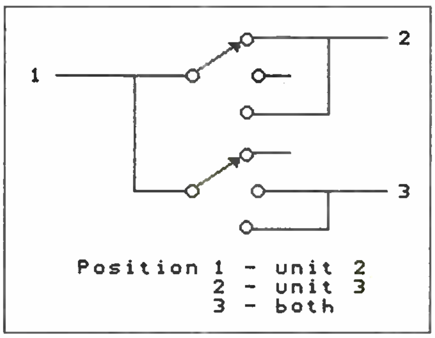


Fig.2: A two-pole, three-position switch allows three intercoms to have the option of either full privacy, or 'conference'.

Next solder in the ICs. It is a good idea to solder the earth and supply voltage pins first. Take care with each chip's orientation. The top of the chip usually has a dot or a notch, and the pins number down the left side and back up the right (as viewed from the top).

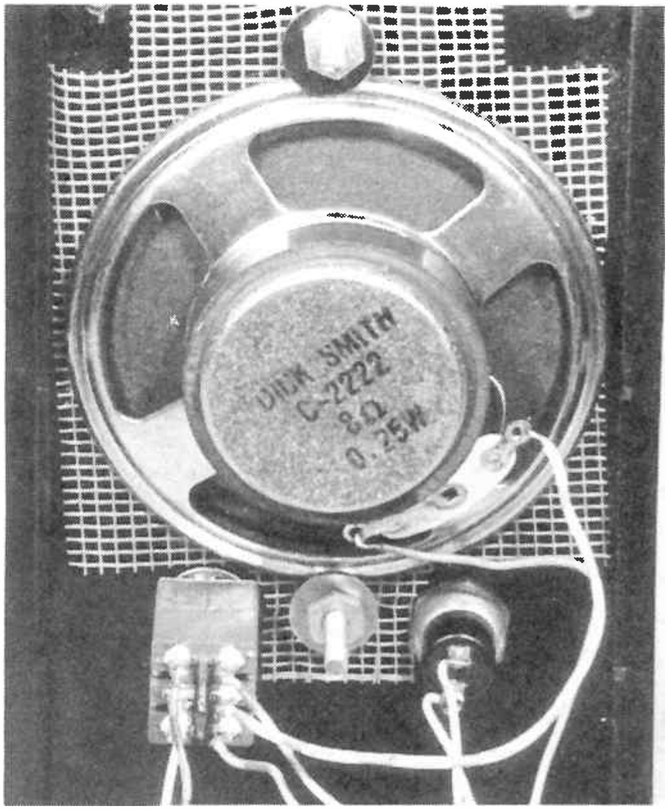
But don't be confused by apparent 'notches' which can be formed when adjacent chips on a strip are separated — the dot moulded into the casing is more reliable for identifying the top of the package.

With the chips inserted, connect wires to the battery clip, the pushbuttons and the output switch. (Don't solder the four output phone wires until you have checked that the unit works). For convenience, we soldered all wires directly to mounting pins on the PCB, including the interconnecting wires between the stations. However, if you intend to unplug a unit to use it in different locations, then make this connection to the phone wire with a suitable plug and socket.

Finally, you will need to cut notches in the top corners of the PCB to give space for the wires to the privacy switch SW1 — the PCB fills the whole gap.

The most tedious part of the construction is cutting the holes in the plastic box. Use a copy of the front panel artwork (Fig.4) as a template to mark the holes for the speaker and the two pushbuttons. For the privacy wiring, you must make another hole for the toggle switch SW1, but this is below the panel.

Remember to keep this switch as close to the bottom of the box as possible, since it must clear the PCB board —



The clamping arrangement for the speaker. Extra nuts beneath the washers act as spacers to keep the mounting bolts vertical. The protecting mesh for the speaker cone is a piece of non-metallic fly-wire.

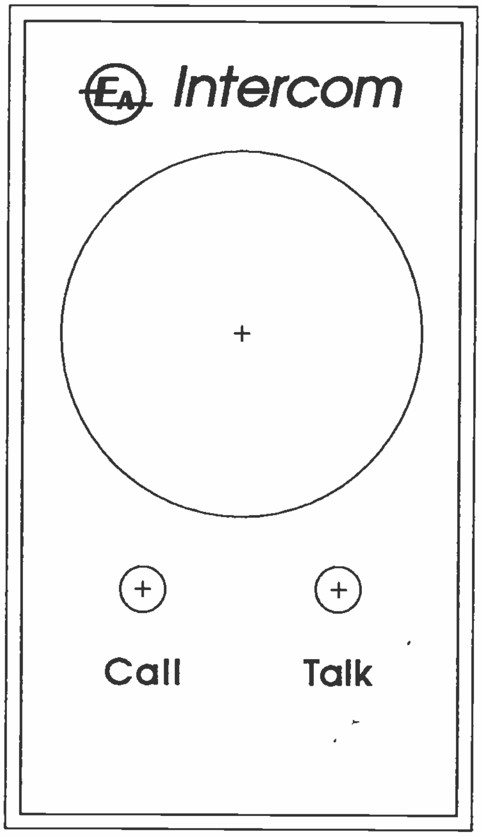


Fig.4: The actual size artwork for making the front panel. A photocopy can be used as a template to drill mounting holes.

which slots into the grooves along the sides of the box, just above it.

Next, drill an access hole for the connecting cable. How you decide to mount your intercom will decide the best place for this hole. Our model is designed to be screwed to the wall, so our leads emerge from the side, at the bottom.

Our front panel, therefore, is attached to the plastic top which is screwed to the zippy box. This arrangement means that two screws have to pass through the front panel at the top corners.

However, if you do not intend to fasten the intercom unit to the wall, but just sit it on a desk, then the base of the box could become the front of the unit. This would remove the need to drill these extra two holes, but would require the front panel to be trimmed to the inner line to fit the smaller surface.

From the photo, you can see that we didn't trust just gluing the speaker to the panel. The danger here is that the cardboard cone surround can tear away. Instead two countersunk bolts, with extra nuts as spacers to keep the bolts vertical, secure the flange of the speaker via large, overlapping washers.

Don't drill the bolt holes too close to the edge of the speaker — you need room for the spacers. The heads of these bolts don't show, as they are covered up by the front panel.

Another hole should also be drilled if you wish to be able to adjust the amplifier gain without removing the lid of the box. The vertically-mounted trimpot is positioned so that there is clear access from the left side of the box (see photo).

The zippy box we used had a continuous series of slots down the sides, so there was no problem with siting the PCB, components upwards, near the lower end of the box. Other boxes come with fewer slots, which might require inverting the PCB in order to have sufficient room above the board for the pushbuttons and speaker. In this case, the adjustment hole will have to be drilled on the opposite side of the box.

Because there isn't a lot of spare room in such a small box, check all clearances before drilling mounting holes. The switch bodies need to poke down into the box without colliding with electronic components, and you have to find room for the battery. Ours was attached by double-sided tape, on its edge, in the space above the top of the speaker.

Now you are ready to join up your units, and start communicating. Because each unit transmits an amplified signal, there should be no problems with the length of connecting wire.

Our model worked perfectly over a distance of 25m.

Testing

It is a good idea to build your units, one at a time, and test that they are working before installing them in their boxes. Use a spare speaker for these tests.

First connect that speaker to the output points for wires 2 and 4. Press PB1 and you should hear the buzzer. If you don't hear it, throw switch SW1 — you might be connected to wire 3! Next, press PB2 to talk.

You should hear a howl, caused by feedback from the test speaker to the nearby 'microphone' speaker. (If either of these tests don't work, refer to the later section on 'Troubleshooting'.)

If all is well, proceed with the construction of unit 2 (and 3). When you come to test your final unit, you will of course have no spare speakers left to do your testing. Connect to the speaker in one of the finished units, via wires 1 and 4, to do this final test.

Three way intercom

Modifications

Our setup was built for three units, with complete privacy between any two stations. This required the use of ordinary 4-core, telephone wire. Fig.1 shows how this was done. (The fourth wire, not shown, is the common ground wire.)

You want four or five units? Simple — just add one more wire to the interconnecting cable for each additional unit, and also add one more position to the output switch of each existing station.

For example, suppose you want to add a fourth unit to your system. You will now need a five-wire (instead of four) interconnecting cable, and the two-position selection switch at each unit must be replaced by a three-position one.

The extra wire is joined to the speaker of unit 4 via PB2b, and then to position 3 of each of the existing switches. Existing wires 1-3 are also extended to connect to the first three positions of unit 4's SW1 switch.

By using a multi-pole, multi-position switch, you could also add the option of a private connection to each of the other stations, as well as a common 'conference' connection where everyone can talk to anyone else. To do this, three intercoms would require a 2-pole, 3-position switch, while four units would need a 3-pole, 4-position, etc. (See Fig.2. for wiring details.)

The simplest wiring occurs if your intercom only has two units, or you have more units with no need for privacy. In this case, you need just two interconnecting wires, and you can also dispense with switch SW1.

The first wire connects all inputs and outputs, while the second wire is the common ground, 'GND'. (How to do this is shown in Fig.1. Dispense with all wiring to the right of the dashed line, and interconnect with one wire the pair of terminals 'T' on each unit — join all six terminals shown).

Yet another wiring option is to add a +9V wire from a common battery or power supply, and eliminate the separate battery in each unit. We tried this out, and it presented no problems.

Often intercom units are used as monitors, to listen in on a sleeping baby, etc. To add this facility, wire a DPDT toggle switch to duplicate the action of PB2. This lets the monitor be switched on permanently. But for any extended use in such a setup, a battery supply is not really practical.

And one final modification. We used cheap and nasty(?) 57mm speakers to cut costs. These are very ineffective microphones, which explains why our amplifier needs a gain of about 2000! If it is possible to replace these tiny speakers with larger ones, you will vastly improve the output quality and volume of your intercom.

But you must wind back the gain of the amplifier, otherwise the signal will distort when the output voltage varies by more than ±4.5V — the limit imposed by a 9V supply.

Any larger speakers, even older types from old radios, etc., will be an improvement. They will of course require larger mounting boxes.

PARTS LIST — EACH UNIT

Miscellaneous

41x68x130mm zippy box
PCB 61x37mm, coded 92IC6
57mm mini speaker
1k CT: 8 ohm audio transformer T1
SP (NO) momentary pushbutton PB1
DPDT momentary pushbutton PB2
SPDT toggle switch SW1
9V battery
4-core telephone wire (see text)
hookup wire, bolts, solder, etc.

Resistors

All 1/4W, 5%

1	560	R1	green-blue-brown
1	12 ohm	R2	brown-red-black
1	1k	R3	brown-black-red
1	10 ohm	R4	brown-black-black
1	10k vertical-mount trimpot	RV1	

Capacitors:

PC-mount electrolytic

1	470uF,16V	C1
2	220uF,16V	C2,C8
1	0.47uF,50V	C3
1	10uF,16V	C6

Capacitors:

polyester (greencap)

2	47nF	C4,C7
1	15nF	C5

Semiconductors

1	555 timer	IC1
1	LM386 audio amp	IC2

Troubleshooting

Say you finish building your intercom, plug in the battery, and it doesn't work! What do you do next? Well, most times when this happens, you can lay the blame on bad soldering. So check all the connections to see that the component leads don't wobble, and that all the joints have that complete, neat little cone of solder.

If the buzzer doesn't work, check the circuit around IC1. To do this, you will need a voltmeter to measure the voltages at various points. All these measurements presume that PB1 is depressed, so to save RSI in your finger, you might like to bridge across its two contacts to keep it permanently 'on' for as long as you are testing.

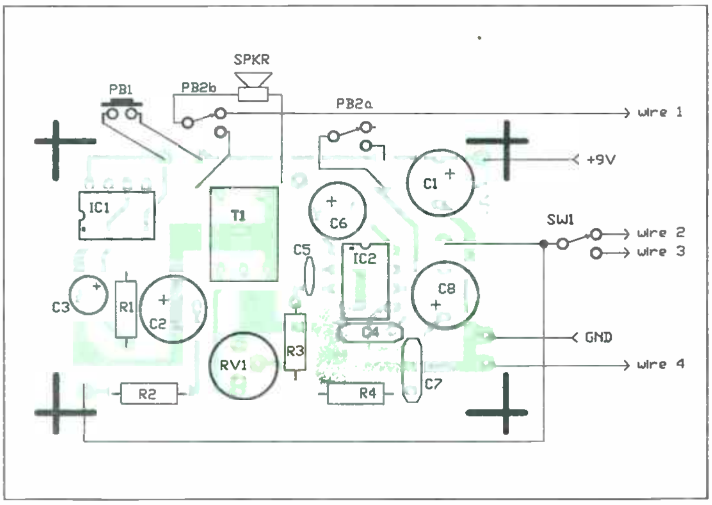
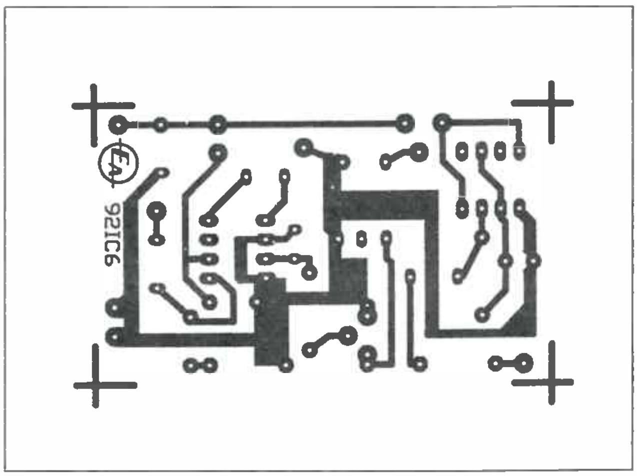


Fig.3: The component overlay diagram. If switch SW1 is not used, wire 1 must be joined to the output wire, as shown in the close-up photo of the PCB.



The PCB pattern is shown actual size for those who wish to etch their own boards. Each intercom unit uses the same PCB, as our design has 'masters' and no 'slaves'.

First, use the positive (red) probe on the meter to check that pins 4 and 8 both measure 9V.

Do this with the negative (black) lead connected to 'GND', and again with it touching pin 1. If you don't get the correct voltage values, then you have isolated a faulty connection.

Next check the voltages at pins 2, 3 and 6. Pins 2 and 6 should be rapidly varying from 3-6V, so your meter should give an average of about 4.5V; pin 3 should vary from 9-0V, also with an average of 4.5V. Briefly connect pin 2 to ground — pin 3 should go high (about 7.5V); next connect pin 6 to +9V — pin 3 should go low (0V).

If all these voltages check out, blame your wiring! Check this with another speaker. Connect one wire of the speaker to ground and the other via a series resistor (say 470 ohms) to various test points. First try pin 3, then the junction of R1/C2, then C2/R2, and finally the centre contact of SW1. As soon as the speaker doesn't work, there's your faulty connection.

If it's the amplifier section that doesn't work, first check that RV1 is set to give maximum gain (fully clockwise). Next, check the supply voltage to the chip. Between pin 6 and ground, and also between pin 6 and pin 4, you should get a reading of 9V (with PB2 depressed).

To see whether both sides of the transformer are connected to ground, measure the resistance on both the input and output coils. The DC resistance readings will be quite small: <1 ohm and <100 ohms. Don't confuse these resistances with the AC impedance values of the transformer (8 ohm:1k).

You can't check the AC signal circuitry with a voltmeter, but you can check it, provided one of your other units is completed, and works. We will use this second unit to amplify the input signal. So, join together the 'GND' of both units, then connect one end of your test lead to the RV1/R3 junction of the working amplifier. Both units should have their batteries connected.

With the other end of the test lead, work your way along the circuit of the faulty unit, from the speaker to the input (pin 3) of IC2, checking at each side of all components.

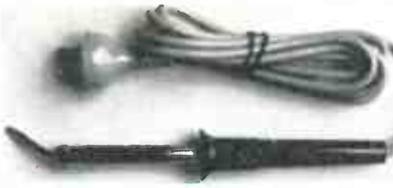
The howling from feedback indicates all is well. When the amplifier doesn't howl, you have your bad contact — one of the two joints immediately before your test point. Test on the copper track side of the PCB to isolate which join is faulty.

With all troubleshooting complete, join up your intercoms, and start talking! Happy communicating. ❖

[illegible]

60 WATT SOLDERING IRON

If your 20 or 25 watt iron doesn't have enough heat for those LARGE soldering jobs, this is the iron for you. It's 240V operated and is Electricity Authority approved. It comes supplied with two tips, one bent to 45° and one straight, both with chisel 3mm points.



Cat TS-1470

$29.95

NEW BOOKS

BUILD A PERSONAL EARTH STATION FOR WORLDWIDE SATELLITE TV RECEPTION

Now anyone can receive programs from anywhere in the world by way of satellite transmission. So if your tired of the TV programs you've been getting, now you can do something about it. For only the cost of the equipment you can gain access to an almost unlimited variety of television programming from 24 hour news to uninterrupted movies and special events. You can literally tune in the world a lot easier and for far less money than you'd imagine. This easy to use guide tells how to do it.

Cat BM-2481

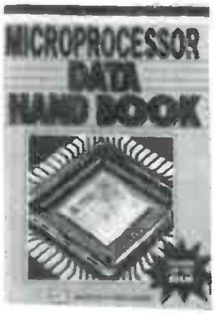
Only $22.95

THYRISTOR THEORY & APPLICATION

Explore the potential offered by solid-state thyristors in applications ranging from living room light dimmers to robot control in automated manufacturing. This excellent new book puts the full power of thyristor technology at your fingertips and shows how you can put these devices to practical, productive use in your own projects and experiments. Including plenty of theory to make thyristor technology easily understandable.

Cat BM-2480 **Only $12.95**

MICROPROCESSOR DATA HAND BOOK (NEW EDITION)



One of the best comprehensive data books we've seen. Covers TTL-CMOS, linear ICs, memory chips, analog devices, 8/16/32 bit CPUs, voltage regulator ICs, and clock/calculator ICs. This book is very well set out explaining data and diagrams on each IC, 667 pages in total. Every Electronic enthusiast should have one and at this price it is an absolute bargain.

Cat BM-2479 **$24.95**

THE 386/486 PC - A POWER USERS GUIDE

Many users are considering switching from the standard and well known PC to a more powerful machine based on the 80386/486. If you have been confused about extended and expanded memory, LIM, hard disc seek rate, SCSI, ESDI, ISA, EISA, MCA, wait states, caching, memory interleave, shadow ram or any other technical terms relating to the 386/486 PC, then you need to read this book. If you are considering purchasing a 386/486 or 386SX machine in the near future then this book will help you make sense of the choices offered to you. If you already have a 386/486 then this book will enable you to make it work as it should with the software of your choice.

Cat BM-2478 **Only $16.95**

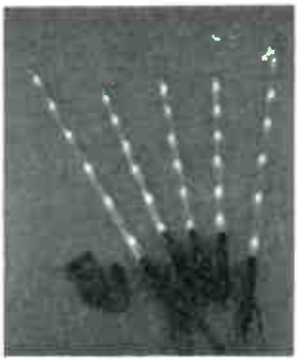
GARDEN LIGHTS NOW IN STOCK!!

Pathway Garden Lights

At last, garden lights that don't cost a fortune. This garden light kit has 5 tube lights, and each light has 6 globes. They are supplied with a special tapered base which is pushed into the ground. Two lights are 600mm tall, and the other three are 430mm high. All 5 lights are prewired with 2.3mt of cable between each one, with an additional 10mt to go to the mains adaptor. The lights operate on a safe 24 volts and each kit is supplied with a mains plugpack which reduces 240V AC to 24 volts. Current draw for all 5 is 450mA.

Cat SL-2840

$39.95



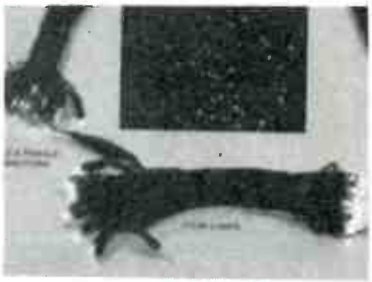
Outdoor Garden Lights - 80 Lights

Have the best looking garden in the street! Completely prewired - simply hang them through your garden. Safe, low voltage (24V) supplied with a mains plug pack to run off 240V. Globes are replaceable if they burn out. The set consists of: 20 metres of cable with a lamp moulded every 250mm (total 80 lamps). All cable and globe bases are green, so it easily hides in the garden. Current draw for the 80 globes is approx 750mA. Replacement globes are available.

Replacement globes Pkt 5

Cat SL-2822 $2.95.

Cat SL-2820 **$49.95**



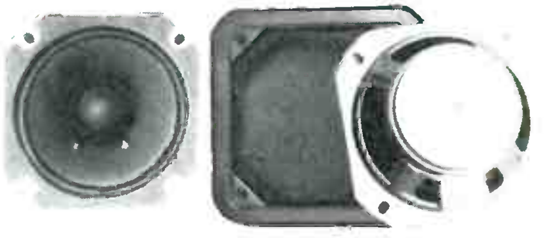
TURN YOUR SURPLUS STOCK INTO CASH!

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

Call Mark Harris or Bruce Routley now (02) 743 5222

UNBELIEVABLE CLARION CAR SPEAKER BARGAIN

Another surplus deal. These are Clarion brand Japanese made 5" twincone high power speakers complete with quality black grill. They were designated to be used in a locally built motor car. Power handling is a massive 40 watts maximum and they sound amazing.



Impedance is 4 ohms, and they have a large magnet for the speaker size. They will work in small enclosures and we were staggered at how good they sound. Ideal for cars, or simply use one or two together in a box for Hi Fi extension speakers. These would cost a fortune as a replacement, or even as a car speaker we would expect these to cost around $25-$30 each.

Features • 40 Watt power handling • Japanese Clarion brand • High quality • Complete with grill

Dimensions: Grill 126mm sq

Mounting holes 124mm diagonal

Spk frame 120mm sq

Depth including grill 50mm

Cat AS-3011

ABOUT 1/2 PRICE

Only $12.95 ea

STOCK UP NOW

UNIQUE DIGITAL TECHNOLOGY SCRAMBLER PHONE

... IS YOUR PHONE BUGGED?

WHO CARES, IF YOU HAVE TWO OF THESE!

Jaycar has made a scoop purchase of Telecom approved telephones that scramble your message so that it can be deciphered only on a similar unit. The phone (faun in colour) is housed in a standard Telecom set. There are no dial out facilities. You use by simply connecting in parallel to another telephone. Dial out on the standard phone and once the line is connected, pick up the scrambler. (The party on the other line must have a scrambler phone as well.) You can talk with relative security (we can't guarantee that ASIO or the CIA would not be able to decode the conversation).

These units once sold for $299. Another famous Jaycar scoop buy - far far below manufacturers cost - enables you to own a sophisticated scrambler phone at an unheard of price. You can own a scrambler phone for the ridiculously low price of $39.95 each! Remember, you will need at least two though. The stock is brand new, in cartons and has a 3 month warranty.

Unit requires 9V DC to operate.

Were $299

PLUGPACK MP-3007 $15.95

Cat YT-7000 **Now only $39.95 ea**

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

[illegible]

OK

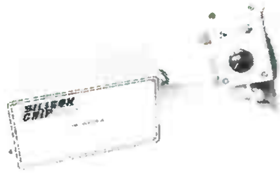
[illegible]

[illegible]

15W 12-240V Inverter Kit

Ref SC 6/92

This new design is based on the Feb 92 60W project, and is ideal for those who wish to run low power consumption equipment. The project fits snugly into a medium-sized jiffy box and is suitable for use with electric toothbrushes, camcorder battery rechargers and the like. An inexpensive option can be added (details supplied) to allow speed control for a telescope drive. Kit supplied with case, front panel label and all components to complete the project.



Cat KC-5117 **$49.95**

Off-Hook Timer Kit

Ref SC 6/92

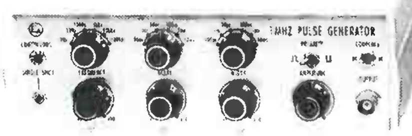
How many times have you taken the phone off the hook just so you can enjoy that dinner for two, or watch that Sunday movie uninterrupted? The problem here is that it is simple to forget to put it back on the hook again. This handy kit once activated, automatically takes the phone off the hook for either 30 minutes, one hour, or two hours, then replaces it automatically for you. Jaycar kit supplied with all specified components, including phone plug and cable.

New kits from Jaycar

Cat KC-5118 **$17.95**

Low Cost 1MHz Pulse Generator Kit

This project is an updated and improved design that has many features found on expensive commercial generators, but at a fraction of their cost. It can be used for fast evaluation of wideband amplifiers and filters, adjusting the frequency compensation of scope probes and other attenuators. It is a must for troubleshooting and developing digital circuits. The project provides BNC o/puts for CROs with single-shot and continuous pulses. The Jaycar kit comes complete with case, front panel label, PCB and components.



Cat KA-1743

$89.50

BUY 10 LESS 10%

NEW PENRITH STORE

199 HIGH STREET

Ph (047) 21 8337

FACSIMILE (047) 21 8935

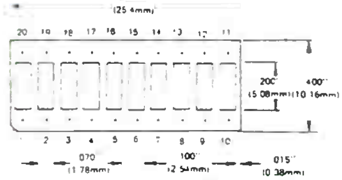
OPEN 7 DAYS A WEEK

Sat 9am-4pm / Sun 10am-4pm

JAYCAR No 1 FOR HOBBYISTS

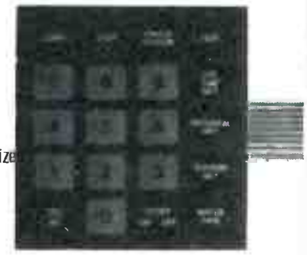
NEW BARGAIN PRODUCTS Grab these while they last and at these prices, they won't last long

LED Bar Graph



10 Red LEDs
Bargain priced
Cat ZD-1704
Only $2.95

Membrane Touch Keypad



Worth well over $10 each. Has 20 separate keys, 1 to 0 and 10 others. Supplied with peel off adhesive back. Size 91(W) x 96(H)mm.
Cat SK-0755
$2

Round 240 Volt Clipsal Socket

Well below normal price. A 240V socket which is self switching when a plug is inserted. White in colour.
Cat PS-4014 **A bargain at $2 ea**

IDC Lead Bargain

This lead has a 16 way IDC DIL plug on each end, with ribbon cable connecting them. Length is 180mm. The plugs can easily be re-used. Cat PI-6552 **$1 ea**

Relay

12 Volt 5 Amp SPST. PC mount Cat SY-4057 **Only $2.95**

Pushbutton Thumbwheel Type Interlocking Counter Switch

These normally sell for $13-$15 each. Save a fortune.
Cat SP-0785

Only $3.95 ea

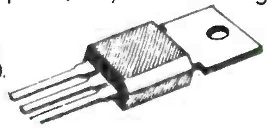
PC Mount Pushbutton Switch

High quality push on SPST. Grey/black.
Cat SP-0725 **$1 ea**

28 Way Pin Header

Cat HM-3211
$1.80

C106Y1 SCR



These have been used in countless projects and normally cost $1.20 each. They are 30V 4A. Stock up now. Pkt 50.
Cat ZX-7010
50 for $10

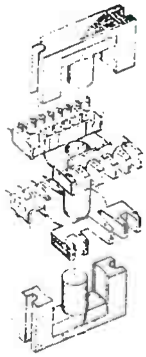
High Voltage Electrolytic

100uF 450V RT. Small quantity and very rare in this high voltage.
Cat RE-5888
$3.95 ea

Circuit Breaker

125V 20 Amp.
Well below normal price.
Cat SF-2280
1-9 $1.50
10+ $1

Siemens E Core Sets



Siemens E Cores use high quality N27 siferrit material, featuring an extremely high flux density and a frequency range of 0-0.1MHz. Ideal for compact power transformers, DC-DC converters, Chokes, Transducers, Interference suppressors. Coil former is glass fibre reinforced thermoplastic flame retardant polyester. Bobbin and cone pair supplied.
Cat LF-1270
BARGAIN AT **$3.95**

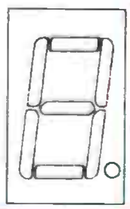
.47 Farad 5.5V Supercap

Cat RU-6702 **$5.50**

2N5192 Transistor Bargain

NPN, VCB 80V, IC 4A, HFE 20-80, 40W. Flat pack TO-126 device. Normally about $1 each.
Cat ZT-2100
Pkt 50 for $10

LED Display Bargain



7 segment red LED display, same as those in our catalogue - No ZD-1803. Common cathode. Connection details available on request. Normally $3.50 ea.
Cat ZD-1803

1/2 Price

1-9 $1.75 ea	**25-99 $1.00 ea**
10-25 $1.20 ea	**100+ .70¢ ea**



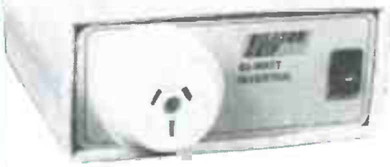

KITS KITS KITS KITS KITS KITS KITS KITS

60 Watt 12 - 240V Inverter Kit

Ref: Silicon Chip February 1992

This inverter is ideal for use anywhere where 240V AC power is not available. The Jaycar kit includes an improved and larger version of the transformer specified for the 40W version, which gives an extra 20 watts to around 60 watts. Ideal for fax machines, electric toothbrushes, battery chargers for mobile telephones, incandescent lamps, etc., etc. The Jaycar kit includes PCB, box, punched and screened front panel and all specified components including the larger transformer.

Cat. KC-5108 **$99**



THERMOSTATIC SWITCH KIT FOR CAR RADIATOR FANS

Ref Silicon Chip March 92 Has the thermostat failed on your electric radiator fan? Our electronic thermostat can replace it and be adjusted to switch on at a temperature to suit your particular vehicle. The switch will ensure that your fan cuts in and out only as required so that your engine operates at the correct temperature for peak efficiency. The Jaycar kit is supplied with diecast aluminum box, PCB and all specified components except for the sender unit (which is available from K-Mart). Cat KC-5115 **$37.95**

Dolby Surround Sound Decoder Kit

Ref: EA January 1992. Experience cinema sound in your own lounge room. The Dolby "Surround Sound" process increases the sensation of "being there" by producing an effects channel to create surround sounds which a conventional stereo system can't produce. Hook this simple kit in conjunction with your Hi Fi VCR or stereo TV and take full advantage of movies recorded with Dolby encoding. Short form kit - includes PCB, and all on board components. Cat. KA-1741 **$39.95**

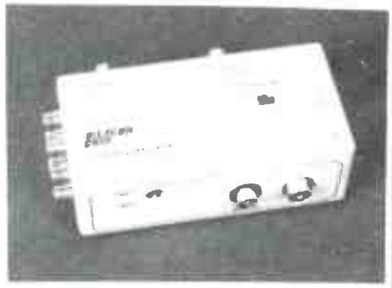
TV Transmitter for VHF VCRs Kit

Ref Silicon Chip March 1992

How many times have you wanted to watch something from your VCR on another TV set located in another room of your house? Up until now you had to run along cables through the walls or through the ceiling. Want to fix that? Our new transmitter does away with all those cable and simply connects into your VCR, and transmits a signal to your second TV set. THe Jaycar kit is supplied with Jiffy box, front panel labels and the VHF modulator, plus all specified components except the antenna assembly and connecting VCR cables.

Cat KC-5114

$99.50

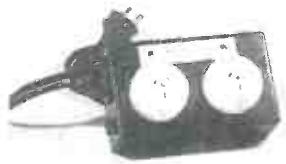


240V Power Relay Kit

Ref: EA January 1992

This kit will monitor the power drawn from a "master" power point socket, and automatically switch on a slave socket. It's very versatile because it can monitor one or several appliances plugged into the "master" and switch one or several devices plugged into the "slave". An ideal use for this project would be to switch on your Hi Fi system. With a four outlet board plugged into the slave socket, turning on your amplifier (in master) will switch on your tuner, tape deck, CD player and turntable etc. The kit includes PC board, box, 240 volt sockets, lead and plug and all specified components.

Cat. KA-1740 **$49.50**



LOW COST SINE/SQUARE WAVE OSCILLATOR KIT

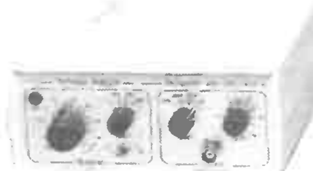
Refer EA March 92

This project is an addition to our range of low cost bench gear and is relatively straightforward to construct. The kit covers the frequency range of around 6Hz to 70KHz in four ranges with very low distortion (typically 0.07%). It is based on a Wien bridge circuit, due to its low cost, high performance characteristics.

The Jaycar kit comes complete with instrument case, front panel label, plus the PCB and all specified components. Our kit is also supplied with 1% resistors and the ultra-low noise 5534 op amp.

Cat KA-1742

$55



Studio Twin Fifty Stereo Amplifier Kit

Ref Silicon Chip Feb, March, April 1992

FEATURES OF THE TWIN 50

• 50 watts per channel with both channels driven into 8 ohm loads • Very low noise on phone and line level inputs - comparable with many CD players • Up to seven stereo program sources can be connected • Tape monitor loop • Separate ultra-low distortion stereo headphone amplifier • Stereo/mono switch • tone defeat switch • Straight forward construction.

BEGINNER CONSTRUCTORS CAN BUILD THIS AMP - If you can use simple hand tools and a soldering iron you can build this project. virtually everything is board mounted making construction incredibly simple, allowing you to complete this project in a couple of nights.

PERFORMANCE SPECIFICATION • Power output (one channel) - 4 ohms 80 watts, 8 ohms 55 watts • Power output (both channels) - 4 ohms 70 watts, 8 ohms 47 watts • harmonic distortion less than 0.05% 20Hz to 20kHz at rated output level for any input or output. See catalogue for full specifications.

The new Studio Twin Fifty is housed in a midi-sized case and comes as a complete kit including punched and screened front panel; black anodised knobs, all specified components and high quality pre-tinned printed circuit boards.

Cal KC-5110 **$299**

SOLAR BATTERY CHARGER KIT (High Power)

Ref Silicon Chip Nov 91

EXCLUSIVE KIT TO JAYCAR

This new kit will handle currents of up to 2 amps or so, making it suitable for use with solar panels up to around 25 watts. Panels above 25 watts can be used but the charger will only allow 2A maximum charge to the batteries. This kit will stepdown the voltage to the batteries when the solar panels output is above 15 volts and stepuo the voltage when there is less than 12 V available.

Kit includes: PCB, potcores, heatsink and all specified components.

Cat KC-5102 **$34.95**

Jaycar ELECTRONICS

HEAD OFFICE
6 Leeds Street Rhodes 2138
Telephone (02) 743 5222
FAX (02) 743 2066

POST & PACKING	
$10 - $24.99	$ 3.75
$25 - $49.99	$ 4.50
$50 - $99.99	$ 6.50
OVER $100	$ 8.00

MAIL ORDERS
P.O. Box 185 Concord 2137
ROAD FREIGHT ANYWHERE IN AUSTRALIA (up to 20kg) $13.50

MAIL ORDER VIA ☎
FREE CALL - FOR ORDERS ONLY
(008) 022 888
HOTLINE (02) 743 6144

Bankcard MasterCard AMERICAN EXPRESS VISA Cards Welcome

ADELAIDE SA	190 Wright St (Cnr. Selby St) (08) 231 7355 Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 12
BURANDA QLD	144 Logan Rd (07) 393 0777 Mon-Fri 9 - 5.30 Thurs 8.30 - Sat 9 - 4
COBURG VIC	266 Sydney Rd (03) 384 1811 Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 4
MELBOURNE CITY	Shop 2, 45 A'Beckett St City (03) 663 2030 Mon-Fri 9 - 5.30 Fri 8.30 - Sat 9 - 2
SPRINGVALE VIC	887-889 Springvale Rd Mulgrave (03) 547 1022 Nr Cnr. Dandenong Rd Mon-Fri 9-5.30 Fri 8.30 - Sat 9 - 2
SYDNEY - CITY	117 York St. (02) 267 1614 Mon-Fri 8.30 - 5.30 Thurs 8.30pm - Sat 9 - 4
BANKSTOWN	363 Hume Hwy Cnr Meredith St (02) 709 2822 Mon-Fri 9 - 5.30 Thurs 8.30pm - Sat 9 - 4 - Sun 10 - 4pm
GORE HILL	188 Pacific Hwy (Cnr. Bellevue Ave) (02) 439 4799 Mon-Fri 9 - 5.30 Thurs 8.30 - Sat 9 - 4pm
PARRAMATTA	355 Church St (Cnr. Victoria Rd) (02) 683 3377 Mon-Fri 9 - 5.30 Thurs 8.30pm - Sat 9 - 4pm Sunday 10am - 4pm
PENRITH	199 High St (047) 21 8337 Mon-Fri 9-5.30 Thurs 8.30 - Sat 9-4pm Sun 10-4pm
RHODES	6 Leeds St (02) 743 5222 Mon-Fri 9 - 5.30

Construction Project:

ELECTRONIC KEY

'And it was written that man shall enter great and not so great buildings, by poking little blocks of doped silicon into receptacles within the building'. The time has come to pass...

by DOMINIC DECARIA and PETER PHILLIPS

These days entry into buildings, cars, security areas and so on is often controlled electronically. Wipe a card through a reader, enter a code via a keypad, press a button on a hand-held transmitter — the methods are endless. In fact it seems the mechanical lock and key is now out of fashion, mainly because it offers such low security.

But somewhere the simplicity of turning a key in a lock has been forgotten in favour of 'technological advances'. While an electronic entry system has numerous advantages, it also has its problems, especially the complexity (and expense) of the system. So how about a system that has all the simplicity of a key in a lock, but without the problems of forgetting the entry code, loosing the magnetised plastic card, flat batteries in the transmitter, and so on?

This project was conceived by Branco Justic from Oatley Electronics, with much of the final development undertaken by Dominic Decaria. It was Branco's aim to produce an electronic key that overcame the limitations of most electronic entry systems, while retaining a high security. As you will see, like all good ideas the concept is simple, even revolutionary.

In principle, entry is achieved by touching an electronic key (it even looks like a key) against two terminals fitted near the point of entry. The terminals connect to a decoder board located somewhere inside the building, and if the code on the key matches that of the decoder, the lock opens. Otherwise it refuses entry.

The clever part is that the 'key' doesn't require a battery — instead it gets its power from the decoder board.

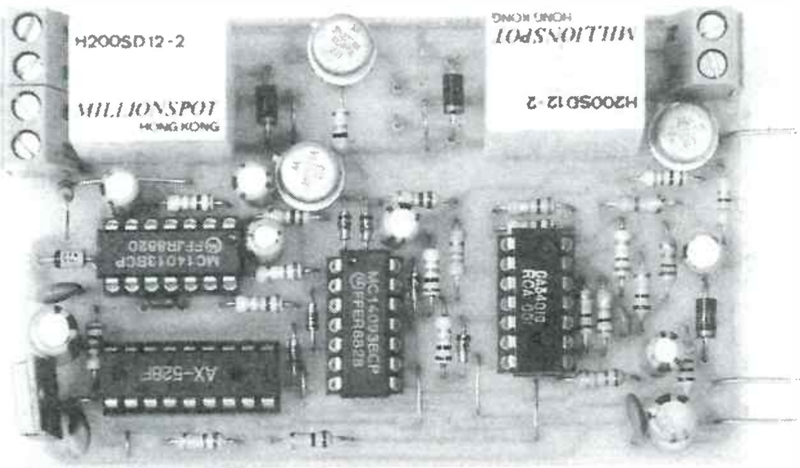
As the lead photo shows, the solid-state key is about the same size as a conventional key; the decoder board is equally compact. Security is extremely high, as there is virtually an unlimited number of possible codes available to the user. And because the code is not transmitted, it cannot be detected by scanning devices.

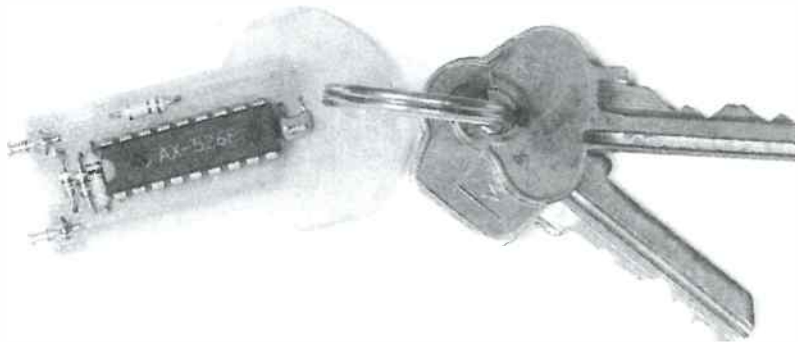
The decoder board contains two relays that can be used to operate a door strike solenoid, to deactivate an alarm, or in the case of an illegal code, to trigger an alarm. There is also a 'tamper' output, which can be used to either activate an alarm or perhaps to send a high voltage to the offending key, destroying it instantly but without damage to the decoder.

Installation is incredibly easy, as the decoder board can be placed anywhere and connected with two wires to the touch terminals. Because one of the terminals connects to the common of the circuit, if the system is used in a motor vehicle one terminal can be the body of the vehicle. All you need in this case is another terminal insulated from the metalwork. The decoder board can operate from 11V to 15V DC, making it ideal for use in a car, truck and so on.

The two relays on the decoder board are connected to give two types of outputs. One is a toggle output that can be used to switch other equipment on and off with alternate key touches. For instance, the first contact of the key might enable an alarm and the second disable it.

The other relay pulses on for a short time with each alternate key touch, allowing it to be used to flash an indicator light or pulse a door strike solenoid. In short, this project has it all; simplicity of operation, high security, lots of features and a low cost.





ELECTRONIC KEY

A point to note is that the PCB designs used in the project are copyright to Oatley Electronics, meaning that boards will not be available from any other suppliers. However Oatley is making available complete kits for the project at a very reasonable price.

For around $60 you get two keys and the decoder, including postage to anywhere in Australia. An electric door strike costs less than $40, giving a complete door lock system for less than $100. All you need to add is the 12V power source.

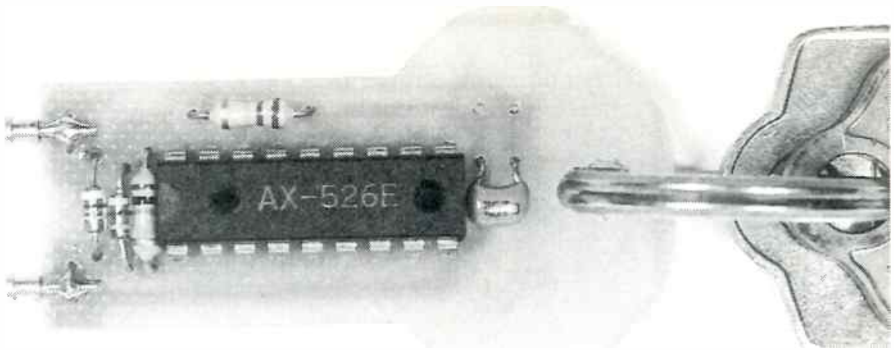


Fig.1: This photo shows a close-up of the key. The input terminals can be metal thread screws or PCB pins as shown here. The contacts should be attached with a loop of wire over each contact, soldered to both the contact and the PCB pad. The authors have applied for a trademark covering this aspect of the design.

How it works

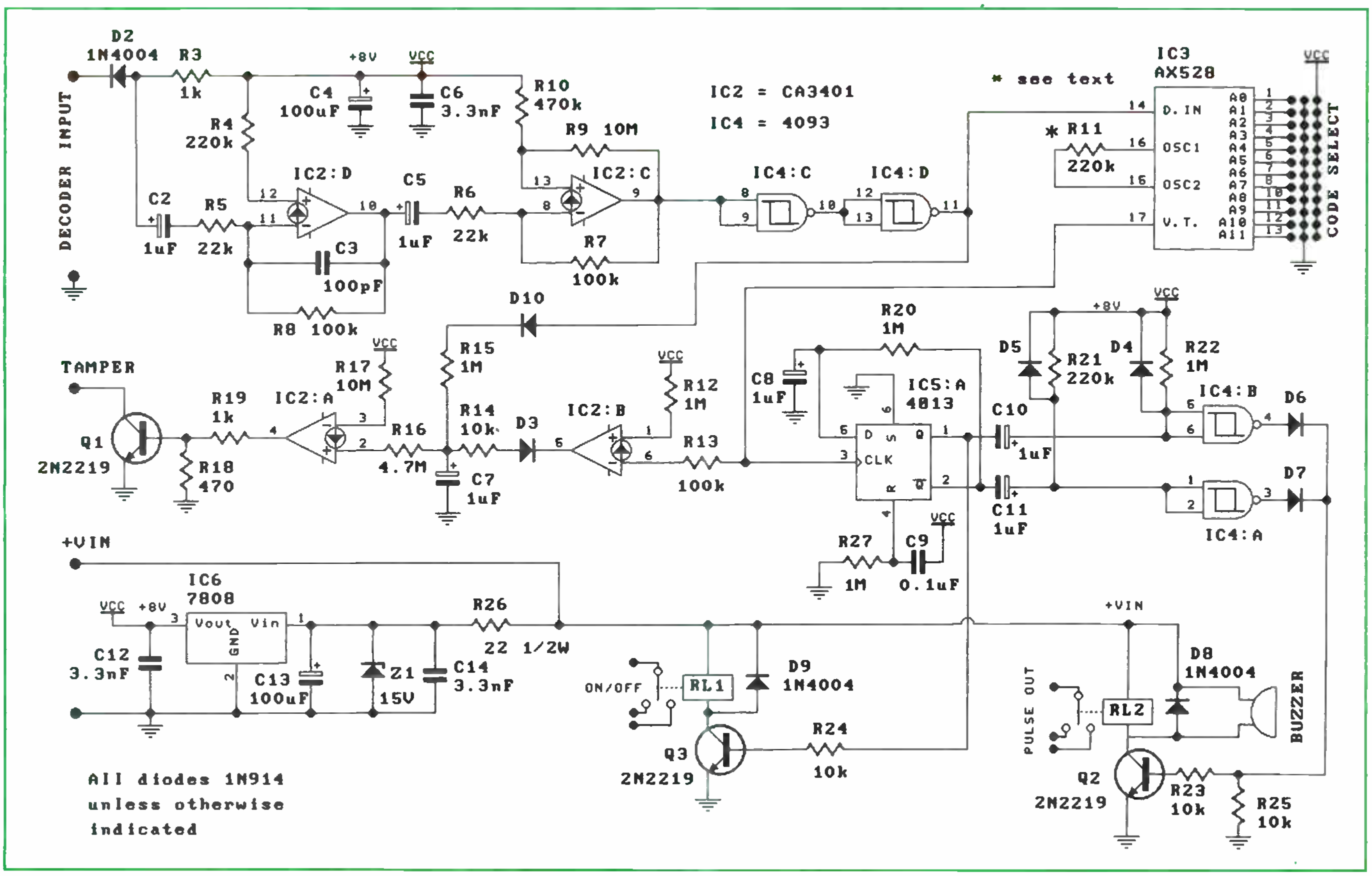
The circuit is in two sections, the encoder (key) and the decoder section. The whole circuit is based around a trinary encoder IC in the key and a trinary decoder IC in the decoder section. The key therefore consists mainly of the encoder IC1, type AX-526 plus a few additional components.

When the key is pressed against the input terminals of the decoder PCB, the encoder IC (IC1) generates a code sequence determined by the logic states on its address lines A0 to A11. Each of the 12 address inputs can be connected to either the supply (logic 1), ground (logic 0) or left open-circuit — giving over half a million codes. Resistor R1 determines the rate of the code transmission and its value must be the same as the timing resistor (R11) for the decoder IC. The value of the timing resistors can be anywhere between 50k to 10M, giving an almost unlimited variety of codes.

When the key contacts the input terminals of the decoder, a voltage divider made with R2 (on the key) and R3 (on the decoder PCB) couples data from IC1 onto the 8V supply line.

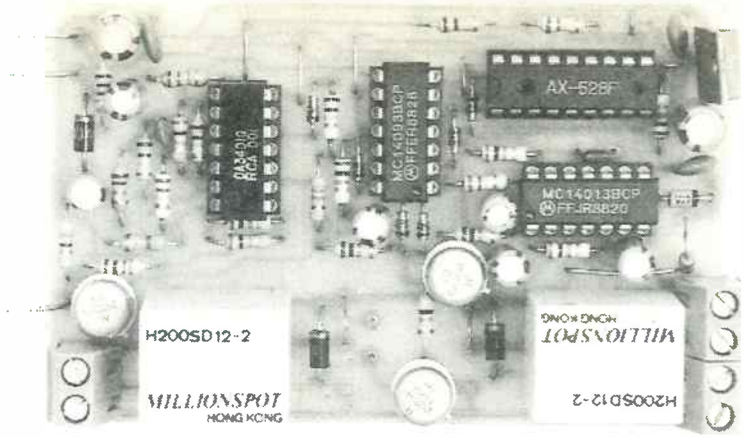
This signal appears as ripple at the cathode of D11, which is filtered by the peak voltage storage network of D1 and C1. This gives a smooth DC to the key circuitry, preventing the ripple from affecting the operation of the encoder IC itself.

Diode D11 protects the key from damage if it's connected with reverse



When the key is connected across the input terminals, the resulting signal is amplified by IC2d and IC2c, shaped by IC4c-d then passed to decoder IC3. If the code is correct, pin 17 (VT) of IC3 goes high, operating flipflop IC5a. The outputs of the flipflop operate the two relays via timing networks.

[illegible]



This photo shows the decoder PCB. Because the board is fairly compact, fit all the links and components before soldering the ICs in place.

polarity to the input terminals. Normally D11 is reverse biased, conducting only if the supply polarity is incorrect.

Diode D2 in the decoder section protects the decoder circuit against an excessive positive input voltage, while coupling capacitor C2 passes the data to the first amplifier stage of IC2d. This stage has a gain of approximately five (R8/R5) and is connected as an inverting amplifier.

The output of IC2d connects to IC2c, another inverting amplifier stage again with a gain of five, but with a small amount of positive feedback (via R9) to give a degree of hysteresis to the amplifier. The output of IC2c is biased to about 2V and the digital code from the encoder appears at the output of this stage. The Schmitt input NAND elements IC4c and IC4d shape the signal and pass it to the data input terminal of the trinary decoder IC3.

As for the encoder IC in the key, address lines A0 to A11 of IC3 are connected to either a logic 1, logic 0 or left open-circuit. If the code applied to pin 14 of IC3 matches the code set by the address line connections, and if the timing rate as set by R11 is the same, the valid transmission output (pin 17) goes high.

The VT terminal is connected to IC5a and also to the input of the comparator around IC2b. Alternate connections of the key to the decoder will operate IC5a, a D-type flipflop connected as a toggle flipflop. The timing components R20 and C8 prevent the flipflop from changing states at less than one second intervals, minimising false triggering due to a bad connection between the key and the decoder inputs. The flipflop is reset by C9 and R27 when power is first applied.

The outputs of the flipflop are connected to two separate time constant networks. The Q output connects to a network with a time delay of about 0.2 seconds, determined by R22 and C10, while R21 and C11 set the time delay for the Q-bar output to about two seconds.

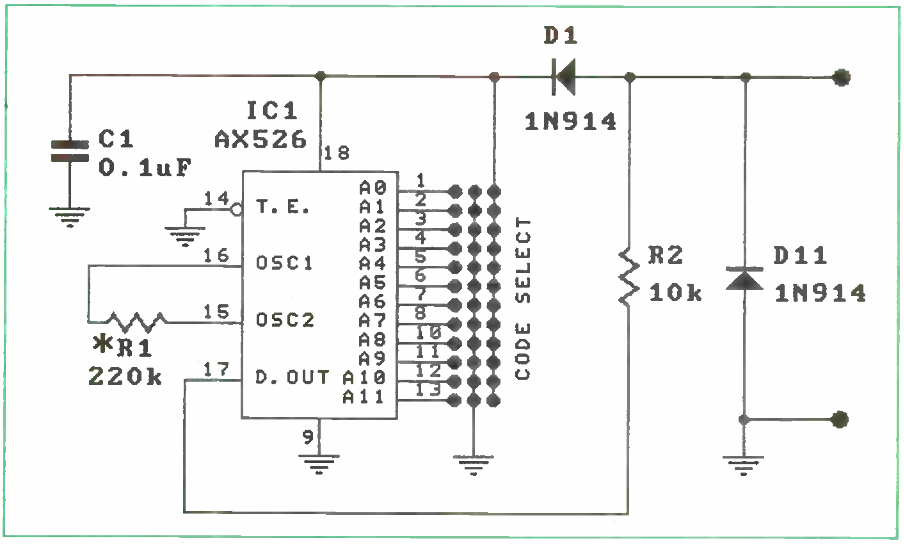
When the Q-bar output goes low, the input to IC4a is pulled low for 0.2 seconds, causing the output of IC4a to go high for this time duration. As a result, Q2 is turned on, driven by IC4a via isolating diode D7 and resistors R23 and R25. Relay RL2 is then pulsed on for 0.2 seconds, and if a buzzer is connected, it will also operate for this time.

Similarly, the Q output of IC5a connects via the two second time delay to IC4b. When this output goes high, relay RL2 is again operated, but for two seconds rather than the 0.2 second interval of before. Therefore, if the flipflop is initially reset (Q = 0), a valid code will toggle the flipflop, turning on RL2 for around two seconds. If another valid code appears, the flipflop will reset, operating RL2 for the shorter interval of 0.2 seconds.

Transistor Q3 is driven directly from the Q output of IC5a and activates relay RL1 when the Q output is high, and off when the Q output is low. Thus, RL1 is a toggle, operated with alternate contacts of the key. Relay RL2 gives a pulse output, and can be used to operate an indicator light, a buzzer and/or a door strike solenoid.

The tamper section of the decoder includes amplifiers IC2b, IC2a and transistor Q1. This part of the circuit causes the tamper output terminal to become low if incorrect data is fed to the decoder for more than a few seconds. As already described, when the key is connected to the decoder, a digital pulse train is produced at the output of IC4d. This output connects to a timing network comprising R15 and C7 via isolating diode D10. Each logic 1 pulse will therefore apply a charge to C7.

The output of the comparator of IC2b is normally low, unless the VT output of IC3 is high. If a pulse train is present, C7 will eventually charge and when its voltage reaches approximately 4V (half the supply voltage), the output of the comparator of IC2a will switch high, turning on the tamper transistor Q1. However, if the VT output of IC3 responds as well, the output of IC2b will be switched to a low. This will forward bias D3 and discharge C7 via R14, preventing IC2a from switching high and operating the tamper transistor. In other words, a pulse train that is not recognised by IC3 will operate Q1, providing the pulses are present for a few seconds. If the pulses carry the cor-



The key is based on a trinary encoder IC, type AX-526. When the key is connected across the input terminals of the decoder, a pulse train containing a preset code is applied to the cathode of D11.

[illegible]

rect code, the VT output of IC3 prevents the tamper circuit from operating. The tamper output therefore becomes low when activated, and can be used to operate additional circuitry as required.

The DC input voltage is regulated by IC6, an 8V three-terminal regulator. A DC input between 11V to 14V is required, and an input greater than 15V will cause Z1 to conduct, via R26. The rail voltage for the circuit is therefore set to 8V, filtered by the various capacitors in the circuit. The only parts of the circuit not fed from the 8V rail are the relay driver circuits, which connect directly to the Vin rail as 12V relays are used. Diodes D8 and D9 suppress the induced EMF from the relay coils, caused when the relays are switched off. Without these diodes, the relay driver transistors will be destroyed.

Construction

The board for this project is silk-screened to show the location of each component, making construction relatively straightforward. Start by cutting both key sections from the board. These can then be shaped to give the outline of a key, with a hole in the top so the key can be fitted to a key ring.

Fit and solder the passive components to the key(s) first and then solder two contacts (metal screws or PCB pins) to the solder pads at the base of the key, as shown in the photo of Fig.1. Next solder the encoder IC in place, taking care with its orientation and the amount of heat u sed in the soldering process. At this stage, leave all the address pins open circuited.

There are several wire links required on the decoder PCB, and these should be fitted first. Follow by fitting the resistors, capacitors and the diodes.

Check carefully that you have the correct polarity for the diodes and the electrolytic capacitors. The board is quite compact, so make sure you have all the passive components fitted before mounting the ICs. Also note that R26 is mounted vertically. The ICs can be soldered directly to the PCB, or mounted in sockets if you wish. As with the key, leave all the address pins of the decoder IC (type AX-528) open-circuit. The regulator IC doesn't require a heatsink and is mounted so the metal tab is towards IC3.

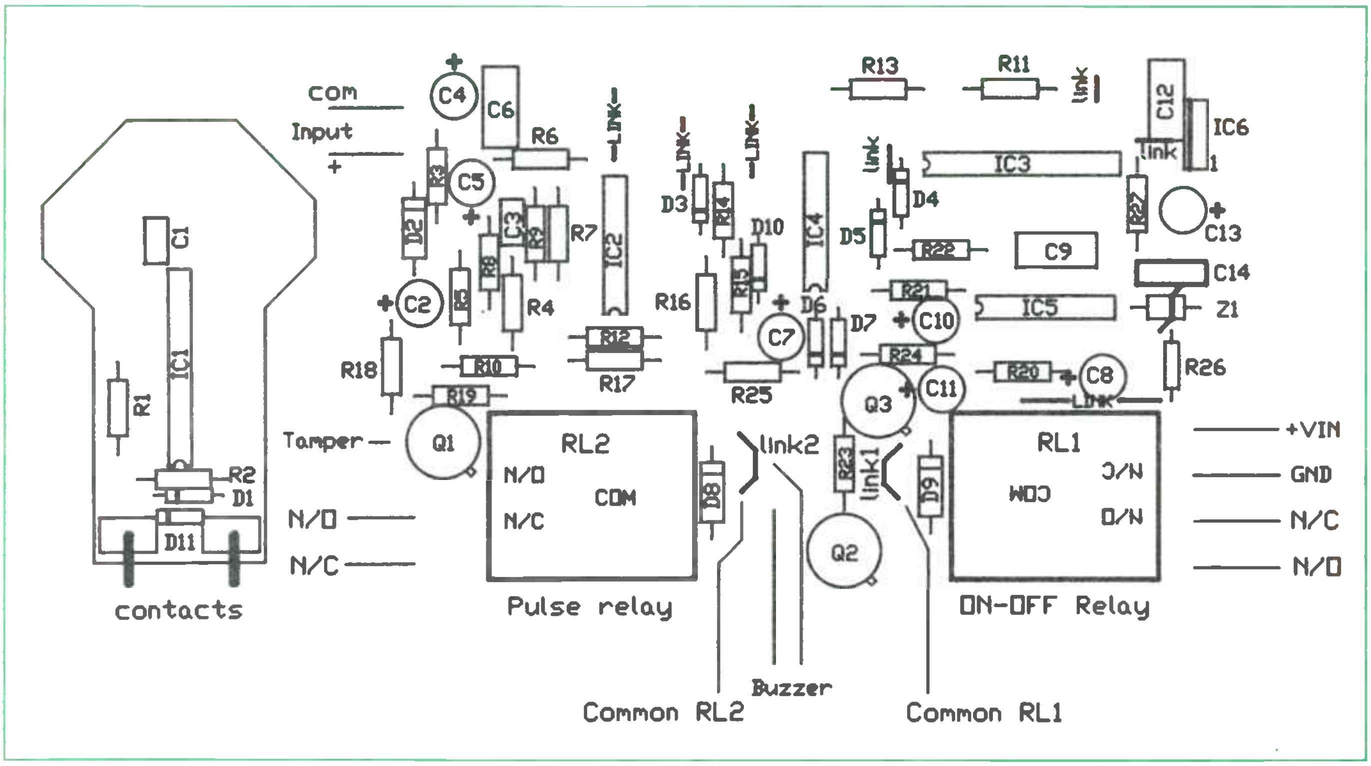
The relays and the transistors can now be fitted. Make sure the metal can of each transistor is not in contact with other components, as the can is connected to the collector. If required, links can be fitted so the common contact of each relay is connected to the 12V DC supply. This allows a single supply to operate the decoder board and any devices driven by the relays. Alternatively, a separate supply can be used for the devices switched by the relays. For testing purposes, you'll need two leads for the input terminals and two for the supply voltage. We fitted PCB mount terminal blocks to allow easy connection to the relays, although the relay wiring can be directly soldered to the PCB if required.

Testing

When both boards have been loaded and examined for any soldering errors, connect 12V DC to the supply input terminals of the decoder PCB. When the supply is first connected, the pulse relay (RL2) should energise then switch off after 0.2 seconds. The on-off relay (RL1) should not energise. With both relays off, the current consumption should be around 10mA to 12mA.

If all is working so far, connect the key across the input terminals and check that the circuit operates correctly. You should find that the on-off relay toggles for each key contact and that the pulse relay switches on for 0.2 seconds or for two seconds with each alternate contact of the key. If the key is placed across the input terminals with the wrong polarity, nothing should happen.

If the circuit is not working, check that all the address pins of the encoder and decoder ICs are open circuit. If their codes are different, the decoder will not respond. Also make sure that resistors R1



The PCB for this project is silk-screened, making assembly relatively simple. This layout doesn't include the PCB pattern, but shows the component placing and connecting wires. Fit links 1 and 2 if you want the input supply voltage connected to the common of the relays.

[illegible]

and R11 are the same value. Because the circuit is relatively simple, you should have no difficulty troubleshooting if you have a multimeter or a 'scope.

The circuit description should make it fairly clear what to look for. For instance, you can confirm that the key is operating by checking the signal at pin 14 of IC3. This signal should be an 8Vp-p pulse train that occurs only when the key is connected. If there is no signal at pin 14, work back through the circuit.

There should be a DC voltage of around 2V at pin 9 of IC2 when the key is not connected, and an 8Vp-p waveform when the key is connected. Because a Norton type op amp is used for IC2, most pins of the IC will have a DC voltage, unlike a conventional op amp.

The only other test is the tamper section. The output of this section is 'open-collector', meaning a voltmeter check cannot be applied unless a pull-up resistor is used. You will either get a floating output (0V) or a logic 0, also 0V. The simplest check is to connect an ohmmeter, set to a reasonably high range so that it can't deliver more than a milliamp or two, across the tamper output (collector of Q1) and common. The ohmmeter should read infinity under normal operation.

If an invalid code is applied to the decoder, the tamper output should switch to a logic 0 after about two or three seconds. The ohmmeter will then read something less than 100 ohms.

The easiest way to get an invalid code is to connect any address line of the encoder IC (in the key) to either a logic 0 or a logic 1. Remember that the correct code (at this stage) is all pins open-circuit.

Coding

Once you're satisfied the circuit is working, it remains to wire in an access code. The drawings of Fig.2 show the track-side of the relevant sections of the PCBs. Choose a code that has some address lines connected to a logic 0, some to a logic 1 and the rest left open-circuit.

The coding is applied by soldering short lengths of tinned copper wire from an address pin to the track with the required logic level. Remember that both ICs must have the same coding applied.

You might like to check your coding as you go by confirming that the circuit works as each pin is wired. Otherwise, you might end up not knowing where you are! If you have two or more keys, code them all while you're at it.

You might want to also change the values of the timing resistors R1 and R11, for even higher security. You can use resistor values anywhere between 50k and 10M. Once the coding is complete, it's a good idea to lacquer the track-side of the key. After all, it's likely to cop the same amount of wear and tear as a conventional key.

You might even decide to coat the entire key in some sort of epoxy, for both protection and security. Just make sure you don't accidentally cover the contact terminals as well!

PARTS LIST

Resistors

All 1/4W, 5% unless otherwise stated:

R1,R11	220k (see text)
R2,14,23,24,25	10k
R3,19	1k
R4,21	220k
R5,6	22k
R7,8,13	100k
R9,17	10M
R10	470k
R12,15,20,22,27	1M
R16	4.7M
R18	470
R26	22 ohm 1/2W

Capacitors

C1,9	0.1uF monolithic
C2,5,7,8,10,11	1uF/16V low leakage electrolytic
C3	100pF ceramic
C4,13	100uF/16V electrolytic
C6,12,14	3.3nF ceramic

Semiconductors

D1,3-7,10,11	1N4148/1N914 signal diode
D2,8,9	1N4004 diode
Z1	15V 1W zener diode
Q1-3	2N2219 NPN transistor
IC1	AX-526 trinary encoder
IC2	CA3401 quad Norton op amp
IC3	AX-528 trinary decoder
IC4	4093 quad Schmitt NAND
IC5	4013 dual D flipflop
IC6	7808 8V regulator

Miscellaneous

Silk-screened PCB; 2 x 12V/5A relays; PCB mount terminals, 1 x 2-way, 1 x 4-way; hook up wire.

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 West NSW 2223.
Kit containing all PCB components, silkscreened PCB for two keys and decoder (incl. P&P)...$59.90
12V AC/DC door strike ... $39.90

Complete system

Because the outputs of the decoder board are relay contacts, the system can be used in a variety of ways. For example it can be used as a door lock. For this, you'll need a 12V door strike, which fits in the door jamb in place of the existing fitting. The door strike is then connected to the pulse relay. The input contacts can be fitted in any convenient location, preferably protected from the weather to prevent corrosion. The decoder board can be located anywhere that suits, connected to the key contacts with a pair of wires.

A 12V DC supply is also required, either mains derived or from a 12V battery connected to a trickle charger. Make sure the power supply has sufficient capacity to operate the various devices connected to the relays. The relays have a 5A contact rating, so the total load should not exceed 10A.

An alarm can also be operated by the decoder board, switched by the on-off relay or from the tamper output. Remember that the pulse relay operates once when power is first applied, while the on-off relay operates only with the application of a key. This means the pulse relay will operate when power is restored after a black-out, and if an alarm is connected to this relay, it will also be triggered.

As mentioned before, you can use the tamper output in a variety of ways. This output detects a deliberate attempt at false entry, and could be used to operate an alarm or to send a high voltage to the input contacts, destroying the offending key. If you decide to add a relay to the tamper output, don't forget to connect a protection diode across the relay.

As we've already said, the unit can be used in a motor vehicle, to either control an alarm or to perhaps operate a central locking system. The relays are designed to switch automotive blinkers, and the pulse relay could be used to operate the blinkers as a status indicator.

One input contact can be the body of the vehicle, with another insulated contact perhaps fitted to the rubber surround of a window. You could use metal tape for the insulated contact and an adjacent chrome surround as the other contact. There are many possible ways of installing the required contacts, and no doubt readers will have ideas of their own.

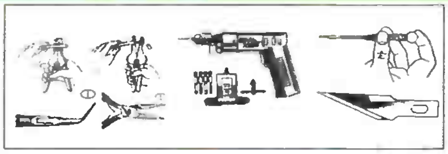
The only limitation is that the relays are rated at 5A. In other words, if a central locking system requires 10A or so, it may be necessary to include a driver relay for the locking system. You might also want to use the system inside the vehicle, perhaps to operate a fuel cutout or other anti-theft device. This arrangement should be easy to implement, as the contacts can be fitted anywhere that suits.

In summary, this project has many applications where a high security is required but with a minimum of fuss. And you have to admit it's a simple, but very clever application of current technology! ❖

[illegible]

TOOL BOX

If you want to do a good job, you need the right tools – and we ve got 'em! Call in and check your requirements whether it's for your job or your hobby, we'll have the best quality and the best price.



ALLEN KEYS

ALLEN-KEY-HT6	1.5-6mm 8 Sizes in Box	4.95

CRIMPING TOOLS

CRIMPER-CS500	RG58/RG59U COAXStripr	19.95
CRIMPER-CS600	BNC/F/Mini M/M/N/TNC	64.95
CRIMPER-KTC1	6 Tension Rtcht Crmpr	82.60
CRIMPER-HDSUB	D-Sub Crimp Tool	88.00
CRIMPER-HX2	RG58/59 Coax Crimper	88.00
CRIMPER-TCT44	4 Pin US Plg Crimper	29.95
CRIMPER-TCT66	6 Pin US Plg Crimper	29.95
CRIMPER-TCT88	B Pin US Plg Crimper	34.95

CUTTERS

CUTTERS-HT12	104mm Diagonal Cutters	10.95
CUTTERS-CK3799	110mm Angld Flsh Ctr	46.25
CUTTERS-CK3798	110mm Oblique Cutter	50.60
CUTTERS-CK3773	115mm Side Cutters	44.10
CUTTERS-CK3786	120mm Oblique Cutter	55.05
CUTTERS-CK3780	110mm Side Cutters	47.50
CUTTERS-CK3841	120mm Side Cutters	15.40
CUTTERS-CK3775	135mm Side Cutters	45.80
CUTTERS-CK3623	145mm Side Cutters	16.60
CUTTERS-HT13	104mm Mini End Cutters	8.95
CUTTERS-HT14	115mm Diagonal Cutters	9.95
CUTTERS-MPC290	Heavy Duty Cutter	69.95
CUT-N-CLINCH	Cut and Clinch Tool	35.00
CUTTERS-TRV-30-V	End Cutters	22.95

HOT AIR GUN

ARLEC-EHG998	Dual Heat Hot Air Gun	69.95

DRILLS and DRILL BITS

ARLEC-DRILLNDRIV	ARLEC Drill N Drive	69.95
DRILL-ME12	5-14V OC Drill	29.95
DRILL-SET-T2330	Drill Set	14.50
EZ-C7SC/1	0.70mm Carbide Orill	12.50
EZ-C8SC/1	0.80mm Carbide Drill	12.50
EZ-C9SC/1	0.90mm Carbide Drill	12.50
EZ-ClOSC/1	1.00mm Carbide Drill	12.50
EZ-C12SC/1	1.20mm Carbide Drill	12.50
EZ-HSS.70	0.70mm HSS Drill	8.70
EZ-HSS.80	0.80mm HSS Drill	5.55
EZ-HSS.90	0.90mm HSS Drill	5.55
EZ-HSS1.00	1 .00mm HSS Drill	5 .55
EZ-HSS1.20	1.20mm HSS Drill	3.50

FILES

FILES-CK124P	Needle Files	33.00

HOLE PUNCH

HOLE-PUNCH	16-30mm Hole Punch	69.95

IC EXTRACTORS

IC-EXTRCTN-TWZR	16 Pin Extraction	2.50
IC-EXTRCTN-16	14/16 Pin Extrctn Tool	9.80
IC-EXTRCTN-PLCC	PLCC Puller	29.75
IC-INSRTN-16	14/16 Pin Insrtn Tool	12.50
IC-INSRTN-28	24/28 Pin Insertn Tool	12.50
IC-INSRTN-40	40 Pin Insrtn Tool	12.50

KNIVES and BLADES

EZ3108	X-ACTO No.11 Blades x 5	4.50
EZ3110	X-ACTO No.16 Blades x 5	4.50
EZ3141	X-ACTO CUT-ALL Knife	5.25
KNIFE-SET-HT23	Boxed Set of 3 Knives	19.95

NIBBLING TOOL

NIBBLER-HT2049	Nibbling Tool	19.95

NUT DRIVER

NUT-ORIVER-HT11 5	Nutdrvrs 3 to Smm	17.95

PICK UP TOOLS

PEARL-CATCH	Spring Loaded 3 Claw	3.95
PICK-UP-HT27	Tweezers + Magnet	11.95

D TYPE PIN INSERTERS

PIN-INSERTION	Pin Inserter for D Type	4.25

PLIERS

PLIERS-HT15	115mm Long Nose Pliers	9.95
PLIERS-CK3767	Snipe Nose	35.10
PLIERS-CK3770	120mm Flat Nose	33.10
PLIERS-CK3783	145mm Needle Nose	36.60
PLIERS-CK3771	120mm Round Nose	29.50
PLIERS-CK3772	120mm Snipe Nose	34.75
PLIERS-CK3777	150mm Snipe Nose	40.80
PLIERS-CK3769	150mm Snipe Nose-Bent	44.60

REAMER

REAMER-M422	Tapered Reamer	15.50

SCRIBING TOOL

SCRIBER-HT25	Scribing Tool	3.95

ASK FOR OUR FREE SEMICONDUCTOR LISTING

SCREWDRIVERS

SD-HT28	Stubby Ratchet Driver	9.95
SD-W86252	Stubby XBlade	7.10
SD-CK4880-2.5	2.5x60mm XBlade Dvr	10.20
SD-CK4880-3	2.5x75mm XBlade Dvr	6.60
SD-W73101	2.5x75mm Insltd Xblade	6.00
SO-CK4880-4	3xl00mm XBlade Dvr	7.30
SD-CK4880-6	3xlSOmm XBlade Dvr	7.30
SD-CK4881-4	4xl00mm XBlade Dvr	6.60
SD-W73104	4xlODmm Insltd Xblade	7.10
SD-CK4880	4xl5Omm XBlade	6.60
SD-CK4881-6	4xl50mm XBlade Dvr	6.60
SO-CK4975	4x250mm XBlade	8.50
SO-W74008	5.5xl25mm XBlade	8.50
SD-CK4965	5.5x300mm XBlade	10.80
SD-W86982	6x25mm Xblade Stubby	7.10
SD-W74010	6.5xlSOmm XBlade	9.50
SD-CK4882	00x60mm Philips	11.45
SD-CK4882-	lx80mm Philips	11.20
SD-W73501	0x60mm Phlps Insltd	6.50
SD-W73502	lx80mm Phlps Insltd	7.65
SD-W73503	2xl00mm Phlps Insltd	9.90
SO-W94208	02x25mm Phillips Stubby	7.10
SO-CK4977	250mm Philips	8.25
SD-W77003	2xlOOmm POZIDRIVE	8.95
SO-TORX-HT20	1.5xlSOmm Torx for Mac	4.95
SD-TORX-W82010	T.10 TORX Driver	11.20

POWER DRIVER BITS

SD-BIT-W26724	2x4mm XBlade Bits	4.75
SD-BIT-W26726	2x5.5mm XBlade Bits	4.75
SD-BIT-W26720	2 Nol Phlps Bits	4.35
SD-BIT-W26732	3 PhilipsBiB	10.70
SO-BIT-W26721	2 No2 Phlps Bits	4.35
SO-BIT-W26717	2 No2 POZIDRIVE Bits	4.70
SD-BIT-W26716	POZIDRIVE Bits	3.75
SO-BIT-W26735	TORX T-10 Bit	6.50
SO-BIT-W26736	TORXT-15 Bit	4.75
SD-BIT-W26737	TORX T-20 Bit	4.75
SD-BIT-W26703	Extender	11.25
SO-BIT-W27620	6 Assrtd Bits+Holder	20.50
SD-BIT-W26713	7 Asrtd Bits + Extender	23.20
SD-SET-CK4854P	Watchmakers Orivers	21.00

SCREWDRIVER SETS

SD-SET-CK4884		29.30
SO-SET-HT7	6 Pce Jwlrs Ovr Set	5.95
SO-SET-HT8	Jewellers Philips Set	5.95
SD-SET-HT9	6 Pce Jwlrs Ovr Set	6.95
SO-SET-W18970	1000V 6 Dvr + Tester	57.60
SO-SET-W20130	2 Phlps & 5 XBlade	87.95

TEST DRIVERS

SD-TEST-ES1	140mm Neon Test Ovr	2.45
SD-TEST-B3226	Test Oriver	3.35

TIN SNIPS

SNIPS-CK4531	250mm Tinsnips	32.50

STRIPPERS

STRIPPER-CS200	Stripper0.5 to 3.5mm	16.95
STRIPPER-CS500	RG58/59 COAX Stripper	19.95
STRIPPER-CK3754		28.90
STRIPPER-KFLEX	JOKARI Flex Stripper	32.00
STRIPPER-KOAX2	JOKARI Coax Stripper	32.00
STRIPPER-W/W	Wire Wrap Stripper	27.80

SUPERTOOL and BITS

ARLEC-SUPER-TOOL	12V Orill/Grinder	69.95
ARLEC-ET612	Eraser	4.50
ARLEC-ET625	Drill Bits Pack of 4	7.95
ARLEC-ET627	Grinding Bits Pack of 3	2.95
ARLEC-ET643	Erasers	3.25
ARLEC-ET669	Engraving Bits	10.95
ARLEC-ET688	Diamond Engraving Bit	18.95
ARLEC-ET689	Splitting Discs	15.95
ARLEC-ET722	Wire Brushes Pack of 3	16.95

TOOL KITS

TOOL-KIT-HT11	20 Piece Tool Kit	17.95
TOOL-KIT-HT17	16 Piece Tool Kit	19.95

TWEEZERS

TWEEZERS-CK2302	115mm Straight Tweezers	6.95
TWEEZERS-CK2312	150mm Clamp Tweezers	19.95
TWEEZERS-CK2314	150mm 45d Tweezers	15.90
TWEEZERS-CK2316	110mm Straight Tweezers	19.95

VICE

VICE-MV3	PlasticVice Suction	6.95

WIRE WRAP TOOL

WIRE-WRAP-TOOL	Wire Wrap Tool	19.80

New Electronic Workbench

The Electronics Lab you keep in your PC!

YES you can now build, simulate and test Analog and Digital Circuits without laying your hands on a single component!

It's so easy with Electronics Workbench®. Do it all with the mouse – drag new parts from the parts bin, drop them onto the breadboard and click to run wires. Editing circuits is easy as wires are re-routed automatically.

It's much faster than building real circuits . No faulty parts! It's the result of 10 years innovation and thousands of students, hobbyists and engineers have been using the Workbench since its introduction in 1988.

Analog Module includes

- Comprehensive parts bin includes op-amps, zeners, transistors etc
- Function Generator with sine, square, triangle etc
- Oscilloscope with dual trace, int/ext trigger, nanosecond timebase upto 999MHz
- Bode Plotter for frequency responses and phase shift (-200 to +200dB)
- SPICE Simulation plus transient and steady-state simulation

Digital Module includes

- Comprehensive parts bin with gates, flip-flops, half adders, displays etc
- Word Generator up to 16x8-bits
- Logic Analyser with 8 channels, int/ext trigger
- Logic Converter converts between gate, truth table and boolean

Professional version has inhanced colour interface, supports maths co-processor. Requires IBM AT or PS/2 with 286 or greater, hard disk, 640kB RAM, Microsoft mouse, EGA/VGA and DOS 3.0. **$429.00**

Personal Plus Version is monochrome. Requires PC/XT/AT or PS/2 , 2 floppies or hard disk, 512kB RAM, Microsoft mouse, CGA/EGA/VGA/ Hercules graphis adaptor and DOS 3.0 or greater. **$299.20**

See the review in Electronics Australia March 92 – "Electronics Workbench is certainly the easiest simulator I've ever used" Peter Philips

New Lab 4 – Everything you need in a single instrument!

Ideal for the professional and keen hobbyist. Saves bench space. High accuracy yet low cost. Just check the features –

Function Generator

- Sine, square, triangle, skewed sine, pulse, TTL level square
- Covers 0.02Hz to 2MHz
- Output from 0.1Vpp to 20Vpp
- Linear and Log sweep – 20ms to 2s (int) or 100:1 VCF (ext)
- 50Ω/600Ω output

Frequency Counter

- 1Hz to 100MHz
- 15mV sensitivity to 60MHz
- 0.1 to 100Hz resolution
- 10ms to 10s gate
- 10MHz reference, with 5ppm stability
- 8 digit display with annunciators

Digital Multimeter

- 3 1/2 digit LCD
- Auto/Manual ranging
- Vdc, Vac,Ω, Adc, Aac functions
- 0.5% basic accuracy
- Data Hold
- Memory mode for relatiuve measurements and zeroing Ω's

Power Supply

- 3 1/2 digit voltage display
- Triple output
- 0 to 50V, 0.5A
- 15V 1A and 5V 2A fixed
- 1mV ripple
- Full overload protection

Incredible value – **$837.00 inc tax**
$722.00 ex tax

NEW SC-7000 DeSoldering Tool

- Now with 100W ceramic heater
- Work on up to 12 layer boards
- Special antistatic housing
- Optional surface mount kit

$482.50 ex tax
$579 inc tax

Appa 95 Multimeter

Check these value features –

- ***3999 count high resolution display***
- ***Eleven functions – Vdc, Vac, Adc, Aac, ohms, diode, logic, continuity, frequency, capacitance and transistor hfe***
- ***Peak hold button***
- ***Automatic power off***
- ***0.5% basic accuracy***
- ***Shock proof from 1.5m drop***

$139.00 ex tax, $166.80inc tax

QUV-T8/N Industrial EPROM Eraser

- ***125x200mm slid-out tray with anti-static pad***
- ***UV indicator***
- ***15,000microwatt/sq cm***
- ***7700 hour lamp life***
- ***Safety interlock switch***

$133.80 ex tax, $155.20 inc tax

8.30am to 5.00pm Mon to Fri. 8.00am to 12 noon Saturday.
Mail Orders add $5.00 min to cover postal charges.
Next day delivery in Sydney add $8.00.
All prices include Sales tax unless stated otherwise.
Tax exemption certificates accepted if the line value exceeds $10.00.
BANKCARD, MASTERCARD, VISA, CHEQUES or CASH cheerfully accepted.

GEOFF WOOD ELECTRONICS

Geoff Wood Electronics Pty Ltd

READER INFO NO. 19 **(inc in N S W)**

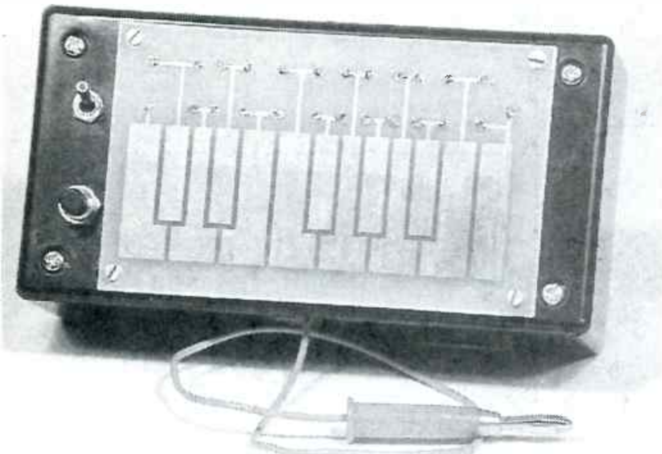
229 Burns Bay Road,, Lane Cove West N S W
(Corner Beatrice Street)
Mail Orders to – P O Box 671, Lane Cove N S W 2066
Telephone : (02) 428 4111 Fax : (02) 428 5198

Experimenting with Electronics

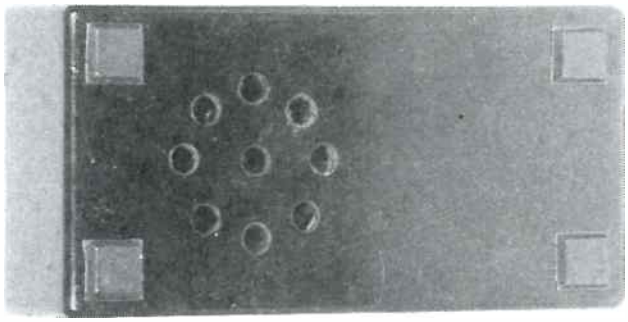
by PETER MURTAGH

Mini organ

This month's circuit is one for all you budding musicians. It is a simple organ which produces all the notes — 'sharps' included — for one octave, starting at middle 'C'. And, if that is not sufficient, by adding a pushbutton and a capacitor, you can have the next octave up as well.



The finished mini organ with its banana plug touch-probe. Pressing the pushbutton at the lower left doubles the frequency of each key — giving us a second octave.

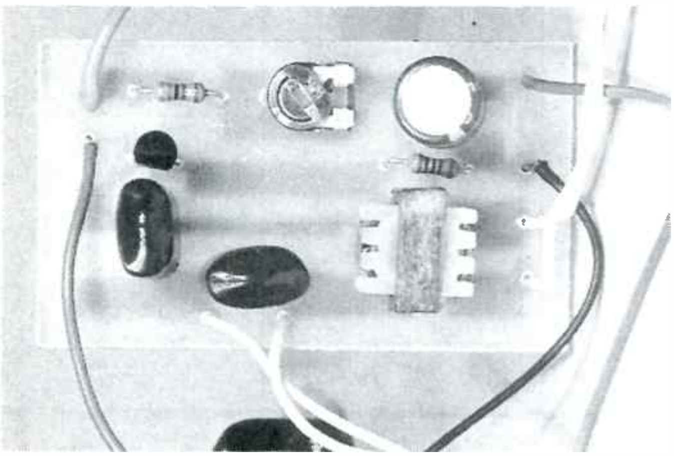


The bottom of the jiffy box, showing the holes drilled immediately below the loudspeaker. The self-adhesive rubber feet lift the box slightly off the table to increase the organ's volume.

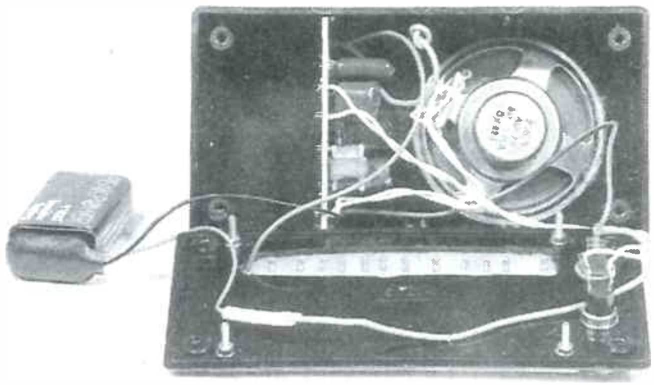
On most simple 'organs' you can only play tunes in the key of C major, i.e. you can only use the notes C, D, E, F, G, A and B. Because this restricts the tunes you can play, we decided to add the 'sharps' to this basic scale.

This lets you play tunes in other keys — but one octave now won't give enough notes. To solve this problem, without increasing the complexity of the circuit, we had to compromise.

Rather than adding another 13 resistors to get the second octave, we have simply added a second capacitor in series with the first. The second capacitor is only included in the circuit for the higher octave — for the lower octave, the normally-closed contacts of pushbutton PB1 short it out. But the price we pay for this simple arrangement is that the notes of the upper octave sound different because they have dif-

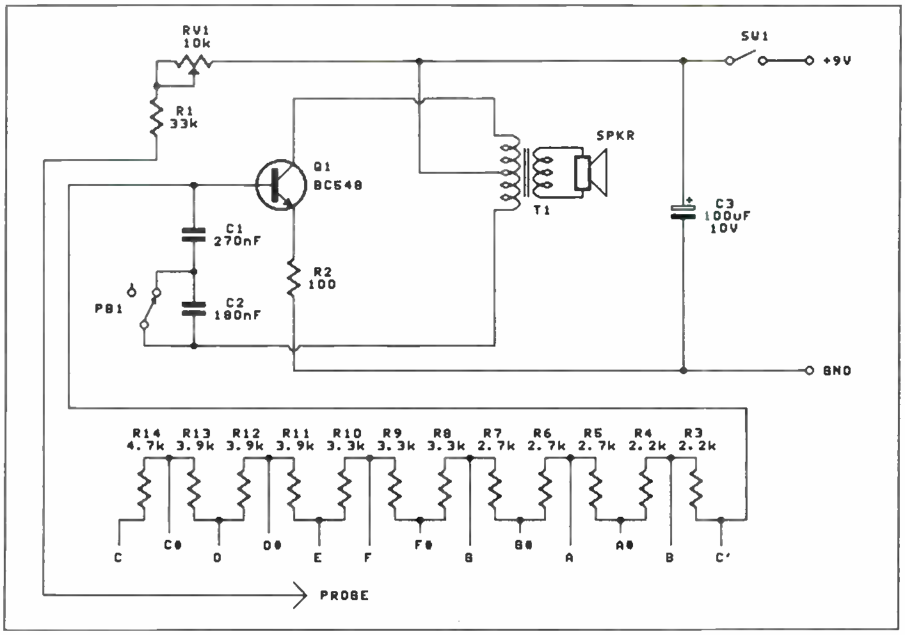


A close-up of the PCB. The trimpot allows you to adjust the 'middle C' frequency (hence the whole octave), and the bottom capacitor is normally shorted-out by pushbutton PB1.



Inside the jiffy box, showing the hole cut in the top to give clearance for the keyboard resistors. The PCB fits neatly into the slots on the side of the box and the speaker is glued to the base.



The schematic diagram shows the simple oscillator circuit at the top, with the resistor chain at the bottom. Different notes are selected by the probe by altering the RC time constant of the components connected to the input of transistor Q1.

ferent overtones. The top note of the lower octave is actually the same frequency as the bottom note of the higher octave — but they certainly don't sound the same! But this minor inconsistency is worth tolerating in order to have a simpler, cheaper circuit.

1% resistors

In order to get greater accuracy with the notes on our organ we have used resistors with 1% tolerance. So, let's first make certain that you know how to read the colour code on them — it's a little different to the 5% resistors we normally use.

On the 5% variety, there are four coloured bands — and the fourth is always 'gold' to indicate the 5% tolerance (and this is a completely different colour to those normally used for the first two digits and the multiplier).

Now the 1% resistors not only have an extra band — a total of five — but the fifth band is 'brown' to indicate the 1% tolerance. Hence the possibility of confusion! The additional band means that there are three significant digits for the value (to express the greater accuracy), so now the fourth band is the multiplier. For values less than 100, this means that the multiplier must be 0.1 (gold), or if less than 10, 0.01 (silver). Fortunately, the smallest resistor in this circuit is 100 ohms, so its multiplier is 1 (black) — we don't need to use the gold or silver as the fourth band colour.

You can check if you have understood all this by matching the values and the colours given for all the resistors in the 'Parts List'. Note that this list only gives the first four coloured bands — the fifth band for all the resistors is 'brown' because they are all 1% tolerance. (You see why you need to take more care to decode correctly the values of these 1% resistors.)

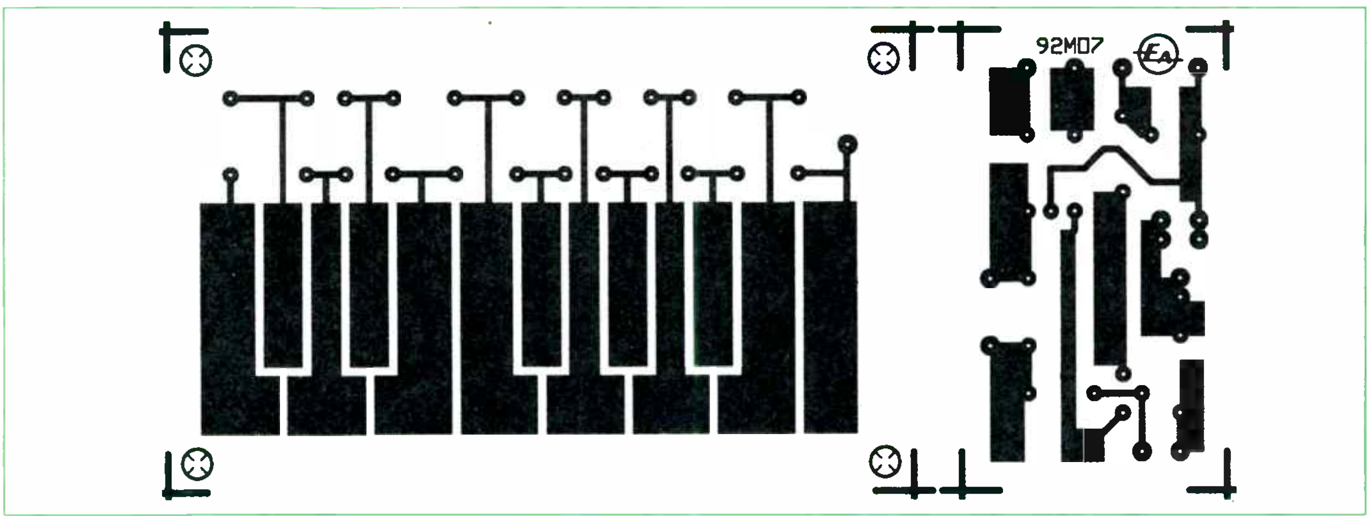
Construction

We strongly recommend building this project on a printed circuit board. Even though the oscillator circuit which produces the notes can easily be built on stripboard, you will find it a lot harder to build your keyboard. The PCB outline of the keys is, we feel, the far easier way to go.

Apart from making the keyboard without the PCB pattern, construction is quite simple. Solder the resistors, the capacitors and the audio transformer. The transformer is inserted with the three leads of the 1k CT side facing towards the left, and the two leads for the speaker output towards the right, on both the PCB and stripboard versions of the circuit. This leaves only the electrolytic capacitor C3 across the battery, and the transistor Q1, to be inserted the right way around. Refer to Fig.3 to identify which lead is which for these polarised components.

To play a tune, you need to make contact with the tip of a probe onto each key. We built our probe by soldering a banana plug to the end of the lead — it made good contact without scratching the copper surface.

We decided to improve the ease-of-use and appearance of our 'mini organ' by inserting it in a medium-sized jiffy box. The size of the oscillator circuit PCB means that it fits neatly into the slots on the sides of the box, while the keyboard section is bolted to the plastic lid. Of course you have to cut a clearance hole in the lid (the



This is a full size reproduction of the PCB artwork which can be used to etch your own board.

dashed line in Fig.1) for the resistors, so that they don't stop the board sitting perfectly flat.

However, if you are making your own PCB, you might prefer instead to make the keyboard section a bit larger (130 x 68mm instead of its current 99 x 61mm) — then you can fasten the keyboard directly to the top of the box, and dispense with the plastic lid altogether.

Now to mount the loudspeaker. We followed the simplest approach and just glued it to the bottom of the box. To let the sound out, we drilled several holes in the base, and added four self- adhesive rubber feet to lift the box slightly off the table.

If you do decide — like us — to enclose your organ in a jiffy box, then you should add the on/off switch SW1 to make it easy to disconnect the battery when the organ is not in use. Mount this switch, along with the high octave button, to the left of the keyboard. This means that you depress PB1 with your left hand, and play the notes with the probe in your right. ('Left-handers' should, of course, place these switches on the right.)

PARTS LIST

Miscellaneous

PCB 99x61mm, coded 92MO7
9V battery
8 ohm 57mm mini speaker
pushbutton (momentary, NC) PB1
8 ohm: 1k CT audio transformer
organ probe (banana plug)
hookup wire, solder, etc.
medium jiffy box, 41x68x130mm (optional)
SPST toggle switch SW1 (optional)
4 nuts, bolts and rubber feet (for jiffy box)

Resistors

All 1/4W, 1% (see text)
1 33k R1 orange-orange-black-red
1 100 ohm R2 brown-black-black-black
2 2.2k R3,R4 red-red-black-brown
3 2.7k R5-R7 red-purple-black-brown
3 3.3k R8-R10 orange-orange-black-brown
3 3.9k R11-R13 orange-white-black-brown
1 4.7k R14 yellow-purple-black-brown
1 10k horizontal trimpot RV1

Capacitors, polyester (greencap)

1 270nF C1
1 180nF C2

Capacitor, PC-mount electrolytic

1 100uF,10V C3

Semiconductors

1 BC548 NPN transistor Q1

The music scale

We designed our circuit to play the notes in what is called the 'equally tempered major scale'. This means that our lower octave covers the frequency range from 261.63-523.26Hz. On this scale, the value of each new semitone, or half-note, is obtained by multiplying the frequency of the previous note by the number '2' raised to the power of 1/12 (approximately 1.06). To find a note which is a full tone higher, you multiply by 1.06 twice. You can check this by calculating the frequencies for the notes D, E and F (2 tones followed by a semitone increase) — their frequencies are 293.67, 329.63 and 349.23Hz.

Of course we can't make notes with such accuracy without using a very large number of very accurate resistors. But if your ear is only as good (or as bad!) as ours, then you won't really notice that our organ's notes are 'slightly off' — the price we pay to use the readily available resistor values.

However, you will notice that we have used 1% tolerance resistors to be more accurate, and we have also included the trimpot RV1 to allow the frequencies of the whole octave to be moved up or down. Our organ gave the correct notes (measured with a frequency counter) with the trimpot set at halfway. If you wish, you can set the lowest frequency produced by the organ more accurately, by comparing it with 'middle C' on a guitar pitch-pipe or a piano — adjusting RV1 until both notes sound the same.

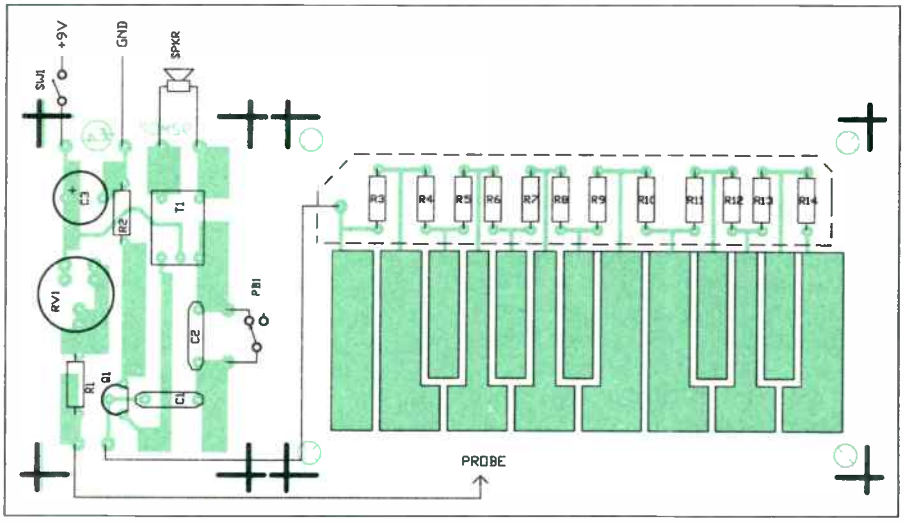


Fig.1: The component layout on the printed circuit board. Because electrical contact has to be made by the probe with the copper keys, the keyboard should not be sprayed with protective lacquer.

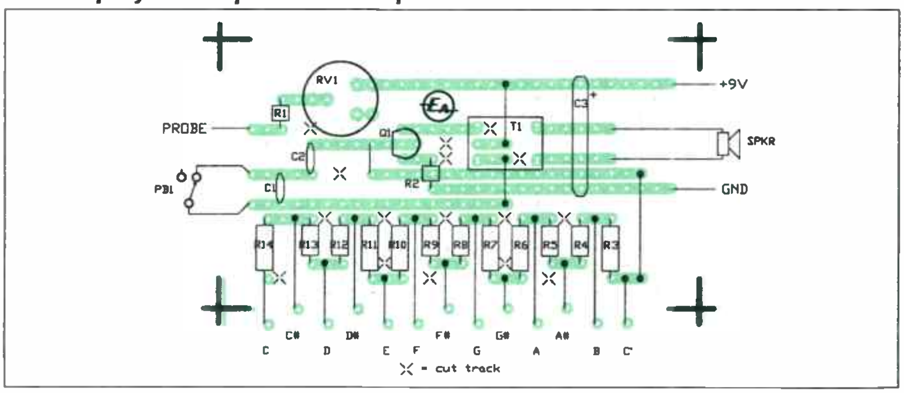


Fig.2: The stripboard layout. With this method of construction you need to design your own keyboard so that you can easily touch each of the notes.

How it works

At the centre of our circuit is a one-transistor oscillator. Like all oscillators, its output is sent back (in phase) to the input — a system of positive feedback. The input produces the output, and part of the output becomes the new input. Hence continuous oscillations can be sustained. The components which do this for us are transistor Q1, the centre-tapped (CT) primary winding of the audio transformer T1, and capacitor C1 (and, if not shorted out by pushbutton PB1, C2 as well).

The way it works is this. Suppose the input signal at the transistor base goes more positive. This turns Q1 more on, which means that the voltage at its collector is more negative. The transistor, as well as amplifying the signal, has caused a 180° phase shift.

But when the AC signal passes through the top half of the primary winding of T1, it also induces a voltage in the bottom half

[illegible]

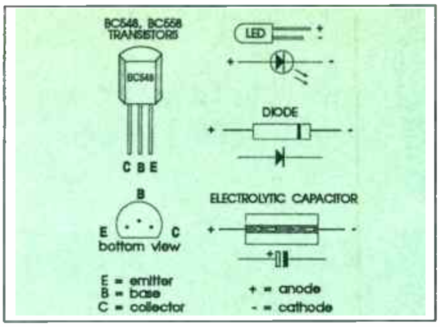


Fig.4: Use this component leads identification diagram for capacitor C3 and transistor Q1.

— but another 180° out-of-phase. And a signal which is 360° (180 + 180) out-of-phase is actually *back in phase*. So the waveform fed back via the capacitors to the base of Q1 is in-phase with the original input signal. Hence it supplies positive feedback.

In addition to supplying the feedback signal, the audio transformer also runs the loudspeaker. Because the output impedance of the transistor is high, and the input impedance of the speaker is low, the signal is 'transformed' in order to run the speaker more efficiently. A larger current, at a lower voltage, is produced, which better suits the speaker's mode of operation.

Another aspect to be considered is the gain of the amplifier. If it is less than '1', then the signal will die away — if it is much greater than '1' then the signal will distort. This is the purpose of emitter resistor R2. It limits the output current, and also provides stability for the amplifier by negative feedback — any increase in the emitter current will result in an increase in the voltage drop across R2, and hence a drop in the voltage applied to the base-emitter junction of Q1.

The operation of any oscillator is a balancing act between the positive feedback to keep it operating, and the negative feedback to stabilise its operation and keep its closed-loop gain equal to '1' (after allowing for operating losses).

And the final aspect of the oscillator operation to be considered is at what frequency does it oscillate. The frequency of our circuit is mainly determined by the RC time constant, determined by the resistor chain (RV1, R1 and whatever section of R3-R14 is selected by the organ probe) and the capacitor(s) C1/C2. With PB1 depressed, the two capacitors in series have a combined value of 108nF, which produces a doubling in frequency. (You might expect that C2 would have the same value as C1, but this isn't the case because the coil in T1 also influences the frequency of oscillation.)

If you listen very carefully, you will notice that the *volume* slightly increases as the *frequency* becomes higher. This occurs because the resistor chain also provides the DC bias for the base of the transistor. The smaller the length of the chain, the larger the base current flowing into Q1. Hence the increase in output volume at higher frequencies. Capacitor C3 is included in the circuit to stabilise the power supply, and to provide a low impedance path for the AC signal when the internal resistance of the battery increases with age.

To test your organ, try playing this very simple (and familiar) tune:

E D C D E E
D D
E G G
E D C D E E
E D E D C

Recognize it? (You need to pause at the end of each line.) Now over to you to play — and perhaps even 'invent' — many more tunes!

Transparencies

A high contrast, actual size transparency (negative) for the PCB used in this circuit is available for only $2. This will allow you to etch your own printed circuit board. This special price applies for transparencies for all projects in this series only. Write to *EA*'s reader services division.

Happy experimenting — and please send us your comments on the circuits we have published as well as ideas for future projects. ❖

[illegible]

[illegible]

INTERNATIONAL ORDER
0011-1-510-770-2345

EASYTECH

THE ELECTRONICS SOURCE

TOLL FREE FAX
0014-800-128-644

•All Prices Shown Are In US Dollars•

STATIC RAMS

Order #	Price	Organization	Speed	Pins
2101	1.65	256x4	450ns	22
2111	1.75	256x4	450ns	18
2112	2.45	256x4	450ns	16
5101	3.95	256x4 CMOS	450ns	22
7C122-15	6.95	256x4 CMOS	15ns	22
2114L20	1.49	1024x4 1Kx4 Low Power	200ns	18
2114L25	1.15	1024x4 1Kx4 Low Power	250ns	18
2114-45	1.05	1024x4 1Kx4	450ns	18
2148-3	1.95	1024x4 1Kx4	55ns	18
2149-35	3.75	1024x4 1Kx4	35ns	18
MK4801AN1	3.95	1024x8 1Kx8	100ns	24
2147-3	2.95	4096x1 4Kx1	55ns	18
20C71-25	6.75	4096x4 4Kx4 CMOS	25ns Skinny Dip	24
6168-45	3.25	4096x4 4Kx4 CMOS	45ns	20
2015-90	3.75	2048x8 2Kx8	90ns Skinny Dip	24
2018-35	5.95	2048x8 2Kx8	35ns Skinny Dip	24
6116ALSP15	2.95	2048x8 2Kx8 CMOS Low Power	150ns Skinny Dip	24
6116FP12	2.45	2048x8 2Kx8 CMOS	120ns SOP*	24
6116LFP15	2.95	2048x8 2Kx8 CMOS Low Power	150ns SOP*	24
6116LP1	2.95	2048x8 2Kx8 CMOS Low Power	100ns	24
6116LP3	2.75	2048x8 2Kx8 CMOS Low Power	150ns	24
6116LP4	2.55	2048x8 2Kx8 CMOS Low Power	200ns	24
6116-1	2.75	2048x8 2Kx8 CMOS	100ns	24
6116-3	2.25	2048x8 2Kx8 CMOS	150ns	24
6116-4	2.15	2048x8 2Kx8 CMOS	200ns	24
6516-45	4.25	2048x8 2Kx8 CMOS	45ns Skinny Dip	24
7C128-55	3.95	2048x8 2Kx8 CMOS	55ns Skinny Dip	24
8128-15	2.15	2048x8 2Kx8	150ns	24
8128-20	1.75	2048x8 2Kx8	200ns	24
2063-10	7.95	8192x8 8Kx8	100ns Skinny Dip	28
6264BP25	8.25	8192x8 8Kx8 CMOS Low Power	25ns Skinny Dip	28
6264LP10	4.75	8192x8 8Kx8 CMOS Low Power	100ns	28
6264LP15	3.95	8192x8 8Kx8 CMOS Low Power	150ns	28
6264LFP10	4.25	8192x8 8Kx8 CMOS Low Power	100ns SOP*	28
6264LFP12	3.45	8192x8 8Kx8 CMOS Low Power	120ns SOP*	28
6264SLP10	5.25	8192x8 8Kx8 CMOS Low Power	100ns Skinny Dip	28
6264-10	4.55	8192x8 8Kx8 CMOS	100ns	28
6264-15	3.75	8192x8 8Kx8 CMOS	150ns	28
7C185-15	8.75	8192x8 8Kx8 CMOS Low Power	15ns Skinny Dip	28
6267LP45	4.95	16,384x1 16Kx1 CMOS Low Power	45ns	20
8167-55	3.45	16,384x1 16Kx1	55ns	20
6288-25	7.95	16,384x4 16Kx4 CMOS	25ns	22
6206-20	24.95	32,768x8 32Kx8 CMOS	20ns Skinny Dip	28
62256FP12	6.25	32,768x8 32Kx8 CMOS	120ns SOP*	28
62256LFP10	6.95	32,768x8 32Kx8 CMOS Low Power	100ns SOP*	28
62256LP7	7.95	32,768x8 32Kx8 CMOS Low Power	70ns	28
62256LP10	6.75	32,768x8 32Kx8 CMOS Low Power	100ns	28
62256LP15	6.25	32,768x8 32Kx8 CMOS Low Power	150ns	28
62256SLP12	7.95	32,768x8 32Kx8 CMOS Low Power	120ns Skinny Dip	28
1600-55	5.95	65,536x1 64Kx1 CMOS	55ns	22
6287-45	6.95	65,536x1 64Kx1 CMOS	45ns	22
628128LP8	31.95	131,072x8 128Kx8 CMOS Low Power	85ns	32
628128LP10	29.95	131,072x8 128Kx8 CMOS Low Power	100ns	32

*Small Outline Package (Surface Mount)

8000

Order #	Price
8031	3.45
80C31	6.95
8035	1.75
8039	1.75
80C39	3.75
8080A	2.75
8085A	2.95
8085A2	3.45
8086	4.25
8088	4.25
8088-1	6.75
8155	2.45
8155-2	3.75
82C11	5.95
8212	2.45
8214	3.85
8216	1.35
8224	2.45
8237A5	3.95
8243	1.95
8250	5.75
8251A	2.25
8253	1.95
8253-5	2.25
8254	4.45
8254-2	5.95
8255A5	2.75
8256	10.75
8257	2.25
8259	1.95
8259-5	2.25
8271	42.95
8272	3.75
8274	6.45
8275	18.95
8279-5	3.45
8284A	2.25
8286	2.95
8288	3.75
A80286-10	14.95
N80286-12	21.95
N80L286-8	9.95
R80286-12	21.95
R80286-6	9.95
82C284-8	4.95
82C284-12	14.95
82288-8	4.95
82288-12	19.95
8741	9.95
8742	14.25
8748H	8.95
8749H	9.95
8751H	24.95
8755A	11.95

EPROMS

Order #	Price	Memory	Speed	Prog. Volt.	Pins
TMS2516	4.25	16K	450ns	25V	24
TMS2532	6.95	32K	450ns	25V	24
TMS2532-30	8.95	32K	300ns	25V	24
TMS2532-35	7.95	32K	350ns	25V	24
TMS2532A35	8.95	32K	350ns	21V	24
TMS2532A45	6.95	32K	450ns	21V	24
TMS2564	5.95	64K	450ns	25V	28
TMS2716	5.95	16K	450ns (±5V, +12V)	25V	24
2708	4.75	8K	450ns (±5V, +12V)	25V	24
2716	3.35	16K	450ns	25V	24
2716-1	3.75	16K	350ns	25V	24
27C16	4.25	16K	450ns CMOS	25V	24
2732	3.95	32K	450ns	25V	24
2732A20	4.45	32K	200ns	21V	24
2732A25	3.45	32K	250ns	21V	24
2732A45	2.95	32K	450ns	21V	24
2732B45	4.25	32K	450ns	12.5V	24
27C32	4.75	32K	450ns CMOS	25V	24
2764-20	3.95	64K	200ns	21V	28
2764-25	3.75	64K	250ns	21V	28
2764A15	4.45	64K	150ns	12.5V	28
2764A20	3.75	64K	200ns	12.5V	28
2764A25	3.25	64K	250ns	12.5V	28
2764A45	2.95	64K	450ns	12.5V	28
2764AOTP	2.95	64K	250ns One Time Prog.	12.5V	28
27C64A15	3.95	64K	150ns CMOS	12.5V	28
27C64FP25*	3.95	64K	250ns One Time Prog.	12.5V	PLCC 32
27128-20	7.55	128K	200ns	21V	28
27128-25	7.25	128K	250ns	21V	28
27128A15	4.95	128K	150ns	12.5V	28
27128A20	4.45	128K	200ns	12.5V	28
27128A25	3.75	128K	250ns	12.5V	28
27128AOTP	2.35	128K	250ns One Time Prog.	12.5V	28
27C128-15	5.65	128K	150ns CMOS	12.5V	28
27C128-25	4.95	128K	250ns CMOS	12.5V	28
27CP128-20	5.25	128K	200ns CMOS	12.5V	28
27256-15	5.45	256K	150ns	12.5V	28
27256-20	4.95	256K	200ns	12.5V	28
27256-25	4.45	256K	250ns	12.5V	28
27256-30	3.45	256K	300ns	12.5V	28
27C256-15	5.75	256K	150ns CMOS	12.5V	28
27C256-25	4.25	256K	250ns CMOS	12.5V	28
27C256FP25*	4.95	256K	250ns One Time Prog.	12.5V	PLCC 32
27512-20	6.55	512K	200ns	12.5V	28
27512OTP	4.95	512K	200ns One Time Prog.	12.5V	28
27C512-12	7.25	512K	120ns CMOS	12.5V	28
27C512-15	6.55	512K	150ns CMOS	12.5V	28
27C512-25	5.95	512K	250ns CMOS	12.5V	28
27C010-12	13.25	1MB	120ns (128Kx8)	12.5V	CMOS 32
27C010-15	9.25	1MB	150ns (128Kx8)	12.5V	CMOS 32
27C011-20	16.95	1MB	200ns (8x16Kx8)	12.5V	CMOS 28
27C020-15	15.95	2MB	150ns CMOS	12.5V	32
27C040-15	42.95	4MB	150ns CMOS	12.5V	32

*Surface Mount

MOTOROLA DEVICES

Order #	Price	Order #	Price	Order #	Price	Order #	Price	Order #	Price	Order #	Price
MC1377P	2.65	MC3350P	.75	MC10125P	1.45	MC146818A	4.15	MC68030RC16B	229.95	MC68882RC25A	149.95
MC1408-6	1.49	MC3470P	1.05	MC14411P	7.95	MC146818AFN	3.95	MC68030RC25B	319.95	MC68701	16.75
MC1408-7	1.49	MC3479P	3.95	MC14490P	4.25	MC146818P	4.25	MC68230P10	8.95	MC68705P3S	13.95
MC1408-8	1.49	MC3486P	.99	MC14495P	3.95	MC68000P12	11.95	MC68450L10	59.95	MC68EC030RP25B	99.95
MC1496P	.89	MC3487P	.99	MC145026P	2.65	MC68008P10	8.95	MC68488P	22.95	MC68HC000P12	17.95
MC1648P	3.95	MC4024P	2.75	MC145027P	3.95	MC68010P12	54.95	MC68661PB	2.95	MC68HC11A1P	18.95
MC2672B4P	19.95	MC4044P	2.75	MC145028P	3.95	MC68020RC16E	139.95	MC68681P	7.95	MC68HC705C8P	19.95
MC2674B4P	19.95	MC6875L	12.95	MC145151P	9.95	MC68020RC25E	189.95	MC68881RC25B	114.95	MC68HC705C8S	29.95
MC3346P	1.45	MC10124P	1.45	MC145406P	2.75						

• 25-99 pieces take 10% off • 100+ pieces take 15% off

READER INFO NO. 21

[illegible]

At last, electronic users all over Australia have easy access to the technology of the Silicon Valley and the USA. Make use of our toll free fax line (directly to the USA) for your orders and catalog requests, or call our order line for personalized service.

Please note when ordering from the USA, you will be responsible for Australian customs charges and sales tax where applicable.

•All Prices Shown In US Dollars•

RF TRANSISTORS

Order #	Price	Order #	Price	Order #	Price
MRF212	19.95	MRF401	13.49	MRF652	11.49
MRF221	16.35	MRF406	14.99	MRF654	19.95
MRF224	17.75	MRF450A	14.49	MRF660	13.95
MRF237	3.69	MRF454	15.49	MRF901	1.50
MRF238	15.95	MRF455A	12.69	MRF911	3.50
MRF239	16.95	MRF458	19.95	2N3553	2.95
MRF240	17.49	MRF515	2.95	2N3866	1.25
MRF240A	17.49	MRF555	3.49	2N4427	1.25
MRF247	24.75	MRF557	5.49	2N5641	16.95
MRF260	11.95	MRF559	2.25	2N5642	18.49
MRF262	12.95	MRF607	2.49	2N5643	19.95
MRF264	13.95	MRF627	9.95	2N5944	11.95
MRF314A	35.95	MRF629	4.49	2N5945	11.95
MRF315A	32.49	MRF630	3.95	2N5946	14.95
MRF316	63.95	MRF641	20.49	2N6080	9.89
MRF317	64.95	MRF644	23.95	2N6081	11.95
MRF321	24.95	MRF646	25.95	2N6082	14.95
MRF327	63.95	MRF648	30.95	2N6083	14.95
MRF340	9.95	MRF650	29.95	2N6084	14.95

CONVERTERS

Order #	Price	Pins
ADC0804LCN	2.95	20
ADC0809CCN	3.75	28
ADC0817CCN	12.95	40
ADC0820CCN	8.95	20
CA3306CE	10.95	18
DAC0800LCN	1.95	16
DAC0830LCN	4.95	20
MB40576	3.55	16
MB87020	29.95	40
MC1408-6	1.49	16
MC1408-7	1.49	16
MC1408-8	1.49	16
TLC549IP	2.15	8
ZN427E8	14.95	18
ZN428E8	7.95	16
ZN429E8	3.75	14
ZN449E	5.75	18

6000 SERIES

Order #	Price	Pins	Order #	Price	Pins
6242	8.95	18	6803	4.25	40
6402	3.65	40	6805	6.95	28
6502	2.75	40	6808	3.75	40
6502A	4.45	40	6809	3.75	40
65C02	5.75	40	68B09	5.95	40
6510	13.95	40	68B09E	4.95	40
6520A	3.45	40	6810	1.45	24
6522	2.95	40	6818	6.95	24
65C22	4.25	40	6821	1.75	40
6526A	12.95	40	68B21	2.95	40
6532	3.95	40	6840	3.25	28
6545-1	3.75	40	68B40	4.75	28
6551A	3.45	28	6844	7.95	40
65C51	3.25	28	6845	2.45	40
6567	15.95	40	68B45	4.75	40
6581	11.95	28	6850	1.75	24
6800	1.75	40	68B50	2.45	24
68B00	3.75	40	68B54	5.75	28
6802	2.95	40	68P01V07	29.95	40

RF POWER MODULES

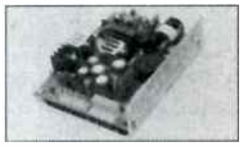
Order #	Price	Freq. Range (MHz)	Order #	Price	Freq. Range (MHz)
M57713	45.00	144-148	MHW710-1	60.00	400-440
M57714M	45.00	430-450	MHW710-2	60.00	440-470
M57715	42.00	144-148	MHW710-3	60.00	470-512
M57716	60.00	430-450	MHW820-1	81.00	806-870
M57727	60.00	144-148	MHW820-2	90.00	806-890
M57729	62.00	335-512	SAU4	48.00	430-450
M57737	40.00	144-148	SAV6	34.00	154-162
M57745	85.00	430-450	SAV7	34.00	144-148
M57747	40.00	144-148	SAV12	17.50	144-148
M57796MA	30.00	430-450	SAV15	45.00	220-225
MHW591	42.00	1.0-250	SAV17	58.00	144-148

SPECIAL ORDERS

ATTN: OEMs
We will accept special orders for shipments of US$100.00 or more, pending availability of parts

BM153 POWER SUPPLY

15W Low Profile High Voltage Power Supply



- Input Voltage: 220-340VAC
- Input Fusing: AC line fused
- Input Current: 0.2 Amp (47-63Hz)
- Dimensions: 1.25" x 3.625" x 4.75"
- EMI: Meets FCC level B limits
- Operating Temperature: 0°– 50°C @ full power
- Storage Temperature: -20°C to +75°C
- Hold Up Time: 20msec./min. after removal of AC input

Data Sheet Included

Order #	Price	Output (VDC)	Weight
BM153-122	7.95	5V@2A/+12V@0.3A/-12V@0.2A	12oz.

Some typical weights on components to help you in assessing freight costs (minimum packaging – 6 oz):

8 Pin Packages	14/16 Pin Packages	28/32 Pin Packages	40 Pin Packages	RF Transistors	RFModules
30-35 pcs. per oz.	13-15 pcs. per oz.	3-4 pcs. per oz.	0.8 oz. each	5-10 pcs. per oz.	1.7 oz. each

FREIGHT CHARGES

Shipping charges based on actual weight

Postal Service*
(Air: 10-14 days Surface: 6-8 weeks)

Weight	Air	Surface
6 oz.	US$4.85	US$1.95
8 oz.	6.41	2.45
10 oz.	7.97	3.95
12 oz.	9.53	3.95
14 oz.	10.09	5.55
1 lb.	10.70	6.55
2 lbs.	16.70	6.55
3 lbs.	22.70	8.65
4 lbs.	28.70	10.75
5 lbs.	34.70	12.85
6 lbs.	39.70	14.97
7 lbs.	44.70	17.05
8 lbs.	49.70	19.15
9 lbs.	54.70	21.25
10 lbs.	59.70	23.35

TNT Sky Pak
(Door-to-Door)
(3-5 days)

Weight	Air
1 lb.	US$25.00
2 lbs.	28.72
3 lbs.	32.44
4 lbs.	36.16
5 lbs.	39.88
6 lbs.	43.45
7 lbs.	47.02
8 lbs.	50.59
9 lbs.	54.16
10 lbs.	57.73
15 lbs.	71.98
20 lbs.	86.23
25 lbs.	100.48
30 lbs.	113.53

*Please call for charges on shipments over 10 lbs.

NOTE: Most components weigh less than 1 oz. For more information on weights, see weight on the item listed or check our chart above.

EASYTECH
THE ELECTRONICS SOURCE

VISA

2917 Bayview Drive
Fremont, CA 94538

MasterCard

Toll Free Fax: 0014-800-128-644
24 Hours A Day – 7 Days A Week

International Orders: 0011-1-510-770-2345
Tuesday-Saturday, 6 am - 12 pm (Australia Eastern Standard Time)

√ USPS √ Federal Express √ TNT Sky Pak

Prepaid Orders Only (Visa and MasterCard Accepted)

Write today for your copy of our 64 page catalog due in June 1992.

(Please include appropriate freight or airmail charges)

12 month warranty on all EasyTech products.
30 day money back guarantee.
We reserve the right to substitute manufacturers.
Prices subject to change without notice.

READER INFO NO. 22

[illegible]

[illegible]

[illegible]

by PETER LANKSHEAR

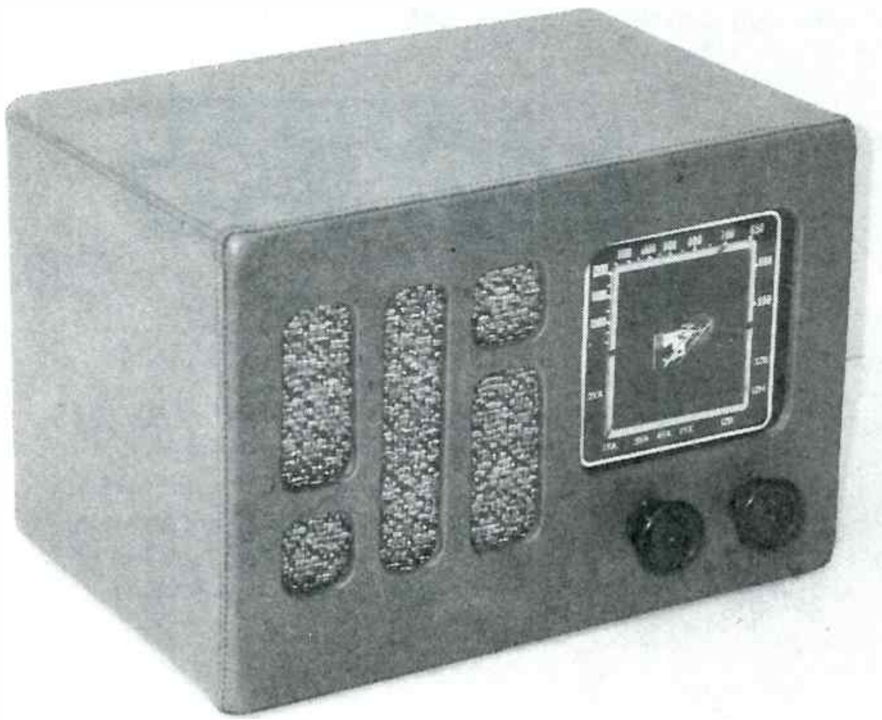
Building your own classic radio

In the last column we traced the history of John Moyle's 'Little General', in its time Australia's most popular mantel receiver. So many were made over a period of about 20 years that the remains of many (possibly unrecognised) must still be in existence. A bit of hunting around may unearth the remnants of one, which could be restored or rebuilt without too much trouble. But the design is so uncritical that in many instances, you could assembly your *own* Little General — from parts salvaged from a junk box, or from receivers considered not worth restoring.

There is a unique satisfaction in making your own electronic equipment, the more so if it is built from scratch. This is evident from the space given over to home construction during the valve era, by magazines such as our predecessor *Radio and Hobbies* — which each month published several constructional articles, ranging from simple one valve battery operated receivers to complex high performance radiograms.

Readers who grew up with these projects could now enjoy the nostalgia of restoring or making a Little General; for others this could be a good project with which to sample valve radio construction. Naturally, the ideal would be to have a Little General to restore; but failing that, building one from salvaged parts is a practical proposition.

Although any of the various versions described last month could be made, the 1947 model was chosen as it used a readily available permanent magnet (PM) speaker and yet retained the 'no frills' circuit of the original Little General. If the benefits of AGC are desired, the circuit of the Dual Wave version published in last month's column could be used with little additional complication.



A Little General built 50 years on. Billed as 'Australia's most popular mantel', John Moyle's design set new standards of simplicity and compact size.

Selecting the parts

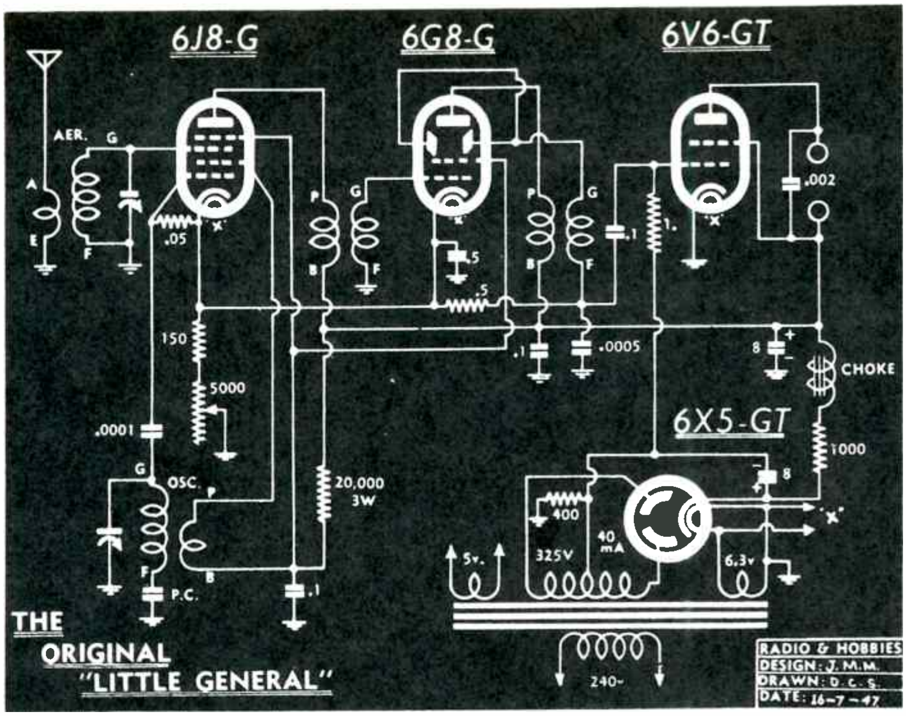
The most critical components are the dial and its associated two gang tuning capacitor, and the aerial and oscillator coils. Although original kitsets used RCS and Crown 3" dials, any small dial would be satisfactory. The set illustrated uses a 4" Companion unit. A dial from a small mantel set or even a knob with a scale would do at a pinch.

Provided that there are two tuned windings, just about any 450 - 470kHz IF transformers can be used. Permeability tuned or iron cored types are preferable, but not essential. Naturally, all components and windings should be carefully checked to make sure that they are intact. Take care to note the connections of the IF transformers. Reversal of one winding will cause a serious loss of gain because of the reliance upon both magnetic and capacitive coupling.

The remaining major items are a small power transformer and a 5" speaker. If an original Little General is being restored, the power transformer and loudspeaker is not likely to present a problem. Most power transformers salvaged from receivers would be suitable, but obviously should not be too large.

HT winding voltages are not critical, anywhere between 200V and 330V being acceptable. Voltages higher than 330V were common with electromagnetic (EM) speakers, but require input filter capacitors with a peak voltage rating higher than the 450 volts normally available today.

Assuming that a matching power transformer and speaker are not available, a PM speaker is the best choice and easiest to find. It is convenient but not essential to have the output transformer mounted on the speaker.



The 1947 version differed very little from the 1940 original, as suggested by the title on its schematic. The main differences were an added 150 ohm RF bias resistor, a 0.1uF HT bypass cap, an indirectly heated rectifier and a permanent magnet speaker — which in turn made it desirable to use an HT filter choke.

PARTS LIST: 1947 LITTLE GENERAL

1 Chassis
1 2-gang tuning capacitor with trimmers
1 Small tuning dial
1 Power transformer, 40mA minimum HT rating
1 Small filter choke (see text)
1 Aerial & oscillator coil set
2 IF transformers (450 - 470kHz)
1 Padder capacitor ('PC')

Resistors

1 1M (470k) for 6V6-GT grid leak
1 0.5M (470k or 270k) for diode load
1 0.05M (47k) oscillator grid leak
1 150 ohm for RF/IF cathode bias
1 400 (390) ohm 1W for AF back bias
1 20k 2W (2 x 39k 1W) screen dropper
1 1k 5W for HT filter (see text)
1 5k wirewound volume control

Capacitors

2 10uF or 32uF 450PIV electro (see text)
1 0.5uF (0.47uF) 150V polyester
3 0.1uF 400V polyester
1 0.002uF (2nF) mica or 400V polyester
1 0.0005uF (470pF) mica or ceramic
1 0.0001uF (100pF) mica or ceramic

Valves

1 6J8-G, 6K8-G/GT, ECH35 or X61M
1 6G8-G, 6B8-G/GT, EBF2G or EBF32
1 6V6-G/GT (see text)
1 6X5-GT, EZ35 or 5Y3-G/GT (see text)

Miscellaneous

4 Octal valve sockets
1 Speaker, permanent magnet 5" with 5k or 7k matching transformer
1 Cabinet, to suit
Knobs, tagstrips, wire, screws, nuts etc.

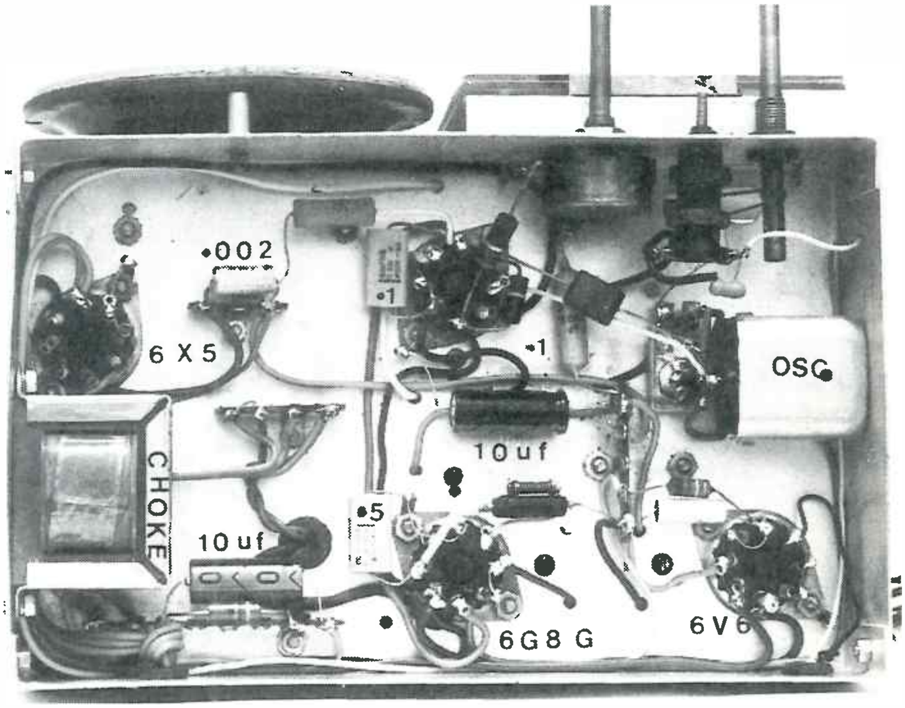
Filtering options

The original version used a 325V transformer and a 2500 ohm field winding on the EM speaker. At 40mA drain, the HT would have been 250 volts. In the 1947 model, the same power transformer was used in combination with a small filter choke and a 1000 ohm resistor, implying a choke resistance of about 1500 ohms. However, most small chokes have a resistance of about 500 ohms.

With transformers rated at a voltage of 250 or less, no resistor is necessary. But assuming a 500 ohm choke and 40mA HT drain, add about 25 ohms of series resistance for each volt above this. Thus for a 270 volt transformer, an additional 500 ohms would be suitable, and for 325 volts, the resistor should be about 2000 ohms. These resistors would need to have a rated dissipation of at least 5 watts, and in the latter case preferably 10W.

Now that compact high value electrolytic capacitors are available, resistive filtering would be a practical proposition. A pair of 32uF capacitors and a filtering resistor of 1000 ohms should be used for transformers with HT windings of less than 270 volts. Above this voltage add 500 ohms to the values shown above. If necessary, a choke can be wound on an old output transformer core using the method described for output transformers in this column for March 1991. Of course a secondary winding is unnecessary — just fill the bobbin with the fine wire.

As the octal valve series was large, there are several alternatives for each socket, with the more common types



The underside layout is not critical, and was quite different in each of the various models. One advantage we have today is the smaller size of modern capacitors.

given in the parts list. Other frequency converters that work well are types OM10, 6A8-G and 6D8-G. A later alternative IF valve intended for this type of service was the 6AR7-GT, but it has different socket connections from the recommended types.

The 6V6 proved to be very satisfactory for the output stage. An alternative, used by many manufacturers of receivers of this type, is one of the European high gain pentodes — examples being the KT61, 6AG6-G and EL33 or EL3NG. If one of these valves is used, the bias resistor (from the centre-tap of the HT winding to ground) should be changed to 220 ohms. As John Moyle pointed out, although these valves have twice the sensitivity of a 6V6, in practice the difference is hardly worthwhile and they have the disadvantage of being large and requiring twice the heater current of a 6V6.

Two popular types of rectifier are suitable. First choice is the indirectly heated 6X5-GT or EZ35. Originally an 80 was used and if the power transformer has a 5.0 volt winding, the octal equivalent 5Y3-G or -GT could be used, but their filament power consumption is double that of a 6X5-GT. The receiver illustrated uses the 5.0 volt winding for the 6.3 volt pilot lamps, which consequently do not regularly burn out.

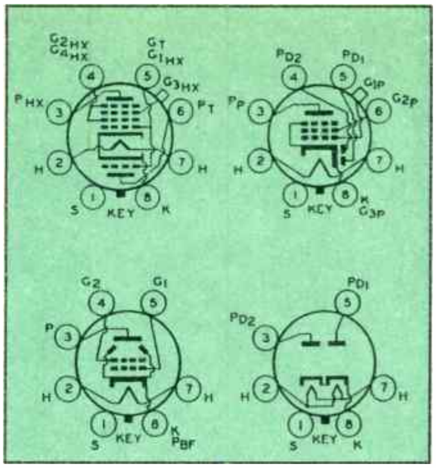
Chassis making

Construction commences with making a chassis, and in 1947 no instructions would have been necessary. But for the benefit of today's readers I will describe the procedure. Aluminium sheet 1mm thick is the easiest metal to work, and it is a good idea to ask the supplier to guillotine the sheet exactly to size.

The chassis plan gives the original dimensions, but first check that your substitute parts will fit. Collect the major components together for a benchtop trial layout — remembering to open the tuning capacitor!

The power transformer and the dial unit used in the unit pictured were slightly larger than those by John Moyle, and the chassis has been lengthened accordingly. Although with modern capacitors the chassis depth could be reduced, the original depth was retained to maintain cabinet proportions.

Now mark out the chassis with a sharp scriber. With a fine hacksaw, remove the metal to be cut away at the corners. Don't use tinsnips as they produce a bent edge — all too obvious in the finished chassis. Folding the sides requires a vice and some angle iron. First, with short lengths of angle in the vice, and, working off their ends, carefully line up the scribed marks and bend the tabs at the ends of the sides at right angles. Note that they are set back by the thickness of the metal.



Here are the base connections for the four valves shown in the schematic, to save you having to look them up. From top left (clockwise) are the 6J8, the 6G8, the 6X5 and the 6V6.

Now, after centring a longer length of angle over the rear jaw of the vice, cut another piece of angle iron to be a few millimetres shorter than the sides of the chassis and position it against the front jaw of the vice. Clamp the chassis with the bending mark in line with the edges of the angle irons. With the aid of a piece of wood (100mm by 50mm is ideal) behind the projecting part of the chassis, carefully fold the chassis forward to form a right-angled bend. Use a hammer on the wood to make the bend as sharp as possible — but NEVER hammer directly on the metal, or unsightly dents will result. Repeat this procedure with the other side and then, with another suitable length of angle iron in front, bend the ends — taking care that the tabs fit inside. Square the chassis up and secure each tab with a screw and nut.

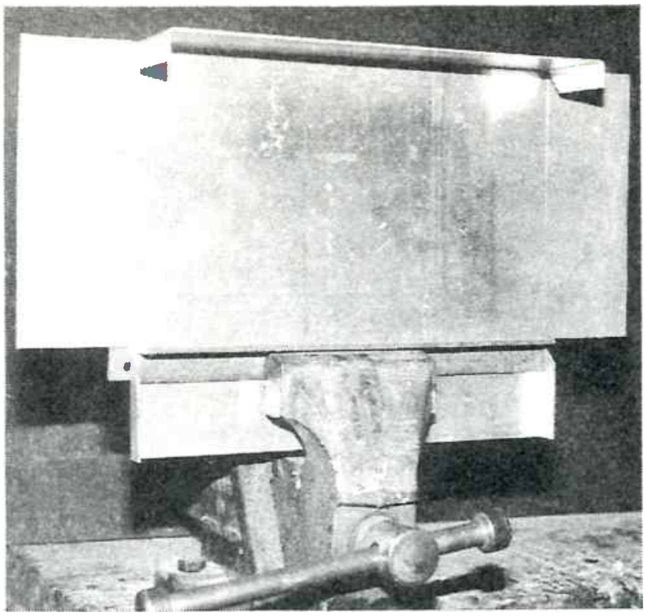
Chassis punch

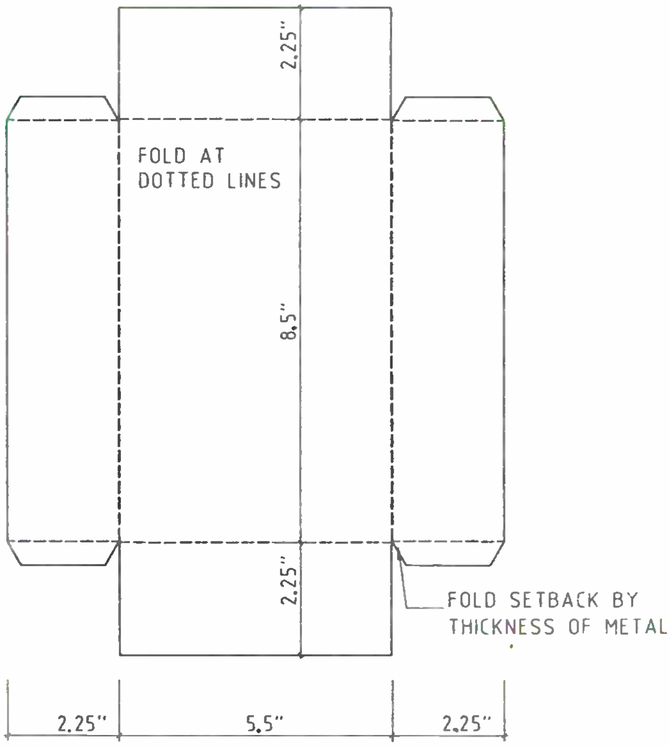
The chassis is now ready for mounting the components. The tools required are minimal, but one tool that will save a lot of work in cutting the valve socket holes is a hole punch consisting of a matching socket and cutter pulled together by a threaded bolt. These are available in various sizes, often from electricians' suppliers, and the 30mm diameter size is suitable for older valve sockets, including octals. Use rubber grommets where power transformer and mains leads pass through the chassis.

To allow for the thickness of a baffle, mount the loudspeaker back about 3mm from the front line of the dial glass. Depending on the speaker's shape, it may be necessary to provide a small cutout at the front edge of the chassis.

There is nothing critical about the wiring, but keep grid and anode leads as short as possible. Support each end of

The completed chassis. A similar layout was used for all versions, with exact dimensions and orientation dependent on the size of the main components. 6G8-G and 6B8-G IF valves require shielding — this chassis uses a 'goat' type shield (centre rear), which John Moyle also used in the original.





Above: Folding the chassis with two lengths of angle iron in the vice — the front piece being a few millimetres shorter than the side being bent. At right are the dimensions for the original 1940 chassis, which may need to be varied to suit your components.

wire ended components, using tag strips if necessary. To cater for shielded valves, earth pin 1 of all sockets.

Making the cabinet

Complete the project by making a simple cabinet. I have not given any dimensions, as these will depend on the size of the finished chassis. Allow 10mm or so clearance for easy fitting. For the sides, top and bottom use 10mm plywood, but 5mm is best for the front. With a fretsaw or fine coping saw cut out the speaker and dial openings before assembling. Well-fitted butt joints, pinned and glued, are quite sufficient to make a very sturdy box. Round the edges with sandpaper.

The original cabinets were covered with upholstering fabric known by names such as 'Leatherette' or 'Rexine'. Fortunately, equivalents are still used for car head linings. For a nominal charge, a co-operative car upholsterer covered my cabinet with an offcut of a mid-brown liner used for Commodore cars.

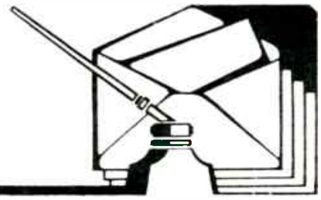
A convenient mount for the speaker grill fabric is a piece of heavy cardboard sub baffle, with a cutout to line up with the speaker cone. Stain or paint the cardboard black. Cut the cloth to be a bit larger than the baffle and stretch it out on a flat surface, holding the edges down with cellulose tape. Lightly coat the surface of the cardboard with PVA glue and lay it on the cloth, leaving a weight on it for an hour or so. Too much glue will bleed through the cloth. The cloth can then be trimmed to the edges of the baffle, which can then be fastened inside the cabinet with short screws. Secure the chassis in the cabinet with a long bolt, through a hole near the rear of the centre of the chassis — lining up with a matching hole in the bottom of the cabinet.

How it performs

John Moyle's assertion that for everyday listening, conventional receivers had excess audio gain is vindicated by this little receiver. Performance is more than adequate for urban locations, and with a few metres of outside aerial it is capable of trans- Tasman night time reception. The only practical difference from five-valve sets is that the volume control is used over more of its range.

Aurally the Little General compares more than favourably with its modern counterparts. Mine has recently performed well in keeping me in touch with the world during house painting, gardening and concrete laying sessions — just the type of service that John Moyle had in mind for his outstandingly successful creation. ❖

Information centre



Conducted by Peter Phillips

Rectifier circuits — in more detail!

I have a rather different column for you this month, as for the first time we occupy the whole column answering a single letter. But it's on a subject that's pretty basic, and one that has been responsible for countless arguments — including a few in the *EA* editorial office...

So let's start with the letter that triggered things off:

I cannot agree with your explanation of February's What?? on the VA rating of transformers used in centre-tapped rectifier circuits. I do not believe that the use of the formula 'RMS = 0.5 x peak value' is valid in this application. This formula only applies in the simple half-wave rectifier circuit, where the load is only powered for one half of the full period of the sine wave. This is not the case for the centre-tapped transformer circuit. (N.W., Dimboola Vic).

You're not alone, N.W. In fact, if the July issue is late this month, it's because we've all spent so much time in the office discussing this very topic! Regular readers will know by now that the topic also concerns the explanation given in March — as to why the VA rating of a transformer for a full-wave, centre-tapped transformer rectifier circuit needs to be larger than that for an equivalent output bridge rectifier.

Jim Rowe, our resident devil's advocate and managing editor, also had misgivings about the explanation, as did other members of the staff.

So is there a fundamental error in the answer provided by V.C. of Kenthurst? I'm not going to give the plot away yet, except to say that Jim Rowe suggested I spend this month fleshing out the whole topic of rectifier circuits, transformer VA ratings and so on...

After all, this is a topic that many readers are interested in and one that is perhaps not always fully understood.

I should point out that I'm not an expert in this field, but fortunately I have a lot of material to refer to — sent to me by readers some 12 months ago when the topic of transformer VA rating was raised in December 1990 and continued in March 1991. I had planned to use this material in a feature article, but it seems appropriate to call upon it now. My thanks to those readers who sent me this material, and apologies to those whose letters now need to wait another month.

OK, so let's conduct a full investigation into the March answer...

Black art

All the literature I've seen says the same thing — a practical analysis of rectifier circuits is very difficult, particularly when capacitive filtering is added. As most rectifier circuits include capacitive filtering, you can see the minefield we're about to enter. I'll refer to capacitive filtering in due course, but we'll start with unfiltered supplies, as this relates to the original question.

The topic becomes more complex when you add the empirical world known as transformer design. Here designers use a mix of equations, experience and 'time honoured constants' to come up with a particular design. Of relevance here is the term *VA rating*, as not everyone agrees this is an appropriate way to explain the problem. In fact, G.W. (Florey, ACT) made this very point in June, and argued that the way to approach the problem is to look at the copper losses. Ok, so perhaps I'd better lead into this one.

Transformers

A transformer is a device that by electromagnetic induction transforms electrical energy from one circuit to another. Like any practical component, there will be some loss on the way, but the concept of the ideal transformer is often used, as the losses are sometimes only a few percent of the power being transferred by the transformer.

In his book, *Transformers: Their Principles and Design*, author F.C. Connelly makes the point that 'the efficiency of any transformer of a given kVA rating can always be increased by increasing its dimensions, limited only by the purchasing abilities of the customer'. Quoting from the classic *Radiotron Designer's Handbook (RDH)* on page 199, an ideal transformer is one 'in which the winding resistances, core loss, leakage inductances and winding capacitances are all zero'.

You might therefore think that an ideal transformer can transform an infinite amount of energy. However, the main limitation is the available area of the core, which (from *RDH*) is the square root of the VA requirements divided by a constant (quoted as 5.58, but probably somewhat higher given today's improved core materials).

Therefore, if losses are ignored, the apparent power delivered to the load will equal that in the primary of the transformer. But all transformers have some losses, usually grouped into the iron loss and the copper loss. The copper loss is mainly the result of the resistance of the windings, and heat is produced due to the I^2R loss in the windings.

The iron loss is due to two main factors: the hysteresis of the core and eddy currents in the core. Hysteresis losses result from the additional power needed to reverse the magnetic field in the core, and is proportional to frequency. Eddy currents are caused by the changing flux inducing a voltage in the core.

This loss is also proportional to frequency, and is minimised by using insulated laminations in a 'stacked' iron core, or using ferrite as the core material. The current required to magnetise the core is also a loss, although it remains roughly constant regardless of the load.

[illegible]

[illegible]

As a very general rule, the copper losses are usually designed to be equal in both the primary and secondary. According to *RDH*, maximum efficiency is reached when the copper losses equal the iron loss, which should occur at full load. According to K.L. Smith (*Wireless World*, October 1984), this is not always the optimum condition for small mains transformers, which are often designed for iron to copper loss ratios of 1:2 or 1:3.

Connelly makes the point that the ideal ratio of the iron to copper loss depends on the intended application for the transformer. For a transformer likely to operate into overload, a 4:1 ratio is preferable. A ratio of 1:4 will give the best efficiency (95% or more) for a transformer operating at 50% of its rated output, illustrating the point that 'bigger is better'.

Therefore, if we assume a 1:1 ratio and losses totalling 10W, the primary copper loss is 2.5W, the secondary copper loss 2.5W and the iron loss 5W. However, as you can see, these losses often bear little relationship to the VA rating, as a large, well designed 500VA transformer may have losses as low as 25W, (95% efficient) while a typical 'el cheapo' 100VA transformer might have the same loss giving an efficiency of 75%. So what is a VA rating?

VA rating

From the various sources I'm using, VA rating is generally referred to as the apparent power a transformer can handle. Connelly states *'The normal rating is derived from a determination of the highest output which can be delivered continuously without exceeding a stated temperature at any part of the windings.'* Apparent power is RMS voltage multiplied by RMS current, disregarding any phase difference between them. True power is apparent power times the cosine of the angle between the current and the voltage. That is, true power equals apparent power x power factor. Therefore, apparent power equals true power only when the power factor is unity (phase angle = 0°), which occurs when the load is purely resistive.

Transformer manufacturers therefore use a VA rating rather than a power rating to make the rating independent of the type of load (resistive or reactive). Referring again to K.L. Smith, 'maximum current in the windings is set by the allowable copper loss heating effect, with a smaller contribution from the hysteresis effect of the core. For transformers up to about 100VA, a current density of 3.1A per square millimetre is satisfactory in the copper'.

Smith continues 'In particular, VA is proportional to the product of the iron and copper areas'. He then validates the equation given in *RDH*, but with a higher constant of 6.9. This equation is actually derived from many factors, including the filling factor (how much the core 'window' is filled by copper windings), the window area, maximum flux density in the core, the cross section of the central limb in an E-I core, Faraday's law (where E = 4.44 x flux x number of turns x frequency) and so on.

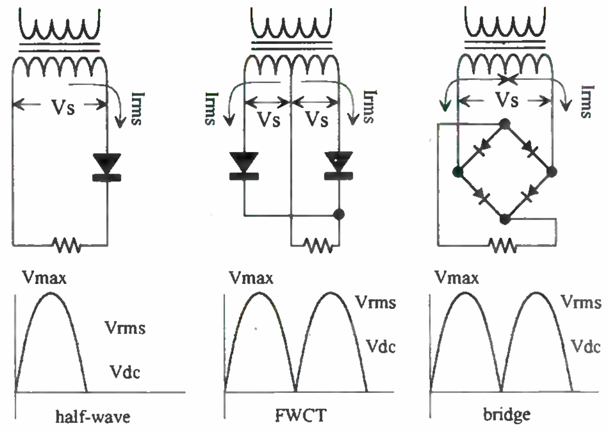
So from this, for a given size core constructed with no-waste laminations (I sections stamped from a pair of E sections), the window size determines how much copper *area* can be obtained. The number of turns is determined by the turns per volt (usually around five to eight turns per volt) and the current rating of the winding is then calculated using the relationship of 3.1A per squaremillimetre.

Putting this together, the VA rating is a limit imposed by the core dimensions — but the equation for VA takes into account all the various factors, including copper loss and so on. If the VA rating is exceeded it will cause the transformer to overheat, due to excessive heat in both the copper and the core.

It's important to realise that the losses (and therefore the power dissipated as heat) are a *percentage* of the VA rating and can be as low as 5%. This means a 95% efficient 100VA transformer reaches its maximum operating temperature due

rectifier circuit

output voltage across load



quantity	**half-wave**	**FWCT**	**bridge**
Vs_{RMS} =	**10VRMS**	**10VRMS**	**10VRMS**
VMAX =	1.41Vs_{RMS} *(14.14V)*	1.41Vs_{RMS} *(14.14V)*	1.41Vs_{RMS} *(14.14V)*
VRMS =	0.5VMAX *(7.07V)*	0.707VMAX *(10V)*	0.707VMAX *(10V)*
VDC =	0.318VMAX *(4.5V)*	0.636VMAX *(9V)*	0.636VMAX *(9V)*
VDC =	0.45Vs_{RMS} *(4.5V)*	0.9Vs_{RMS} *(9V)*	0.9Vs_{RMS} *(9V)*
VRMS =	1.57VDC *(7.07V)*	1.11VDC *(10V)*	1.11VDC *(10V)*
VMAX =	3.14VDC *(14.14V)*	1.57VDC *(14.14V)*	1.57VDC *(14.14V)*
IDC (VDC/10 ohm) =	***0.45A***	***0.9A***	***0.9A***
IDC /diode =	IDC *(0.45A)*	0.5IDC *(0.45A)*	0.5IDC *(0.45A)*
Ipk/diode =	3.14IDC *(1.41A)*	1.57IDC *(1.41A)*	1.57IDC *(1.41A)*
IRMS /diode =	1.57IDC *(0.707A)*	0.785IDC *(0.707A)*	0.785IDC *(0.707A)*
IRMS /transformer leg =	1.57IDC *(0.707A)*	0.785IDC *(0.707A)*	*1.11IDC *(1A)*
secondary VA =	3.48VDCIDC *(7.05)*	1.74VDCIDC *(14.1)*	1.23VDCIDC *(10)*
primary VA =	3.48VDCIDC *(7.05)*	1.23VDCIDC *(10)*	1.23VDCIDC *(10)*

Equations assume ideal diodes and transformer, with no filter capacitor
Values for a 10 ohm resistive load, 10VRMS secondary voltage
* this equation given by Mullard as 0.785IDC , other sources give equation shown

Fig.1: This table gives the relationships between the three basic unfiltered rectifier circuits shown. The table is taken from a Mullard publication first produced in 1965.

[illegible]

to the 5W of power lost in the transfer of 100VA of energy. The available cooling area is a large factor in the temperature rise, and depends on the dimensions of the core. Using forced cooling can therefore increase the VA rating of the transformer without any change to the transformer design.

In other words the VA rating of a transformer cannot be determined 'backwards'. By this I mean you can't simply measure the resistance of the windings, calculate the I^2R losses in the copper then add the iron losses (usually equal to the copper loss) and assume the VA rating equals an increased percentage of their sum.

However, commonsense tells us that the resistance of the windings sets a limit on the VA rating and also determines the copper loss. But if we assume an 'ideal' transformer, the basic VA rating is the only factor we need to consider. And it is perfectly valid to assume an ideal transformer, as the losses are generally small compared to the VA rating.

Rectifier circuits

There are three basic rectifier circuits: the half-wave, the full-wave centre-tap (FWCT) and the bridge rectifier. Usually these circuits operate with a filter capacitor, and most of the literature I've received assumes this. However, R.G. (Wollongong NSW) sent me material published by Mullard and also from another unidentified source, both of which deal with the unfiltered circuits. Here's what Mullard has to say about their tabulation, which is shown in Fig.1:

In evaluating the results in this table, it should be noted that rectifier forward voltage drop and transformer losses have been ignored. The diodes are also assumed to be ideal devices. Despite this, the table gives adequate indication of the relative merits of individual circuits...

So Mullard is happy to ignore transformer losses.

As you can see, I've included values beside each equation to make comparisons easier. I've used the same secondary voltage (10V) given in the What?? question and the same value of resistive load (10 ohms).

This table is complete, except for the various three-phase circuits presented by Mullard and a few relationships that don't have any bearing on the discussion. However, according to other literature (and also to my calculations) there was one error in the table, which is marked with an asterisk. The Mullard equation was shown as $0.785I_{DC}$, which gives the same current in the secondary for the bridge circuit as for the FWCT circuit. This is obviously incorrect, and other sources (Connelly etc) give the equation shown.

Connelly also gives the derivation of the equations.

Now here comes the big one! According to Mullard, Connelly (and others), the *secondary VA* for a bridge rectifier equals $1.23 \times V_{DC} \times I_{DC}$ and for a FWCT circuit it equals $1.74 \times V_{DC} \times I_{DC}$.

OK, so the transformer VA rating for the FWCT circuit is larger than that for the bridge circuit. But by how much? If you multiply 1.23 by 1.41 you get about 1.74. Going back to the What?? answer that started all this, V.C. showed us that the VA rating for the FWCT transformer used in the question was 14.1VA and 10VA for the bridge circuit. Note the 1.41 multiplier. It seems, so far, that he is correct, as verified by the values I've calculated from the Mullard (et al) equations.

But is this the end of the discussion? Perhaps not, as we need to also look at the primary VA rating.

You can see from Fig.1 that the required VA for the primary is the same for both the FWCT and the bridge circuits, at $1.23V_{DC} \times I_{DC}$. This figures, as the load power is the same for both circuits. So what is the total VA rating of the transformer?

According to Connelly, this is determined by adding the primary and the secondary VA figures, then dividing their sum by two. For a FWCT rectifier, this gives a VA rating of 1.48 times the load power and 1.23 times for the bridge circuit. That is, the VA rating for the FWCT transformer is 1.2 times larger than that for the bridge circuit. For the half-wave circuit, you need a VA rating of 3.48 times the power delivered to the load. No other literature I've seen looks at it this way, but Connelly is regarded as a major reference on the topic, so perhaps the other sources didn't complete the exercise.

But by now many readers will be crying foul play — what if we try this out with a real transformer? OK, let's do it!

Real transformers

The easiest way is to take a transformer with a bifilar wound secondary, with each winding having say, 2 ohms resistance. Connected in parallel as for a bridge rectifier, the secondary winding resistance will be one ohm, and from the table of Fig.1 there will be 1A RMS in the winding. The I^2R loss will be $1^2 \times 1$, giving 1W. If we assume a 1:1 transformer, the primary resistance will be one ohm, giving a further loss of 1W. The total copper loss is therefore 2W. If the iron loss equals the copper loss, the total loss is then 4W.

For the FWCT circuit, the total secondary resistance is four ohms, giving a power dissipation of $0.707^2 \times 4$, which equals 2W. The primary dissipation will be the same at 1W, giving a total copper loss of 3W. Adding the iron loss of 2W gives a total of 5W.

While these results show the heating effect due to losses is greater by a factor of 1.25 in the FWCT circuit, they don't tell us the VA rating of the transformer. Manufacturers rarely indicate the efficiency of a transformer (unless it's very high!) so knowing the losses is not enough.

The answer

Now let's briefly return to N.W.'s letter. From the foregoing, I hope it's clear that winding resistance and all that sort of thing can be ignored as it's accounted for in the VA rating. Therefore the required secondary VA rating *must* be determined by multiplying the RMS secondary voltage by the RMS secondary current. Everyone is happy with the bridge rectifier circuit, as the RMS current in the secondary is equal to the RMS load current (1A).

The explanation given in June proves that the RMS current of the waveform from a half-wave rectifier equals half the peak value of the load current. This is validated by the equation in the table of Fig.1 for the RMS load voltage for the half-wave rectifier. OK, so we can let that one rest. However, N.W. doesn't agree that this equation gives the RMS current in each half of the secondary winding for the FWCT circuit.

Again I refer to Fig.1, this time to the relationship used to find the RMS current in each leg of the transformer. The relationship given is not important, but the resulting value is. Notice for the FWCT circuit this current equals 0.707A, which is *half* the peak current in the diode (and therefore half that in the load). The same applies to the half-wave circuit.

So there it is N.W. (and others who aren't sure), the RMS current in each winding for the FWCT transformer is definitely half the peak value of the load current. And the only valid way to arrive at an answer for the VA rating is to multiply the secondary RMS voltage by the secondary RMS current as given in the March answer.

However, according to Connelly, this gives only the *secondary* VA rating, not the *total* VA rating. Technically (if

[illegible]

Connelly is correct), V.C.'s answer is wrong if we talk about the VA rating for the whole transformer. But the method used is valid; the answer simply didn't go far enough.

The explanation given by G.W. in June, (who refuted the use of VA ratings) is therefore missing the point. As I hope I've shown, using winding resistance and I^2R losses doesn't give the whole story; it merely helps prove that the VA rating of a FWCT transformer needs to be larger. But it doesn't show by how much!

Adding a filter

While the foregoing has given me an opportunity to discuss transformers and unfiltered rectifier circuits, most rectifier circuits have filter capacitors. When filtering is added, the waveshape of the current in the transformer changes from sinusoidal (or half-sinusoidal) to a pulse form. So what effect does this have on the VA rating of the transformers? Again I'm going to refer to more of the literature sent to me, in particular that from J.B. (Liverpool NSW), as it provides a relatively simple approach to a complex topic.

As I've already said, rectifier circuits are difficult to analyse, as borne out by some of the other material I've received. Obviously there is no simple answer, and I can therefore only generalise.

Included in J.B.'s literature is material written by Ed Polen, from Signal Transformer, Inc. I'd like to be able to reprint the whole section, titled 'Power Supply Design', but copyright and space limitations make this impossible.

The summary of Fig.2 illustrates the main points made by Polen, which uses some simple equations that, according to Polen 'provide a practical guide for the selection of a power supply transformer. A number of basic assumptions are made to avoid an academic discussion, although these assumptions should be valid for 99% of the average designer's applications.'

He briefly discusses the merits of the FWCT and the bridge configurations and concludes that 'the choice between FWCT and bridge circuits is a trade-off. The bridge rectifier has the best transformer utilisation, but requires four diodes. The extra diodes result in twice the diode voltage drop compared to the FWCT circuit, making the latter preferable for low voltage supplies.'

As you can see from Fig.2, the discussion is based on a full-wave circuit supplying a three-terminal regulator. Polen suggests that the FWCT circuit shown is the 'most common selection for moderate power, regulated DC supplies', but he also gives details for the bridge circuit. The values given are for a 5V DC, 2A regulated supply and the final result is that the VA rating for the FWCT transformer is larger (by a factor of 1.2) compared to the bridge circuit. Incidentally, the multipliers used to determine the RMS secondary current are the same as those given by T.L. Lock in an article published in *EDN*, October 1987.

However, a contributor (C.B., Pascoe Vale Vic) who cites his 40 years experience in transformer design with Trimax Transformers says 'the ratio of RMS to DC current depends mainly on the ratio of source to load resistance. Hence a constant figure cannot be given for this ratio and increases with the size of the power supply. For a typical bridge rectifier supplying 12V DC at 1 to 1.5A, the ratio is about 1.6:1, but for a power amplifier supply of 50V at 3A, the ratio is nearer 2:1. For a FWCT circuit, the current in each half winding only flows for half the time and the ratio of transformer RMS current to DC load current is 71% of these figures.'

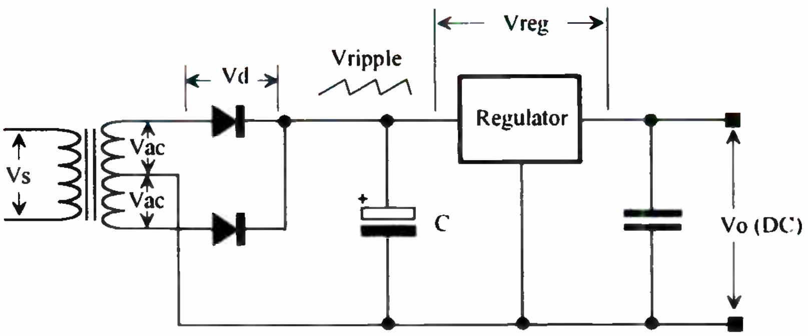
But whatever the ratio, the FWCT transformer needs to have a higher VA rating than that for the bridge circuit. And from all this it seems a figure of 1.2 times satisfies most conditions, with or without a filter capacitor.

Conclusion

Like many of the What?? questions I've presented over the years, the February question has led us into yet another in-depth discussion, prompted by readers (and managing editors!).

Hopefully I've adequately explained the answer, which is fundamentally correct when the secondary VA rating only is considered. Obviously the simplified approach I've used here ignores issues such as harmonics of the waveforms, miscellaneous losses, transformer regulation and so on. Including these factors makes the topic too mathematical for our purposes, although it's likely a similar conclusion would result.

The What?? question I present each



$$V_{AC} = \frac{(V_{OUT} + V_{REG} + V_D + V_{RIPPLE})}{0.92} \times \frac{V_S}{V_{SMIN}} \times \frac{1}{\sqrt{2}}$$

Where: 0.92 = typical rectifier efficiency
Vs = supply voltage, V_{SMIN} = minimum supply voltage

If $V_{OUT} = 5V$, $V_D = 1.25V$, $V_{REG} = 3V$ and $V_{RIPPLE} = 1V_{P-P}$

$$V_{AC} = \frac{9.75}{0.92} \times \frac{240}{200} \times 0.71 = \mathbf{9.03V}$$

for bridge rectifier: $V_D = 2 \times 1.25 = 2.5V$, giving **10.2V** for V_{AC}

RMS secondary current (FWCT) = $1.2 \times I_{DC}$ and for bridge circuit = $1.8 \times I_{DC}$

For a 2A DC supply, $I_{RMS} = 1.2 \times 2 =$ **2.4A** (FWCT), $= 1.8 \times 2 =$ **3.6A** (bridge)

Transformer specification (FWCT) = 18V CT @ 2.4A RMS = **43.2VA**
(bridge) = 10V @ 3.6A RMS = **36VA**

Fig.2: The equations listed here are taken from Section 8 of the 1977 National Semiconductor Voltage Regulator Handbook. This section was written by Ed Polen from Signal Transformer Inc.

[illegible]

month is obviously worth the effort, as it makes the column interesting and keeps me on my toes.

I'm eternally grateful to the many readers who contribute, as without you the column would be very mundane. So be assured I'll try to keep the What?? questions going (although I'm running a bit short, folks!) and either justify the answer if necessary or give in if it's wrong.

On that note, the answer given in April to the March question has a mistake: the resistor values should have been 6 ohms and 12 ohms, not 6 and 13 as shown.

(Editor's Note: Peter's latest discussion of this intriguing topic is very interesting and helpful, I think you'll agree. However I confess there are still a few points where I find myself 'sticking', and unconvinced. In the main, these seem to arise from Peter's use of the term 'ideal transformer' — where, to my mind, he's really talking about a well designed, highly efficient practical transformer rather than what I would call an 'ideal' one.

To my mind, a truly ideal transformer would have NO losses at all, and would thus be able to transfer ANY level of power (because it would neither saturate, nor get hot). It would therefore make little sense, it seems to me, to talk about such a transformer as having a VA rating.

The fact that practical transformers can be given a VA rating, arrived at using certain formulae, simply suggests to me that this is a convenient way of lumping the likely losses into a convenient form, to simplify the design procedure. I really don't think that it means we're IGNORING iron and copper losses, and therefore talking about an 'ideal' transformer...

I've kept these comments separate from Peter's article, and left the latter intact, both to give him a 'fair go' and also to show readers that there can often be a number of viewpoints when complex technical matters are being considered. It will be interesting to learn how readers have found this latest discussion. Don't be shy — write in and let us know!)

What??

Our question this month comes from Wen Liang Soong, who is becoming well known in these columns for his questions. He writes:

The E12 range of resistors consists of 12 values per decade; 1.0, 1.2, 1.5 ... 8.2. Other resistance values can be obtained by combining these E12 values in either series or parallel. In some cases, a particular value can be obtained in *three* ways with two series-connected resistors. For example, a 115 ohm resistor can be obtained with 15 + 100, or 33 + 82, or 47 + 68. How many other resistance values can be obtained in three ways with two series-connected resistors?

Oh yes! Don't include decade multiples of a value, such as 1150 ohms, 11.5k and so on.

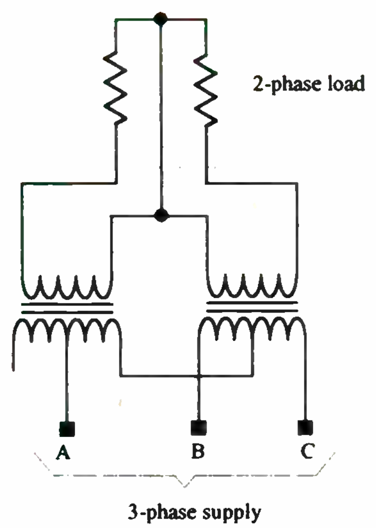


Fig.3

Answer to June's What??

The answer is shown in Fig.3. This circuit is known as the Scott connection and is a technique used to power a two-phase filament in a transmitter output valve from a three-phase supply. Because of the very high filament current (over 100A), this connection ensures a balanced load for the three-phase supply. ❖

NOTES & ERRATA

DOLBY SURROUND SOUND DECODER (January 1992): The PCB overlay has several components incorrectly numbered. C2 should be C5, and C5 becomes C2. C28 should read C20. R15 at the bottom left of the overlay should be R12.

The PCB artwork also has several points where tracks touch adjacent pads. These are fairly obvious and need to be eliminated during the PCB manufacturing process. The parts list has two typesetting errors; C51 is C5 and C132 is C13.

Also, since the time of writing, ABC-TV is now transmitting in stereo. A mono signal for adjusting purposes can therefore only be obtained when a monaural broadcast is made from any of the TV channels.

SECRETS OF SIMPLE DC-DC CONVERTERS - 3 (April 1992): The 0V reference levels are missing from the waveform photographs. In Fig.7 it is the bottom of the graticule; in Fig.8 it is the centre of the graticule and in Fig.9 it is two divisions below the centre of the graticule.

The waveform shown in Fig.9 is the voltage across the 10uF bias bypass capacitor, not the 10,000uF supply bypass capacitor.

In Fig.10, the Y deflection factor should be 10V/division, and no reference level is necessary. In Fig.11 the emitter designation is missing from the 2N3055; the emitter should be connected to the primary of the converter transformer.

In the description of the VZ200 computer power supply, the final sentence should read: 'This time, the *power* stroke is used, in conjunction with a zener diode shunt current regulator'.

Note that FX2242 and FX2243 potcores are listed in the current catalogues of both Rod Irving Electronics and Jaycar Electronics.

However, these cores have been around for about 30 years and indications are that supply difficulties may be experienced in the future. For new designs, the more recent RM/I series of cores should be considered. These cores are fully compatible with the design techniques described in the series, and are manufactured by Neosid, Philips, Siemens and TDK. ❖

NEW KITS FOR EA PROJECTS

Jaycar Electronics has released the following kit for a recent *EA* project:

LOW COST 1MHZ PULSE GENERATOR (June 1992): The Jaycar kit comes complete with a Dynamark (Scotchcal) front panel, but has a conventional captive 240V mains cable, grommet, terminal block and plug in place of an IEC plug on the rear panel, with matching IEC cable. This has allowed the cost of the kit to be kept at an attractive $89.50. The catalog number for the new kit is KA-1743.

NOTE: This information is published in good faith, from information supplied by the firm or firms concerned, and as a service to readers. Electronics Australia cannot accept responsibility for errors or omissions.

SecureData

Impenetrable Data Security

SecureData utilizes the most advanced cryptographic techniques embedded in custom VLSI chips to provide extensive data security to PC, Laptop and LAN users.

Access to data stored on hard or floppy disks, transmitted by modem or circulated on LANS is restricted to users equipped with an appropriate SecureData SmartCard and PIN number.

SecureData transparently provides extremely high levels of real-time in-line security. PCs and software operate normally with virtually no performance degradation and no memory overheads. In addition to part or complete hard disks, discrete files may be compressed and encrypted providing secure data transfer by floppy or modem.

Easy installation, flexible configuration and simple operation makes SecureData suitable for applications ranging from single users with limited needs through to large organizations requiring impenetrable data encryption and access control to military tactical level .

125 bit proprietary encryption key for a key diversity of 4.3×10^{37}

More secure than DES

Real-time *in-line* encryption of directories, partitions and full drives

Individual file compression, encryption and super encryption

SmardCard Access

Multi-user, Multi-level and Group Access

Optional Joint System Administrators

Protects LANs and serial devices

No RAM Overhead

Low Cost

Desktop and Laptop models

VersaKey

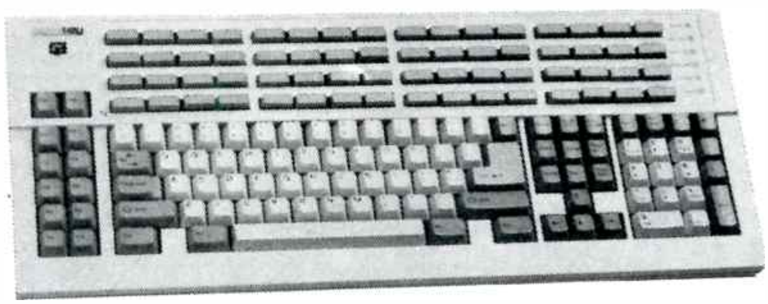
The Intelligent Australian Keyboard

Imagine if your keyboard wasn't limited to just ten function keys. Say there were an additional sixty keys over which you had complete control. Keys that would simply record and replay ordinary keystrokes.

Forget macros, complicated programming languages and tricky TSR software, just press the Learn key and type in your keystroke sequence. VersaKey stores up to 30,000 keystrokes, ready for instant replay at the simple press ofa key.

VersaKey simplifies PC operation, boosts productivity and requires no special hardware, software or PC modifications.

Just plug in and play



VersaKey replaces any standard PC keyboard and provides, in addition to the usual 101 keys, an additional 60 Special Application or Function Keys that record and replay up to a total of 30,000 keystrokes.

Teaching VersaKey is easy. Record any sequence of keystrokes, from simple through to super complex by simply pressing VersaKeys *Learn* key, the target SAKey and typing the required keystrokes. So easy, whilst you use your software normally, VersaKey *Learn*ns. **VersaKey is self contained** , with an internal 16Bit microprocessor, CMOS memory, electronics and 10 year battery backup. **Save your VersaKey configurations** to disk with the free VersaKey utility program. Reload them as required for CAD, Accounting, SpreadSheets, Word Processing, Point of Sale, in fact any software will benefit from VersaKey. Oh yes, **VersaKey is Designed and Manufactured in Australia.**

ACTek Technology Pty Ltd

55 City Road Southbank Vic 3205 Australia

phone (613) **686 9199** fax (613) 686 1337

acTek

ACN 051 739 863

READER INFO NO. 24

NEW RELEASE • NEW RELEASE • NEW RELEASE • NEW RELEASE
NEW RELEASE • NEW RELEASE • NEW RELEASE • NEW RELEASE
NEW RELEASE • NEW RELEASE • NEW RELEASE • NEW RELEASE
NEW RELEASE • NEW RELEASE • NEW RELEASE • NEW RELEASE
NEW RELEASE • NEW
NEW RELEASE • NEW
NEW RELEASE • NEW
NEW RELEASE • NEW

TEST EQUIPMENT

Score top marks for quality, excellence and value! Don't miss our great range of new release test equipment at a store near you.

New Release!

DIGITAL ENGINE ANALYSER

A sturdy and well constructed engine analyser in safety yellow for do-it-yourself car service and maintenance. It's designed for checking the RPM, dwell angle, points as well as the battery charging system. With a large LCD screen, automatic zero adjustment, automatic polarity switching, 0.4 second sampling time, soft carry case, tilt stand and test leads.

Cat Q-1554 **$119**

12 Month Warranty

Features

3.5 digit display

DC V	2V, 20V, 200V, 1000V
AC V	2V, 20V, 200V, 750V
ACA/DCA	2mA, 200mA, 20A
Tacho	4, 5, 6 & 8 Cylinders
Dwell	4, 5, 6 & 8 Cylinders
Resistances	200, 2K, 20K, 200K, 2M, 20M, 200M

Diode and Continuity Test

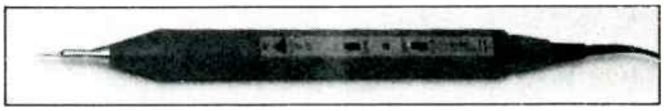
New Release!

DIGITAL CAPACITANCE METER

A portable capacitance meter in safety yellow which has a large 3.5 digit LCD screen. Use it to check tolerances, sort values, select precision values, measure unmarked capacitors and select matched sets. Complete with tilt stand, test leads and a 9V battery for up to 200 hours of operating use. In addition, an onscreen battery indicator tells you when your battery needs replacing. With zero capacitance adjustment knob, push-free rotary range selector, '+' & '-' input connectors, capacitance range of 0.1pF to 20mF and a protective soft carry case.

Cat Q-1224 **$129**

12 Month Warranty



LOGIC PROBE

A high quality logic probe that's ideal for troubleshooting and analysis of logic circuits. It's switch selectable for TTL or CMOS circuits to give the correct threshold for each. The maximum input signal frequency is 20MHz. With deluxe Hi/Low (red/green) LED indicators, a 3mm Pulse/Memory LED and audible Logic Hi/Lo/Pulse logic indication. As well, it comes with a figure 8 moulded power lead with small alligator clips and can be powered by the circuit under test (4 -18V DC).

Cat Q-1274 **$36.95**

New Release!

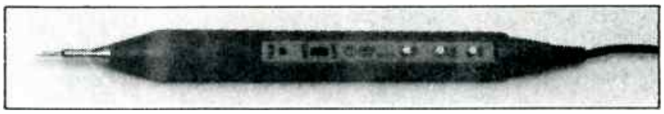
1.2GHz HANDHELD DIGITAL FREQUENCY COUNTER

An unbeatable low price! Anywhere else and you'll be paying a whole lot more for this incredibly easy to use 10Hz to 1.2GHz frequency counter. It has an 8-digit LED display and 3 switchable gate times. Comes with a rechargeable battery and a DC power socket, so you can work while you recharge it at the same time. What's more, it takes only 5 hours to recharge and has overcharge protection. It's ideal for measuring radio frequency transmissions and servicing stereos, videos, computers and cordless phones. With Hi and Low BNC frequency connectors and a full 12 month warranty.

Cat Q-1320 **$199**

Specifications	Range B	Range A
Frequency Range	10Hz - 20MHz	20MHz - 1200MHz
Impedance	1 MEG Ohm,80pf	50 Ohm
Max. Voltage	100Vp-p	5Vp-p

Gate Time: 2s, 0.02s, 0.002s Switch Selectable
Read Out: KHz or MHz
Power: 8.4V rechargeable battery or optional 12V/500mA adaptor, Cat M-9627



LOGIC PULSE

Exceptional quality and value! A very effective and inexpensive tool for inspecting logic circuits. Can be used to inject a signal into logic circuits without removing components or breaking the circuit. The short 10us duration of the output pulse (100mA) insures that no damage will be done to the circuit. The output is switchable between 0.5 & 400Hz. It's powered by the circuit under test (5 -15V DC) and has a figure 8 moulded power lead with small alligator clips.

Cat Q-1276 **$32.95**

DICK SMITH ELECTRONICS

B1334/c

TEST EQUIPMENT

Quality CABLES 30-60% OFF!

Get more cable for your money! All this month you'll save an incredible 30 to 60% off selected cables. Hurry into Dick Smith Electronics and check out our great range of cables today.

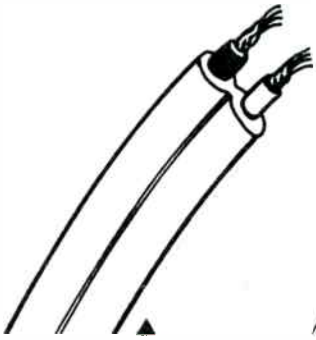
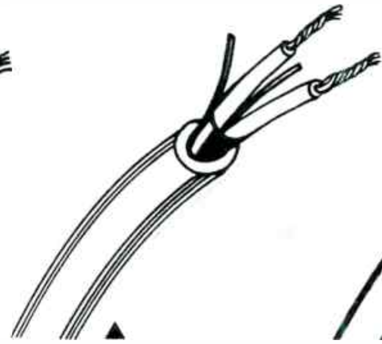
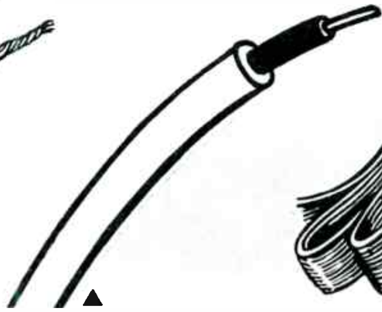


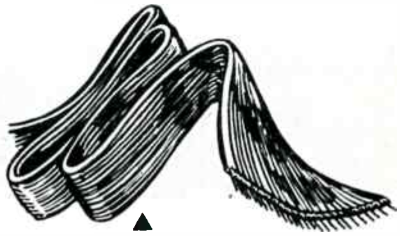
Figure 8 marine cable. It's double insulated with tinned copper conductors to resist corrosion. Was $2.95m
Cat W-2029 **$1.95m**
100m or more $1.45m



'Musiflex' twin shield professional audio cable. A low capacitance, flexible twin core cable with a conductive plastic shield for superior screening and faster wiring. Was $2.45m Cat W-2044
$1.95m
100m or more $1.25m

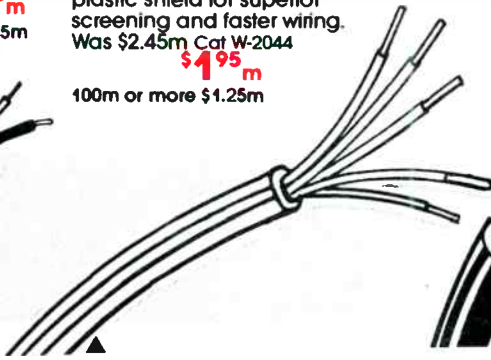


Single core double insulated. 1/113 240V 10A cable. Was 50¢m.
Cat W-2064 **40¢m**
100m or more $0.30m



26 colour flat ribbon cable of 10 x 0.12mm conductors. Was $4.95m
Cat W-2047 **$2.95m**
100m or more $1.95m

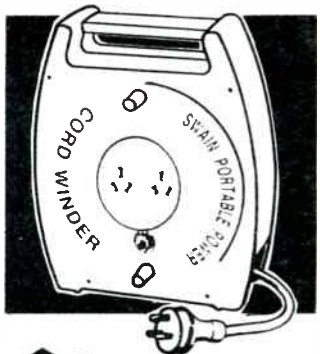
3 Core 240V textile cable.
Was $1.95m
Cat W-2054 **$1.30m**
100m or more 95¢m



5 Core Flat - Austel Permitted Cable. Was $1.75m.
Cat W-2122 **$1.25m**
100m or more 95¢m

RG 11/U professional quality low loss 75 OHM coax cable.
Was $3.95m
Cat W-2083 **$1.95m**
100m or more $1.00m

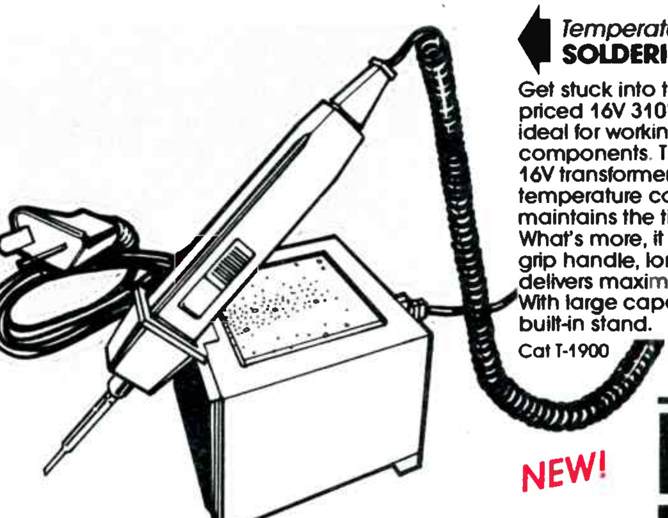
* *Cable stocks strictly limited. Some cables may not be available in all stores.*



25% Off

CORD WINDER

Cord Winder has a 11.5m cable with two power outlets in one handy unit. Includes in-built 10A circuit breaker.
Cat M-7092 **$19.95**



Temperature Controlled
SOLDERING STATION

Get stuck into this for value! A bargain priced 16V 310°C soldering station that's ideal for working with sensitive electrical components. The iron operates from a 16V transformer and has a positive temperature coefficient heater which maintains the tip at a constant 310°C. What's more, it has an insulated cool-grip handle, long lasting fine tip which delivers maximum heat right at the tip. With large capacity sponge tray and a built-in stand. **$49.95**
Cat T-1900

NEW!

CORD STICK

Exceptional value! Makes winding and storing extension cords a breeze! Suitable for cords 16m and over.
Cat M-7090 **$12.95**

DICK SMITH ELECTRONICS

B1334/a

OUR KITS SAVE YOU CASH!

Build it yourself and save! Right now you'll find a fantastic selection of new release kits at a store near you. See them today!

PULSE GENERATOR KIT

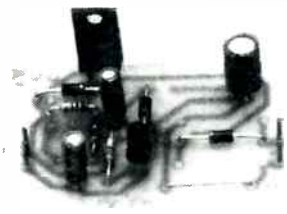
NEW '92

A professional quality yet affordable generator. You'd expect to pay a whole lot more for a commercial unit with similar features. It's ideal for evaluating wideband amplifiers and filters, adjusting the frequency compensation of scope probes and developmental work in digital circuits. It has a frequency range of 1Hz to 1MHz, single-shot, an adjustable pulse width from 350ns to 100ms and adjustable delay on the main output. What's more, it has variable output pulses from 1V to 10V, a choice of either positive or negative output polarity selectable AC/DC coupling and is mains powered. A full form kit with all components, hardware, pre-punched screened front panel and a deluxe case.

Cat K-7342

$89.95

VOLTAGE REGULATOR



NEW '92

Power almost any battery operated device from a car battery or DC plug pack supply and save batteries! This safe and low-cost kit regulates a +12V(nominal) from a plug pack or battery. By changing the resistor value on the PCB you can step-down voltage to 3V, 4.5V, 6V, 9V or other voltages within the range. This device (the LM317) is capable of delivering up to 1.5A (with heatsinking) has an output voltage range from 1.2 - 37V and features internal thermal overload and short circuit protection. What's more, you can design it for existihg equipment or as a stand alone unit. Short form kit with all components and PCB.

Cat K-3592

$6.95

TV TRANSMITTER FOR VIDEO RECORDERS

NEW '92

If you own a VCR and more than one television here's a great idea. This transmitter lets you play a video and watch it from another television without connection leads from the VCR to TV. What's more, it comes with a quality plug pack (valued at $21.95) making this kit exceptional value! As well, all components for UHF or VHF modulator output are included. It's easy to construct and comes as a full form kit with PCB, all components and front panel label. You'll have to build your own antenna, so PCB's and instructions are also included.

Cat K-5700

Includes Plug Pack **$109**

DICK SMITH ELECTRONICS

ELECTRONIC DOORBELL

NEW '92

A quality doorbell system which won't cost you the earth! In fact, it's so good you'll have a hard time convincing friends and family that you actually built it yourself. It's a full form kit and comes complete with a two-tone bell generator,easily replaceable components, doorbell switch, battery holder cable and a stylish deluxe doorbell case.

Cat K-3800

$22.95

ACTIVE CROSSOVER FOR 2 WAY SPEAKER SYSTEMS

NEW '92

Improve your loudspeaker's performance. This crossover kit has features usually found in systems costing thousands of dollars. To overcome the limitations of passive crossovers the active crossover filter network is shifted so that it precedes the power amplifier. This gives ideal high impedance loads, less discrepancies in speaker driver efficiency and less resistance between the voice coil and amplifier. Short form kit, complete with PCB and all components.

Cat K-5405

$29.95

SOLAR EDUCATION KIT

Harness the sun! A fun and inexpensive way to learn about solar energy. It's ideal for children and high school science projects. Learn how to construct projects powered solely by the sun's energy. The kit contains a solar cell module, a solar powered motor, wires, plastic turn-tables and an easy to read booklet explaining solar energy.

Cat K-1060

$9.95

NEW '92

MAJOR DICK SMITH ELECTRONICS AUTHORISED STOCKISTS:

NSW: ARMIDALE: New England Electronics 711655 BALLINA: Ballina Electronics 867022 BATEMAN'S BAY: Baycity Sight & Sound 725030 BATHURST: Electronic Frontiers 323933 BERMAGUI: Oztech Electronic Products 934242 BOWRAL: Bowral Electrical Supplies 611861 BROKEN HILL: Hobbies & Electronics 884098 COOTAMUNDRA: Cootamundra Music & Lite 422561 COFFS HARBOUR: Coffs Harbour Electronics 525684 DENILIQUIN: Deni Electronics 813672 DUBBO: Chris's Hi Fi 828711 FORSTER: Forster Village Electronics 545006 GOULBOURN: Tunlive 22 1288 GRAFTON: Repairs & Spares 421911 GRIFFITH: Miatronics 624534 INVERELL: Inverell Electronics 221821 KEMPSEY: P&L Leonard 631134 LEETON: Leeton Audiotronic 532800 LIGHTNING RIDGE: Lightning Ridge Solar Power 29 1013 LITHGOW: Douroy Photographics 513173 LISMORE: Decro Electronic Services 214137 MOREE: Moree Electronics 522091 MUDGEE: Headware 723895 MURWILLUMBAH: Strings & Things 723684 NARRABRI: Namoi Computer Service 923274 NELSON BAY: Nelson Bay Elect & Hobbies 813685 NOWRA: Nowra Electronics 210722 PARKES: Strad Music Ctr 623366 PORT MACQUARIE: Hastings Computer Service 840255 RICHMOND: Silicon Crafts 784101 TAREE: Manning Electronics 512233 ULLADULLA: Coastal Electronics 553989 WAGGA WAGGA: Phillips Electronics 216558 WALGETT: Walgett Electronic Centre 281116 WELLINGTON: Wellington Service 452325 WINDSOR: Silicon Crafts 776722 YASS: Warmington Electrical 261116 YOUNG: Keith Donges Electronics 821279 **VIC:** ARARAT: Jerram Electronics 522345 BAIRNSDALE: LH & LM Crawford 525677 BENALLA: North East Electronics 622710 CASTLEMAINE: Inspect Electrics 723773 COLAC: Colac Electronics 312847 ECHUCA: Echuca Technical Services 822956 MILDURA: Pullman Auto Pro 232882 SHEPPARTON: Andrew Guyatt Electronics 219497 SWAN HILL: Nyah District TV Service 329303 WARRAGUL: Roylaine 234255 WARRNAMBOOL: Koroit St Elec Services 627417 WONTHAGGI: South Gippsland Photo Service 721411 **QLD:** AYR: Delta Electrix 831566 BLACKWATER: Cool Tronics 825827 BOWEN: Delpro Agencies 86 3477 BUNDABERG: Bob Elkin Electronics 521785 CALOUNDRA: Electro-mart 918533 DYSART: Dysart Videotronixs 582107 GLADSTONE: Electronic Enterprises 726660 INGHAM: Masons Electronics 763188 INNISFAIL: Innisfail Hi-Fi 612014 KINGAROY: MD & MM Siegle 624535 MACKAY: Stevens Electronics 511723 MARYBOROUGH: Keller Electronics 214559 MT ISA: Outback Electronics 433331 NAMBOUR: Nambour Electronics 411966 PIALBA: Keller Electronics 283749 STANTHORPE Granite Belt Communications 813333 **TAS:** BURNIE: Electronic City 314760 DEVONPORT: AI Electronics 248322 LAUNCESTON: Kitronics 344555 **SA:** MT GAMBIER: Hutchesson's Communication 250400 PORT LINCOLN: Basshams TV & Comp World 830075 WHYALLA: Eyre Electronics 454764 **WA:** ALBANY: Micro Electronics 412077 BUNBURY: Micro Electronics 216222 GERALDTON: Batavia Lighting & Electrical 211278 KALGOORLIE: Today's Electronics 215212 KARRATHA: Pilbara Office Supplies 854836 MANDURAH: Mandurah Hi Fi 5812206 PORT HEDLAND: Ivan Tomek Electronics 732531

CASH!

MORE THAN EVER...

You'll find more high quality components, more new books and more value than ever before at Dick Smith Electronics!

July Special

TIPS & TECHNIQUES FOR THE ELECTRONICS HOBBYIST

Gordon McComb - 270 pages.
A concise reference guide to electronics with everything from parts & supplies to safety tips in the workshop. An essential introduction to electronics, with straight-forward answers to the most commonly asked questions.

Cat B-1600

NEW Now Only $29.95

July Special

MASTERING IC ELECTRONICS

Joseph J Carr
Principles and practical experiments designed to give you all the information you need to become familiar with the theory and use of IC circuits. Learn about component specifications, design standards and IC applications.

Cat B-1612

Now Only $34.95

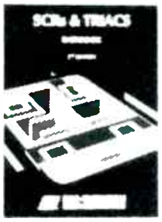
Covers 4000 Series IC

COS/MOS B-SERIES DEVICES

Over 860 pages of information and data sheets on the SGS-Thompson range of CMOS B-series integrated circuits. With the latest product features and technology.

Cat B-5560

$24.95



SCR'S & TRIACS

512 pages
A comprehensive cross-reference index for the latest industry standard components and SGS-Thompson's direct/closest replacement. With data for over 740 Thyrister devices from Small Sensitive Gate SCR's to Alternistors and Trigger Diodes.

Cat B-5564

$24.95

ZENER SCHOTTKY & RECTIFIER DIODES

Ideal for people who work with Zener Diodes, Schottky Diodes or Rectifier Diodes. Includes data covering many products across the diode range, selection guides and cross references to industry parts and numbers.

Cat B-5566

$29.95

July Special

SMALL SIGNAL TRANSISTORS DATABOOK

420 pages of data covering a range of SGS Thompson's discrete devices for small signal, consumer, industrial and professional applications. It also lists data for RF devices and is ideal for evaluating product performance in relation to equipment design.

Cat B-5568

Now Only $19.95

KNOBS & TRANSISTORS

TNC Plug for Cellular Phones
Cat P-2390
New Low Price $3.95

40mm Hi-Fi Knob (Anodized Black)
Cat P-7110
NEW $3.95

30mm Hi-Fi Knob (Anodized Black)
Cat P-7112
NEW $2.95

20mm Hi-Fi Knob (Anodized Black)
Cat P-7114
NEW $1.95

PN 100 G.P Amp/Switching Transistor Multi-Replacement Type For a Wide Range of Transistors
Cat Z-1000
This Month Only 20¢

PN200 as above in PNP
Cat Z-2000
This Month Only 20¢

TIP 142 NPN Power Darlington Output — Cat Z-2026 — $6.95 *NEW*
TIP 147 PNP Power Darlington Output — Cat Z-2028 — $6.95 *NEW*

NEW
BUK 456-60A N-Ch Power Mosfet, 52 Amps, High Power Replacement for BUZ 71, used in 12V-240V voltage inverters
Cat Z-1852
$6.95

NEW
BUK457-600B N-CH Power Mosfet, 600V as used in most switch mode power supplies in computers, TV sets, monitors etc.
Cat Z-1854
$9.95

NEW
PC 16450CN high speed Uart with band generator for 286 PC/AT
Cat Z-9116
$29.95

NEW
C-16550 AFN high speed Uart with band generator for 386/486
Cat Z-9117
$49.95

DS XPRESS PHONE & MAILORDER SERVICE
Outside Sydney (FREE Call) 008 22 6610 Sydney And Enquiries - 888 2105
FAX: (02) 805 1986 or write to DS XPRESS, PO BOX 321 N/RYDE NSW 2113
All Major Credit Cards Accepted. O/Nite Courier Available.
24 HOUR DESPATCH OF ALL ORDERS

STORE LOCATIONS:
NSW • Albury 21 8399 • Bankstown Square 707 4888 • Blacktown 671 7722 • Brookvale 905 0441 • Bondi 387 1444 • Campbelltown 27 2199 • Chatswood Chase 411 1955 • Chullora 642 8922 • Gore Hill 439 5311 • Gosford 25 0235 • Hornsby **New Location** 17-19 Florence St 477 6633 • Hurstville 580 8622 • Kotara 56 2092 • Liverpool 600 9888 • Maitland 33 7866 • Miranda 525 2722 • Newcastle 61 1896 • North Ryde 878 3855 • Orange 618 400 • Parramatta 689 2188 • Penrith 32 3400 • Railway Square 211 3777 • Sydney City 267 9111 • Tamworth 66 1711 • Wollongong 28 3800 **ACT** • Belconnen (06) 253 1785 • Fyshwick 280 4944 **VIC** • Ballarat 31 5433 • Bendigo 43 0388 • Box Hill 890 0699 • Coburg 383 4455 • Dandenong 794 9377 • East Brighton 592 2366 • Essendon 379 7444 • Footscray 689 2055 • Frankston 783 9144 • Geelong 232 711 • Melbourne City 399 Elizabeth St 326 6088 & 246 Bourke St 639 0396 • Richmond 428 1614 • Ringwood 879 5338 • Springvale 547 0522 **QLD** • Booval 282 6200 • Brisbane City 229 9377 • Buranda 391 6233 • Cairns 311 515 • Capalaba 245 2870 • Chermside 359 6255 • Rockhampton 27 9644 • Southport 32 9033 • Toowoomba 38 4300 • Townsville 72 5722 • Underwood 341 0644 • **SA** • Adelaide City 232 1200 • Beverley 347 1900 • Elizabeth 255 6099 • Enfield 260 6088 • St. Marys 277 8977 **WA** • Cannington 451 8666 • Fremantle 335 9733 • Perth City 481 3261 • Midland 250 1460 • Northbridge 328 6944 **TAS** • Hobart 31 0800 **NT** • Stuart Park 81 1977
STORES ACROSS AUSTRALIA AND NEW ZEALAND

DICK SMITH ELECTRONICS

[illegible] THAN EVER...

[illegible]

[illegible]

Construction Project:

Gaussbuster - a low cost ELF radiation detector

The jury is still out on the vexing question of whether ELF radiation can cause cancer and other serious diseases, but building this simple ELF field detector will make you a little bit healthier in any case: just by eating the contents of the yoghurt pot in which it's built!

by PETER VOGEL

Over recent years there has been growing controversy about the possible health hazards of 'extra-low-frequency' (ELF) radiation — the magnetic fields that emanate from many electrical appliances, overhead power lines, and anywhere else alternating current is flowing.

Some studies seem to suggest an association between ELF exposure and cancer, leukemia and other serious disorders (see box 'The Health Debate').

Until we know for sure, it seems sensible to exercise 'prudent avoidance' — that is, minimise exposure just in case. Of course, ELF fields are invisible and if you want to avoid them, it is necessary to have a means of detecting and quantifying them.

A number of commercial 'Gaussmeters' are available (Gauss being a unit of magnetic flux density) but in general these are expensive measuring instruments. The simple 'Gaussbuster' described here has been designed to be as simple and cheap to build as possible.

It is not intended to be used as a precision measuring instrument, being designed to fulfil the need for a simple detector that will warn of potentially hazardous fields, allow the source to be located, and give a rough idea of a field's strength.

The first question to ask in designing such a device is what sensitivity is required. To be useful in locating fields that may be hazardous to health, we need to know what field strengths are dangerous. Magnetic fields are measured in terms of *flux density*, the base units being Webers per square metre.

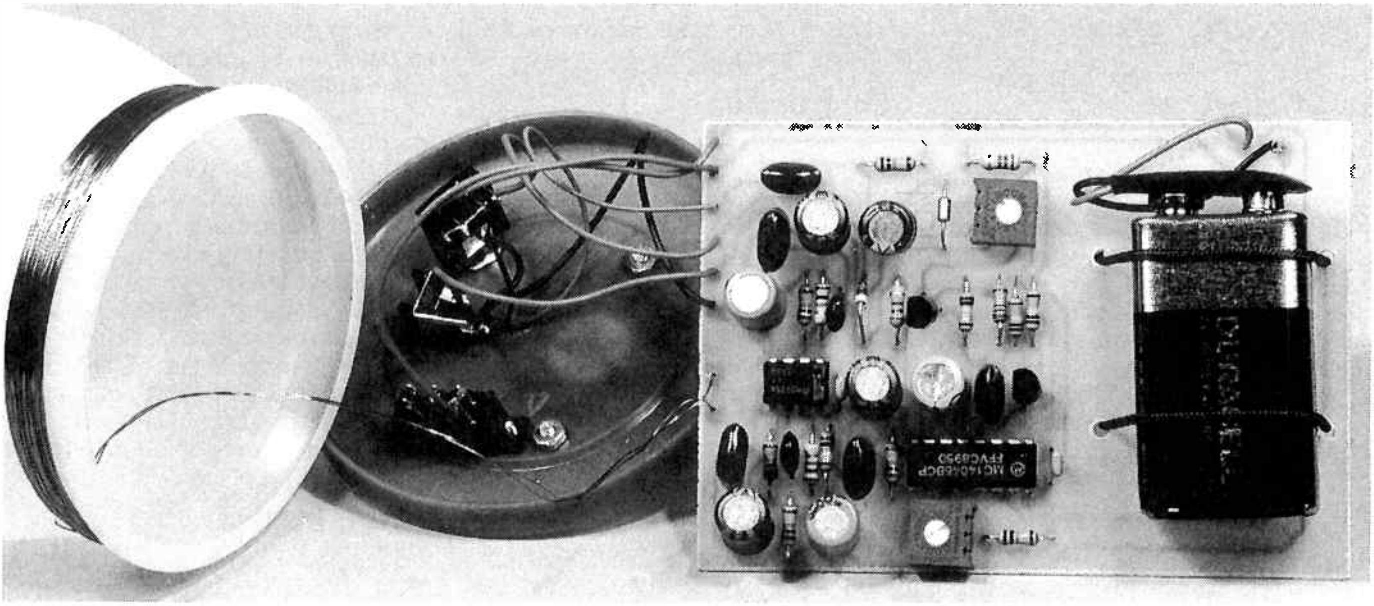
One Weber per square metre is also known as a Tesla. A Tesla is a very strong field, so much of the health literature uses a measure in milliGauss (mG), one Gauss being 1/10,000 of a Tesla.

At the moment, researchers are very divided on the question of how much is too much. The World Health Organisation has adopted the International Radiation Protection Agency (IRPA) guideline of 1000mG (i.e., one Gauss), whereas the Victorian Health Commission has concluded, on the basis of a number of overseas studies, that fields as low as 3mG may be associated with a doubling of the rate of childhood cancer.

This alarming disparity arises largely because the IRPA figure is based on levels that can cause effects by induced current, whereas the lower figure is that which has been found in statistical analyses to be associated with higher rates of illness.

Until more is known about the effects of ELF radiation, it is better to be safe than sorry. The Gaussbuster has been designed with sensitivity centred on the 3mG figure.

The Gaussbuster uses an audible output to indicate field strength, rather than the more usual analog meter or digital display. The Gaussbuster 'ticks', a bit like a Geiger counter; the rate of ticking increasing as the field strength increases.



The PC board can be slipped outside the yoghurt bottle 'case', for easy servicing and/or replacement of the battery.

It is calibrated so that the number of ticks per second is approximately equivalent to the field strength in milliGauss. Of course it is not possible to count large numbers of ticks-per-second, but the threshold level of three milliGauss is fairly easily discerned.

The ticking is also very good for determining relative intensities — that is, as you approach or leave an area of strong field the fluctuation is easily monitored. The audible indication responds much more quickly than a digital display, and more importantly, you don't need to be looking at the device to 'read' it.

This is an important benefit, since it is often necessary to hold the Gaussbuster at an unusual angle to get the best reading, the pickup coil being highly directional.

In case it is desired to measure fields more precisely, a jack is provided to feed an external meter. The takeoff point is after the amplifier stages, where the signal is a respectable 100 millivolts per milliGauss. This can be fed to any reasonably good electronic AC voltmeter.

Pickup device

Gaussmeters generally use one of two basic pickup technologies for measuring magnetic fields. The simplest pickup is a coil of wire. The sensitivity is determined by the number of turns and the diameter of the coil. A hundred-or-so turns of moderate diameter will produce sufficient output to be dealt with by inexpensive circuitry.

The alternative is to use a Hall-effect device, a semiconductor which responds to magnetic fields. These are much smaller than a coil, but have extremely small output at the sort of fields we are interested in and would require sophisticated signal conditioning.

The voltage generated by a coil can be calculated as:

$V = 2.\pi.F.N.B.A$

where

F = frequency (50Hz)
N = number of turns
B = field intensity (Tesla)
A = area of coil (square metres)

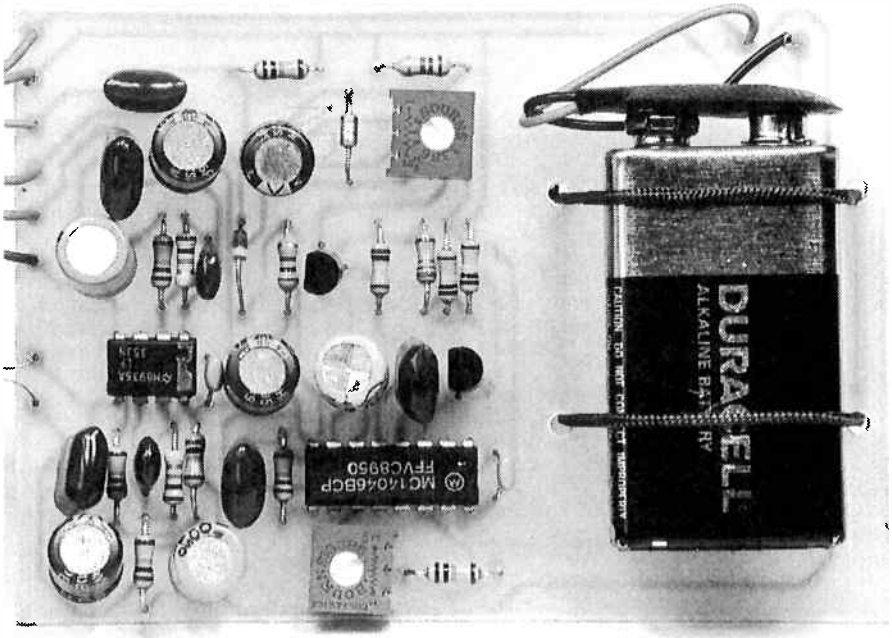
The Gaussbuster uses a coil comprising 85 turns of 70mm diameter, so the voltage generated per mG of field is:

$V = 2*3.1416*50*85*10^{-7}*3.1416*(0.07/2)^2$

$V = 10.2*10^{-6}$,

or about 10 microvolts per milliGauss

Note that the frequency term in the equation means that the output voltage is proportional to frequency — so that a non-sinusoidal field could give erroneous readings, due to the higher weighting given to the harmonics. However this effect will not be significant in a device like this, where absolute accuracy is not required.



A close up of the PC board. Use this shot in conjunction with the wiring /overlay diagram to guide you in wiring everything up.

Novel 'case'

The Gaussbuster is designed to fit inside a plastic yoghurt container — chosen as it is not only inexpensive, but has a convenient recess around one end which is ideal for winding the pickup coil.

To obtain the correct coil diameter, you should locate the exact type used for the prototype, branded 'Jalna'. Alternatively, you can use any plastic enclosure you wish, and if the coil area turns out to be different to that obtained from the Jalna container (70mm diameter) you can adjust the number of turns using the above formula.

The unit is powered by a nine volt battery, ideal for portability and low noise (no risk of hum). Power consumption is about eight milliamps, so operational life of about 60 hours can be expected using an alkaline battery.

Circuit details

As you will see from the circuit diagram (Fig.1), the output of the pickup coil is amplified by two op-amp stages, each providing a gain of 100. The result is a total gain of 10,000 — so that the signal level at the output of the second op-amp is 100mV per mG.

Capacitors C4 and C6 are provided to reduce the low-frequency gain of the amplifiers. If you make these bigger, say 100uF, you will find that the unit responds to the changes in the earth's magnetic field as you move it about.

Capacitors C3 and C5 provide high-frequency rolloff above the desired 50Hz point, providing about 6dB attenuation at 250Hz. This reduces the effects of op-amp noise, improves stability, and reduces the inclination of the pickup coil to produce higher voltages at higher frequencies.

The amplified signal is fed to the meter output jack J2, via a DC blocking capacitor (C10), and also to peak detector D1. This diode charges C9 to the peak voltage produced by the amplifier. RV1 generates a bias voltage to offset the forward voltage drop of D1.

This voltage is about 0.6 volts and will vary a little with temperature. A peak detector of this nature could not be termed high precision, but it is inexpensive and adequate for this application.

Zener ZD1 regulates the 9 volts from the battery to a more stable 5.1 volts for supplying the bias pot and U2.

VCO and 'ticker'

U2 is a phase-locked loop IC, a 4046 CMOS device which uses very little power. Only the voltage controlled oscillator (VCO) section of the 4046 is used. The voltage from the peak detector is fed to the VCO's control voltage input (pin 9). C11 provides the timing element of the VCO. RV2 sets the range of the VCO and can be used for calibration, compensating for the fairly wide tolerance of timing capacitor C11.

The output of the VCO (from pin 4) is capacitor coupled to Q2, which is normally biased off. Each time the VCO output swings positive, a pulse is applied to Q2's base and it momentarily turns on, causing a 'tick' in the piezo transducer.

Although the output from the piezo is not very loud, you should avoid the temptation to use a beefier transducer, such as a small loudspeaker — since the magnetic field of the speaker will be picked up and cause serious feedback problems!

A socket is provided (J1) for connecting head-phones for use in noisy environments. High impedance headphones, such as the 'Walkman' variety, should be used.

Q1 is provided to shut down the VCO when the battery voltage falls too low. While the voltage at the junction of R12 and R13 remains above 0.6 volts or so, the transistor is held on. When the battery voltage drops below 6-7 volts, the transistor turns off, letting the voltage at the inhibit input (pin 5) of the 4046 rise, disabling the VCO.

Construction

The pickup coil is wound on the neck of the container, just below where the cap snaps on. Wind 85 turns of 0.25mm enamelled wire, leaving about 100mm of wire free at each end.

For added stability you can coat the winding with glue or paint — just about

ELF fields — the health debate

Over the past decade, a number of researchers have suggested that exposure to fields from power lines and electrical appliances may promote disease. These fields comprise two components: an electric field and a magnetic field.

Both fields alternate at 50Hz, the frequency of our mains supply. Laboratory tests have shown that alternating magnetic fields can have an effect on biological systems, whereas it is now generally accepted that the electric component of the field does not — except in extreme cases such as a lightning strike!

The most extensive review of the evidence in Australia was conducted by the Gibbs Inquiry, which concluded in 1991 that:

- It has not been scientifically established that ELF fields are harmful to humans, but it has also not been scientifically established that such fields are not harmful.
- The scientific studies, although conflicting, support the view that it is possible that people exposed to ELF fields are at at greater risk of developing certain forms of cancer than other people.
- It is not known at what threshold of exposure (if any) a risk arises, or what conditions are necessary to create a risk.

The most difficult issue of the debate is that there is no known mechanism by which ELF radiation might cause disease, and a lot of research is being conducted to answer this. However, over recent years, researchers have generally agreed that alternating magnetic fields can affect biological functions. The most interesting results so far have been experiments which show that low-level alternating magnetic fields affect the pineal gland and calcium ions in the body. Whether or not these effects are harmful has yet to be discovered.

To further complicate the debate, the effects of ELF found by some experimenters do not seem to follow a classical 'dose-response' relationship.

That is, instances of the observed effect are not greatest when the exposure is maximum. Most adverse health effects do have a predictable dose-response relationship; for example, people who smoke a lot are more likely to get lung cancer than those who smoke a little, and those who don't smoke get lung cancer the least.

One of the most worrying studies has shown a relationship between the way the wiring in a street is arranged and the incidence of childhood leukemia. This study was conducted by the University of Southern California, and involved 232 cases of childhood leukaemia. The study found a relationship between the way the wiring in the street outside the home was arranged and leukemia. However, the risk was not related to the dose (field strength).

There is speculation that the wiring configuration may be an indicator of long-term exposure patterns. Although unusual in medical terms, the lack of dose-response relationship does not necessarily mean there is no relationship. For example, people function better with a body temperature of 36°C than at 30°C, but this does not mean we would do even better at 50°C.

Of course, power lines are only one source of ELF fields. Electrical appliance use has also been implicated — the University of Southern California study also showed a considerable association between childhood leukaemia and electrical appliance use. Fields from appliances can be very strong, especially in view of their close proximity to the user.

The Gibbs Inquiry recommended that until we have a better understanding of the mechanisms involved, a policy of 'prudent avoidance' should be followed. That is, minimise exposure wherever possible.

[illegible]

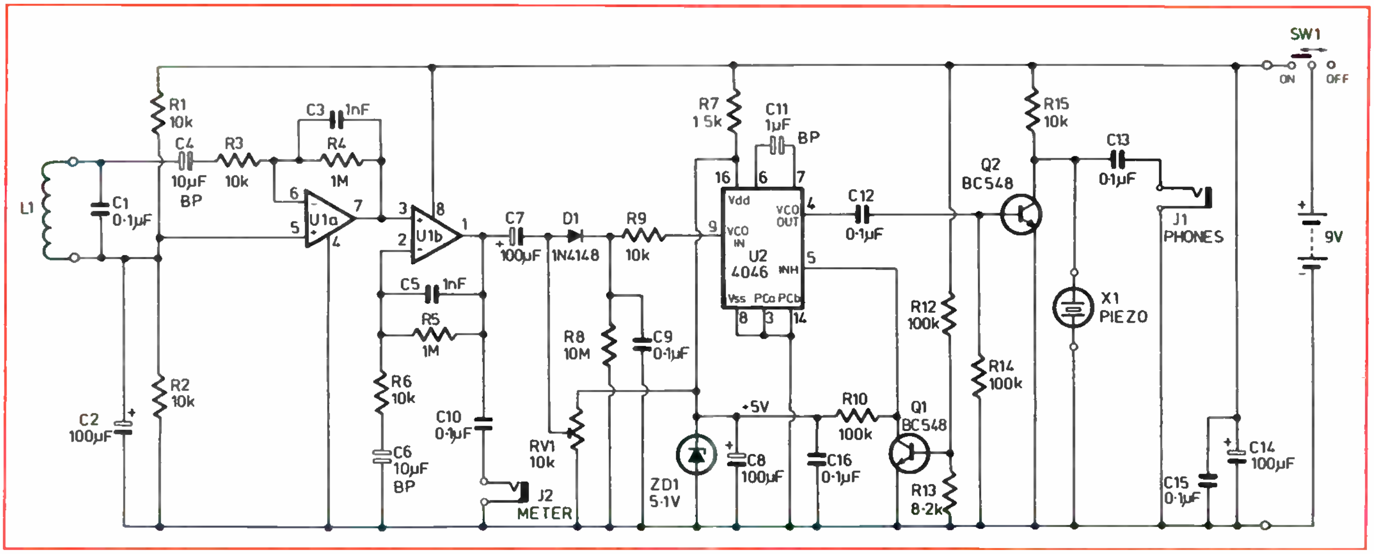
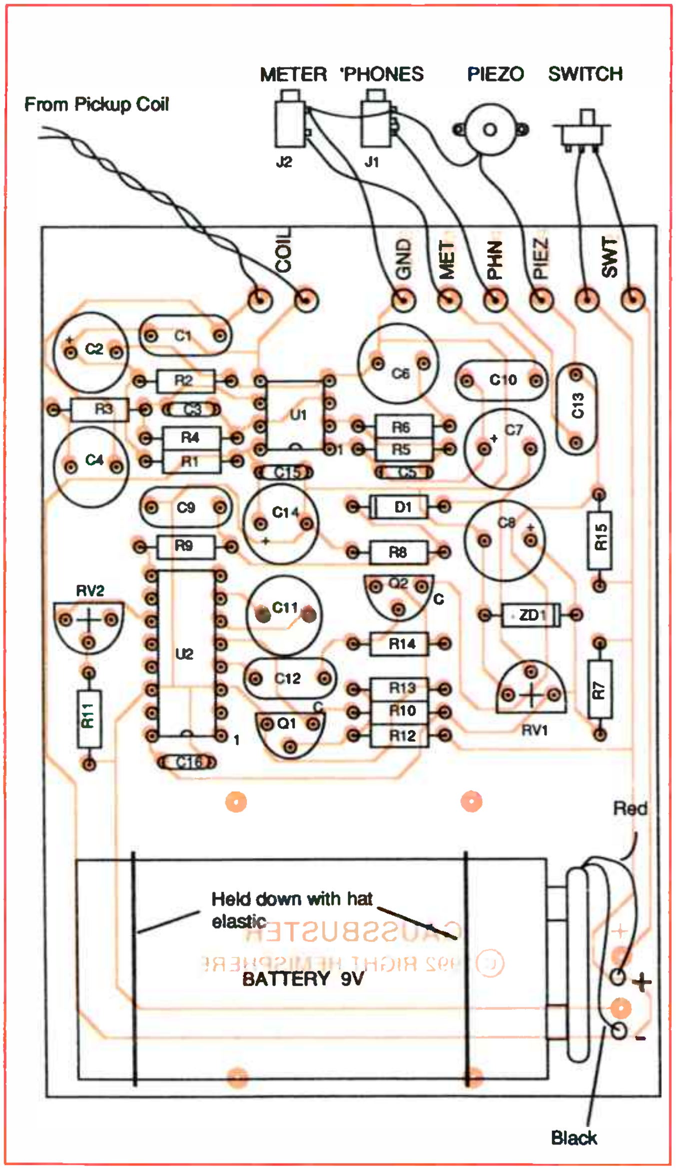


Fig.1: The schematic for the Gaussbuster. The tiny AC voltages induced in pickup coil L1 are amplified by the two sections of U1 (an LF353) and then rectified by D1 and used to control the frequency of a VCO (U2). This produces a series of output 'clicks', which vary in frequency according to the intensity of the field sensed by L1.



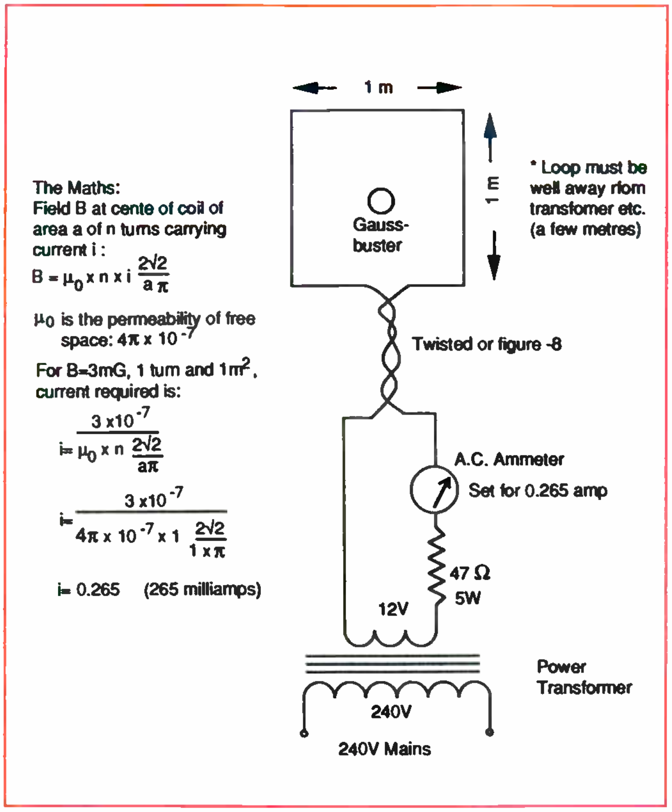


Fig.3 (above): Here is the set up you can use to obtain an alternating magnetic field of known strength for calibrating the Gaussbuster. The current can easily be adjusted if you use a Variac to supply the transformer. Otherwise adjust the current by varying the series resistance.

Fig.2 (left): The PCB overlay/wiring diagram for the Gaussbuster, showing how everything hooks together. Note that the battery is attached to the board using two loops of hat elastic or similar material. As explained in the text, the wiring for the Gaussbuster cannot be mounted in a metal case as this would prevent the pickup coil from doing its job properly.

[illegible]

PARTS LIST

Resistors

R1,R2,R3,R6,R9,R11,R15	10k
R4,R5	1M
R7	1.5k
R8	10M
R10,R12,R14	100k
R13	8.2k

Trimpots

RV1	10k miniature
RV2	100k miniature

Capacitors

C1,C9,C10,C12,C13	100nF polyester
C2,C7,C8,C14	100uF 10V electrolytic
C3,C5	1nF polyester
C4,C6	10uF bipolar electrolytic 25V
C11	1uF bipolar electrolytic 50V
C15,C16	100nF monolithic ceramic

Semiconductors

U1	LF353 dual op-amp
U2	4046 phase-locked loop
Q1,Q2	BC548 NPN transistor
D1	1N4148 silicon diode
ZD1	BZX79C5V1 5.1 volt zener

Miscellaneous

X1 Piezo transducer (DSE L-7022 or similar)
SW1 Miniature slide switch
Batt1 9V battery PP9 size, alkaline
Battery snap connector to suit battery
J1 Stereo headphone socket 3.5mm
J2 Mono headphone socket, 2.5mm
L1 85T 0.25mm enamelled copper wire, 70mm dia.
PCB Printed circuit board 68mm x 93mm
Case 'Jalna' 500g yoghurt container or similar

A kit of parts for this project is available by mail order from:
Right Hemisphere,
Locked Bag 1,
Springwood, NSW 2777
Credit card facility phone orders: (047) 51 1127
Kit Price: $37.00 (sales tax and postage included)
Note that the kit includes all parts except the enclosure and battery. The enclosure is available for an additional $1.50. Fully built and tested Gaussbusters are also available for $58.00 (sales tax and postage included)

anything will do, as long as it doesn't dissolve the enamel. Drill a tiny hole just next to the coil winding area to feed the wires through.

Twist the free ends together and tin the ends for connection to the PCB. The piezo, power switch and jack sockets mount in the snap-on plastic cap of the container. This can easily be drilled for mounting holes and a small rectangular cutout for the actuator of the slide switch can be made with a small knife.

Assemble the PCB using the photographs and the component location drawing Fig.2 as a guide. Then connect the switch, battery 'snap' terminals, jacks and piezo to the board, again according to the wiring shown in diagram Fig.2, making sure you keep the wires just long enough to enable assembly.

Finally, connect the pickup coil to the PCB, and attach the battery to the PCB. This can be conveniently achieved using two loops of 'hat elastic', tied through the holes provided.

As a quick check that no disastrous mistakes have been made, check the current consumption by connecting a milliamp meter across the battery switch (with the switch in the 'off' position). This will allow measurement of the total current consumption, which should be around 7-8 milliamps.

If it is significantly less or more than this, check for wrong or reverse-connected components, or solder shorts or opens. The unit is now ready for testing and calibration.

Calibration

Calibration consists of adjusting the two trimpots RV1 and RV2. RV1 sets the 'zero' level, and RV2 sets 'full scale' sensitivity. In most cases, the calibration of the Gaussbuster need only be very approximate, and to this end the following simple adjustment procedure should be followed.

Take the unit to a place a few metres away from any source of ELF fields — such as out in the garden, away from power lines. Set RV2 to about one quarter of its full travel clockwise. Set RV1 to minimum (anticlockwise). Then switch on.

You should hear a few ticks as the capacitors settle, then silence. Now turn RV1 slowly clockwise and the piezo should start ticking, slowly at first and increasing to a buzz as you turn RV1 further. Back off RV1 to the point that the unit ticks about once every two seconds.

Now you can assemble the unit by inserting the PCB into the container. You will need to squeeze the mouth of the container slightly, to allow the PCB to fit through the neck.

Before snapping the plastic cap on, check that the terminals of the switch and jack sockets do not short to components on the PCB. If it looks as if they might, insert a piece of cardboard over the top edge of the PCB to act as an insulator before snapping the lid on.

Now take the Gaussbuster into your home and seek out an ELF source. Any appliance with a transformer will do. As you approach, the ticking rate should increase. Note that the tick rate will be roughly 1 tick per second per milliGauss.

If you want to calibrate the unit more accurately, you can set up a known field using a loop of wire and a known alternating current. If you set up a one metre by one metre loop as shown in Fig.3, you will produce a field of about 3mG at the centre.

To get this field you will need 260mA of AC flowing in the loop. This is best achieved using a low voltage transformer and a small series resistor. For example, a 12 volt transformer with a 47-ohm five watt resistor should give about the right current.

Connect an AC milliammeter in the loop and adjust the series resistance to adjust the current. If a Variac is available, you can use this to adjust the primary voltage to get the required current.

Once you have established the required 260 milliamps, place the Gaussbuster so that its pickup coil is in the centre of the loop as shown. Note that the Gaussbuster's pickup coil must be in the same plane as the calibration loop.

You now have a reference field intensity of 3mG, so RV2 should be adjusted to give about three clicks per second. This is best checked by counting ticks over 10 seconds. You should also get a reading of around 300mV AC if you connect an AC voltmeter to J2.

Because many of the design parameters are theoretical only, don't expect the accuracy to be much better than 20%.

Gaussbusting

Now that your Gaussbuster is operational, you can map out the field pattern around your home. I was particularly interested to find that some appliances have significant field levels even when switched off, presumably due to the power switching occurring on the secondary side of the mains transformer.

Televisions sets and computer monitors are sources of significant fields, generated by the deflection coils as well as power transformers. It is instructive to sweep around the sides and back of the TV; I found that the field is much stronger to the side than straight in front of the screen.

If you are worried about possible heath effects, you should take particular care where children are exposed, as studies suggest that they are most susceptible. It would seem sensible to avoid putting children's beds where they are exposed

to ELF radiation, and you might find high levels against walls where there is a TV or other electrical appliance on the other side.

A fuse box on the outside of a bedroom wall could cause high fields strengths as well, mainly due to the magnetic field leaking from watt-hour meters.

You might also consider the duration and frequency of exposure in assessing potential danger. An electric drill might generate a huge field, but it is probably only used a few minutes a year.

Electric blankets could be a problem, since the field from the heating coil can be significant, and you spend many hours each night at very close range. You could also check out the bedside clock radio, which probably has a power transformer leaking fields.

Household electrical wiring is generally not a problem area, since the active and neutral conductors are usually close together and the opposing fields cancel. In some cases this balance does not apply, for example where the active to a switched appliance runs separately from the switch.

Surprisingly, even earth conductors can generate fields due to current flowing through the earthing system from the neutral link (in most installations the neutral is connected to earth at the fusebox). These earth paths can also cause imbalance in the active/-neutral conductors on the supply side of the earth point.

Note that the field resulting from two cancelling conductors decreases approximately with the square of the distance (assuming the distance between the conductors is small compared to the distance you are away from them).

When tracking down fields in your home you might be surprised to find that the maximum fields are not necessarily present with the largest number of appliances running, due to complex patterns of cancellation (especially in multi-phase installations).

Also, don't forget that off-peak hot water systems will switch themselves on and off at various times, confusing the issue even further.

Finally, don't forget to turn the Gaussbuster around in each axis to get the highest reading. The pickup coil is highly directional, the maximum signal being received when the winding of the coil is in the same plane as the conductor generating the field.

Happy ELF hunting! ❖

JET EXPRESS DELIVERY• AUSTRALIA WIDE

ALTRONIC COMPONENTS

Stereo 50 + 50W Midi-Style Amplifier Kit (SC Feb and March '92)

Replace That Old Beaten Up Amp!

This fantastic new amp has all the features of commercial units costing hundreds of dollars more using tip 142/147 transistors it is capable of producing a total of 50 Watts per channel RMS. Into 8 Ohms makes an ideal replacement midi unit.

Performance:
Output Power: 55W into 8 Ohms 80 watts 4 Ohms
Harmonic distortion: typically less 0.05%

K 5045 **$299.00**

Beat Triggered Strobe Kit (AEM July '85)

Add Some Life To Your Next Party

Designed by Australian Electronics Monthly. Flashes in time to your music. Will also work as normal strobe. Exclusively customised by Altronics into our H 0480 Instrument Case, making construction a breeze and improving stability and overall appearance. Includes silk screened panel. Two tube option available which boosts lighting output.

K 5790 Normally $79.95 Now **$69.00**

K 5795 Two Tube Option Normally $16.50 Now **$15.00**

50W Mosfet Module Kit

This great module features moderate power output at low harmonic distortion. Simple to build and compact in size this unit makes a great replacement module for your old Hi-Fi or buy two and make your own stereo amplifier.

K 5115 **$49.95**

120 Watt Public Address Amplifier Kit (SC Nov '88)

High Performance Low Noise P.A. Amplifier

This professional quality Public Address Amplifier offers performance equal to better than commercial units, at about half the price. Amplifiers using 100V line outputs are used extensively in everyday situations where numerous speakers and long output lines are employed. Ideally suited for Halls, Churches, Clubs and even temporary setups.

SAVE A MASSIVE $150.00

Inputs: 2 balanced mics (3 Pin XLR connectors), 2 Auxilliaries (RCA connectors)
Outputs: 4 Ohm, 8 Ohm or 100V line.
Power Output: 125W RMS into 4 Ohms, 90W RMS into 8 Ohms, 120W RMS into 100V line
Frequency Response: 30Hz to 30kHz
Harmonic Distortion: Less than 0.3% from 20Hz to 20kHz

K 5020 Normally $499.00 Now **$349.00**

Playmaster Pro Series One 200W Mosfet Module Kit

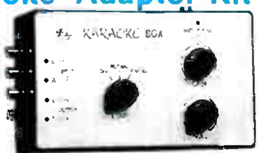
(EA Dec '89)

This amplifier module has all the same high specs as the "Stereo Pro Series One", but in short form i.e.: One mono module — no power supply or case. Fantastic for use in Juke boxes, amplifier racks (multi-amplifier setups) discos etc. See above for specifications.

K 1170 Normally $85.00
Now **$79.00**

Low Cost 'Karaoke' Adaptor Kit

(EA Nov '91)

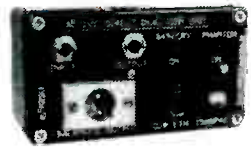


It's time to bring out all those hidden vocal talents that you've always known were there. With this project you can remove the lead vocal from almost any recording, and replace it with your own via a standard microphone. It's a great way to liven up a party! This project works on the assumption that the lead vocal in most stereo recordings has been placed mid-way between the left and right channels, or is in fact a mono signal. Requires 2 x 9V batteries. **Simply connects in line between CD or Tape Deck and Amp. Mic Socket 6.5mm Jack.**

K 1170 Normally $34.95 Now **$30.00**

Single 'DI' Box Kit

(EA Oct '87)



Converts high impedance unbalanced inputs to low impedance balanced outputs. Used in studios, music, PA industry to convert high impedance devices i.e.: electric guitar pickups, synthesizer etc.

K 5550 **$45.00**

New High-Tech Remote Car Alarm

Amazing Price! Save Hundreds $$$ On Comparable Systems

This amazing new model features just about everything you could imagine! Multifunction keyring remote control will arm and disarm alarm (and activate central locking if fitted) chirp the horn, turn on car headlights, panic and even open the boot (if actuator fitted). One remote can control two alarms. Other features include Starter inhibit, valet mode, central locking interface, flashes car indicators when tripped, auto reset plus much more!

DIRECT IMPORT PRICE

S 5230 **$249.00**
S 5231 Replacement Remote Control **$48.50**

Flush/Surface Mount Alarm Panel

With stylish compact good looks this alarm blends smoothly into any residential or office decor by either flush mounting into the wall, or surface mount. 3 sectors include 24 hour panic/fire, perimeter and internal which can be isolated enabling the alarm to be armed at night with occupants inside whilst still protecting entries, simple 4 digit access code for operation. See Altronics '92 catalogue for full details.

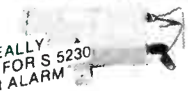
S 5490 $119.00 This Month **$99.00**

Alarm Power Supply

This UPS (Uninterruptable Power Supply) will supply 12V at 1.2 Amps via its internal inbuilt sealed lead acid battery even when the mains has failed. Ideal for use with alarm system power supplies monitoring systems, warning systems etc.

M 9090 **$69.95**

Satellite Siren



IDEALLY SUITED FOR S 5230 CAR ALARM

This self contained compact unit can deliver a massive 120dB. It connects via 3 wires to any alarm system that has an output that is normally negative. Will sound if the wires are cut. Arm/disarm inbuilt key switch.

S 5235 $63.95 Intro Price **$55.95**

UHF Microprocessor Controlled Wireless Security System

Apart from the flawless operation of the system one of the great features is its application with rented or leased premises — let's face it, money spent on installing a wired system in your home or office, factory, etc is irrevocably lost when you move on. With this system you simply take it with you. Ultra high-tech and push button operation makes this unit a breeze to install and operate. Features 6 sectors plus 2 x 24 hour fire and tamper circuits. The **S 5240** system includes main controller, 1 Passive Infra Red Movement Detector, 1 window or door Reed switch, wired siren, power supply, back-up rechargeable battery, and a special personal remote. All sensors are radio transmitters which means no wiring is neccessary (except for the plug pack and siren). The whole system is coded so it can not be interfered with and can be changed any time by the owner. Each individual sensor can be easily set to operate on any sector. The main controller utilizes latest EEPROM technology which means things like selecting user on/off codes, isolating sectors are a breeze. Includes a myriad of other amazing features, too many to mention.

Call ALTRONICS today for a free colour brouchure.

Complete system Includes.

- 1 x Control Panel
- 1 x Passive Infra Red Detector/Transmitter
- 1 x Door/Window reed Switch/Transmitter
- 1 x Hand Held remote Control/Transmitter
- 1 x Horn Speaker — 10 watt/wired
- 1 x 240V AC adaptor
- 1 x 1.2Ah Back-up Battery
- 1 x Set of batteries for all transmitters

S 5240 Complete System
NOW ONLY **$579.00**

WAS $679.00 SAVE A MASSIVE $100.00!

External Siren
C 2015 $15.95 Now **$11.**

Door/Window Reed Switch & Transmitter
S 5247 $72.95 Now **$63.95**

Personal Remote
S 5250 $62.95 Now **$54.95**

Wireless Remote Keypad
S 5255 $136.00 Now **$114.95**

Passive Infra Red Movement Detector
S 5245 $155.00 Now **$134.95**

PHONE ORDER TOLL FREE 008 999 007

JET EXPRESS DELIVERY• AUSTRALIA WIDE

ALTRONIC COMPONENTS

AM/FM PLL Tuner

A 2210
Normally $229.00
This Month **$199.00**

This fantastic tuner is the ideal add-on to any sound system. Can be used as background music source in restaurants, shops etc or any PA application. Also a great upgrade for the home Hi-Fi.

Features:
• Digital LED frequency readout display • FET FM front end for high image rejection • Phase-linear ceramic filters are incorporated in both AM and FM IF section • Phase-lock loop (PLL) IC for FM multiplex stage • Dimensions: (W x H x D) 435 x 60 x 232mm • Weight: 3kgs.

Two Channel Pro Power Amp 90 Watts Per Channel

THESE UNITS IDEALLY SUITED FOR EACH OTHER. BUY BOTH AND SAVE EVEN MORE — ASK ALTRONICS FOR YOUR SPECIAL PRICE!

A 2040 $625 This Month **$539.00**

This stereo amp is ideal for background/foreground applications. Fantastic for restaurants, shops, disco's, aerobics, PA sound systems and home.
• 90 watts RMS per channel • 2 large power meter indicators • XLR socket for speaker terminal • Output relay to eliminate turn-on and off transients

100mm Super Carbon Fibre Speakers

These amazing little speakers will impress you and your friends. Carbon Fibre is a new high tech material from which these speaker cones are made. Complimented with Barrium ferrite magnets the results are simply amazing. 8 and 16 ohm versions available makes multi speaker installations a breeze. Weatherproof design makes them ideal for car doors and boats!

C 0641 8 Ohm
C 0643 16 Ohm
Save Up To 50%
Normally $38.95
This Month **$25.00** or **$40.00** pr

Polyswitches

These devices provide excellent protection for your speaker system. They simply connect in series between your amp and speaker. When the current exceeds the polyswitch rating they go open circuit, thus protecting your expensive investment.
R 4050 For Tweeters up to 100 watts 0.5 amp at 50V **$6.20 ea**
R 4055 For Midrange/Woofers up to 100 watts 1.15 amp at 50V **$6.95 ea**
R 4060 For Complete system up to 200 watts 2.45 amp at 50V **$8.90 ea**

Squeeky Clean Mains Filter

New 8 Way Model At The Old 4 Way Price!

P 8170 **$289.00**

Save your precious and expensive computer hardware and hi-fi etc from the power surges, spikes and lighting. A must for anyone who doesn't want their equipment blown up! New 8 way model contains two power filters.

Quality Replacement Speakers
SAVE OVER 30%

165mm
3 watt, 4 & 8 Ohm taps
C 0620 were $8.95
This month **$5.95**

150 x 100mm
3 watt,4 & 8 Ohm taps
C 0622 were $9.95
This month **$6.95**

178 x 125mm
3 watt, 4 & 8 Ohm taps
C 0624 were $12.50
This month **$8.50**

Audio Frequency Generator

Specifications:
Frequency Range: 10Hz - 1MHz
Accuracy: +/-3% + 2Hz
Output Waveforms: Sine/Square
Output Level: Sine: 8V rms
Square: 10V P-P
Output Attentuator -20dB, -40dB and fine adjust
Q 1540 Normally $325.00
Now **$250.00**

RF Signal Generator

With provision for both internal and external modulation.
Specifications:
Frequency Range: 100kHz - 150MHz in 6 ranges
RF Output Level: 100mV rms
Accuracy: +/-3%
Modulation: • Internal (30% depth): 1kHz • External: 50Hz-20kHz • Crystal Locked Oscillator
Q 1550 Normally $299.00
Now **$225.00**

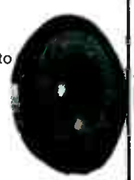
12" Guitar Speaker

50 Watts RMS, 100 Watts Max.
Attention all guitarists and keyboard musicians This fine USA designed speaker is supplied as standard equipment to the world famous brand name series of Guitar Amps. • Impedance: 8 Ohm • Sensitivity: 101dB/W (0.5m) • Weight: 2400gm

C 3102
Normally $99.00
This Month Only **$79.00**

Sensational Dome Tweeter

Ferro Fluid cooled voice coil 60 watts power capability. Silky smooth frequency response 1.5kHz to 20kHz. Wide angle dispersion. In comparative tests we rate this fantastic new Dome Tweeter superior to the VIFA D19! (which costs $45 or more). Incredible low price.



C 3016 Normally $39.50
Now **$30.00**

Stereo Extension Ceiling Speaker Kit

Want a set of high grade extension speakers for the back patio, games room, den, workshop, kitchen? Well here at Altronics we have put together this great kit which includes speakers, grilles, cable, screws and even a wall mounted volume controller. The speakers are our high quality 4" C 0626 dual cone drivers, with stylish white grilles — ideal for mounting in the ceiling. Volume control mounts in standard electrical wall box and includes 6 volume settings as well as off. Includes 2 x 20m cable.

C 0988 Normally $99.00
This Month Only **$69.00**

IRODA Gas Soldering Iron

OVER 20,000 ALREADY SOLD AUSTRALIA WIDE

T 2450 **$39.50**

Winner of the Taiwan Good Design Award
Now you can solder anywhere with this new gas soldering iron.
Features • See through gas chamber (no more guessing how much gas is left!) • Built in ignition cap • Uses standard butane gas • Comes with safety bench stand • Supplied with 2mm soldering tip and blow torch tip • Adjustable temperature from 400°C to 1200°C • Can be easily refilled with standard butane lighter gas • Replacement tips are less than half price of some other brands!

REPLACEMENT TIPS - ALL $4.95 ea

T 2451 Replacement 1mm Conical Tip	**T 2455** Replacement Exhaust Port
T 2452 Replacement 2mm Conical Tip	**T 2456** Hot Knife Tip
T 2453 Replacement 3mm Conical Tip	**T 2458** Blow Torch Tip
T 2454 Replacement 3mm Chisel Tip	**T 2457** Hot Blower Tip **$10.95**
	T 2448 Weller Butane Gas Refill **$6.95**

Components Bargain Packs

¼W Carbon Resistor Pack
Average Contents: 300
R 3501 Normally $6.95 Now **$6.00**

¼W Metal Film Resistor Pack
Average Contents: 150
R 3505 Normally $5.95 Now **$5.00**

Greencap Capacitor Packs
Average Contents: 50 value.
R 3510 Normally $5.95 Now **$5.00**

Ceramic Capacitor Packs
Average Contents: 100
R 3515 Normally $5.95 Now **$5.00**

Electrolytic Capacitor Pack
Average Contents: 40
R 3520 Normally $6.50 Now **$6.00**

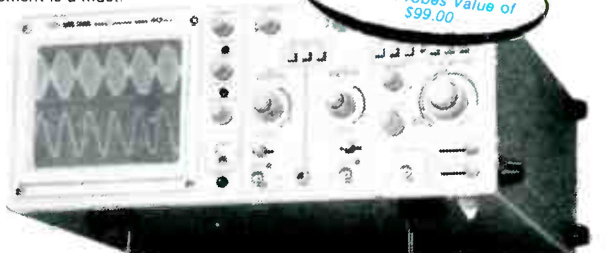
40MHz Dual Trace Oscilloscope

Q 0160 This Month **$1445.00**

A superb oscilloscope for technicians and engineers working on projects where other instruments would be stretched beyond their capabilities. Where precise measurements of computers, CD's, digital videos, RF applications, high speed digital, and other high speed equipment is a must.

BONUS — Includes 2 FREE Probes Value of $99.00

With Features Like: • Delayed sweep for partial waveform expansion • Channel 1 signal output for use with a frequency counter • CH2 polarity inversion switch • Vertical deflection magnification, X5 • Switchable chopping frequency • Scale illuminating system • B Intensity control for bright, magnified waveforms • Variable hold-off for observation of waveforms with complex periods • Single sweep mode for one time or other suddenly occuring events • Sweep magnification, X 10 • Signal delay line for accurate view of high frequency pulse leading edge • Trigger preset function.



PHONE ORDER TOLL FREE 008 999 007

JET EXPRESS DELIVERY • AUSTRALIA WIDE

ALTRONIC COMPONENTS

Massive Savings On Old Style Rack Cases and Blank Panels

Save Up To 50%

With the introduction of our new range of rack cases, we have sacrificed the old stock at below cost! This means fantastic savings for you — our valued customer. Please note stocks are limited - no back orders.

1 Unit — All $25
H 0404 Grey

2 Unit — All $30
H 0405 Grey
HS0402 Silver Anodised

3 Unit — All $35
HS0403 Silver Anodised
H 0413 Black Powdercoat
H 0406 Grey

SORRY — NOT AVAILABLE FROM ALTRONIC RE-SELLERS

Top quality blank panel clearout. All stock must go at these crazy prices. Stock is limited with definately no back orders at these prices.

2 unit — All $8.00
H 0422 Natural Aluminium
H 0432 Grey
H 0435 Black

3 unit — All $12.95
H 0423 Natural Aluminium
H 0433 Grey

Australian Designed and Manufactured Professional Series Modular Rack Frames

Suitable for home or commercial use, these fantastic rack frames are durable strong, good looking, light weight and easy to assemble. The frames are available in either Natural Anodised aluminium or Black Powder Coat aluminium and the side panels in Electric Blue or Black Powder Coat finish. Ideal for use in home Hi-fi systems, Professional Audio installations, Band Gigs, Computer Patch panel etc.

Two colours to choose from:
Frames: Natural Anodised or Black Powder Coat
Panels: Electric Blue or Black Powder Coat.

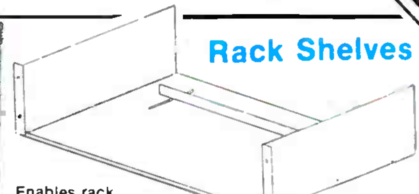
Proudly Made In Australia

NOW AVAILABLE IN BLACK POWDERCOAT

		Were	Now
H 5204	Rack frame 4U Nat.	$139	$125
H 5205	Panel set for H 5204	$49	$44
H 5206	Rack frame 6U Nat.	$149	$135
H 5207	Panel set for H 5206	$55	$49
H 5212	Rack frame 12U Nat.	$169	$152
H 5213	Panel set for H 5212	$89	$80
H 5218	Rack frame 18U Nat.	$189	$170
H 5219	Panel set for H 5218	$110	$99
H 5230	Rack frame 30U Nat.	$229	$205
H 5231	Panel set for H 5230	$159	$143
H 5238	Rack frame 38U Nat.	$269	$242
H 5239	Panel set for H 5238	$195	$175

		Were	Now
H 5304	Rack frame 4U Black	$139	$125
H 5305	Panel set for H 5304	$49	$44
H 5306	Rack frame 6U Black	$149	$135
H 5307	Panel set for H 5306	$55	$49
H 5312	Rack frame 12U Black	$169	$152
H 5313	Panel set for H 5312	$89	$80
H 5318	Rack frame 18U Black	$189	$170
H 5319	Panel set for H 5318	$110	$99
H 5330	Rack frame 30U Black	$229	$205
H 5331	Panel set for H 5330	$159	$143
H 5338	Rack frame 38U Black	$269	$242
H 5339	Panel set for H 5338	$195	$175

Rack Shelves



Enables rack mounting of tuners, videos, C.D. players, amplifiers etc. which normally can't be rack mounted. Supplied in flat pack form - easily assembled in minutes. Available in black only.

H 5352 2 Unit (88mm) Normally $49.95 Now **$39.95**
H 5353 3 Unit (132mm) Normally $49.95 Now **$39.95**
H 5354 4 Unit (176mm) Normally $55.95 Now **$45.95**

Save On Discounted Tools

Top quality palm grip series with spring return makes these tools a breeze to use and a must for every tool box.

T 2710 Flat Nose Pliers
T 2720 Needle Nose Pliers
T 2730 Curved Needle Nose Pliers

All were $9.95 ea
This month **$6.95 ea**
or **$18.00 set of 3**

Casio Two Colour Printing Calculator

• Black print and red print for subtractions • Sub-total/total • Item counting • Average function • 3 digit comma markers • Full decimal system. Operates on 4 x AA batteries (included) or power supply. Includes one roll of 58mm paper and dust cover.

WELL BELOW COST!

X 2125 Normally $149.00
THIS MONTH ONLY **$69.00**

Just In Stock — 'Universal Wacki Bracket'

Yet another Altronics innovation, proudly designed and made in Australia. These great new speaker mount brackets simply screw onto the wall and speaker allowing a universal 50° angle of adjustment. Suitable for speakers up to 5kg. No special tools required. Available in white or black. A must for any extension speaker

H 8010 White
H 8012 Black **$39.95 pair**

Proudly Made In Australia

Super Large Instrument Cases

Massive 355 x 250 x 122 mm

• Designed to house amplifiers, inverters, power supplies, micro-processor equipment, etc • Mounting posts provided for PCB's, transformers • Vented for efficient air-flow cooling • Extra tough, super finish front and rear panels.

H 0490 Grey Case, **H 0491** Black Case, **H 0492** Blue Case

Normally $38.95 Now **$29.95**

Digital & Analogue Combination Multimeter

This fantastic meter gives you the accuracy of a digital as well as the ease of an analogue! Features true RMS AC test, AC and DC current test, AC and DC voltage resistance continuity etc and many other features you would only expect on much more expensive meters

Q 1090 Normally $199.50
This month only **$129.00**

ALTRONICS

174 Roe St. Perth W.A. 6000 Phone (09) 328 1599
PHONE TOLL FREE 008 999 007
MAIL ORDERS C/- P.O. Box 8350 Stirling Street PERTH W.A. 6849

STANDARD DELIVERY & PACKING CHARGE $3.50 to 500gms, $5.50 500gms - 1Kg, $8 1Kg-5Kg **AUSTRALIA WIDE** — We process your order the day received and despatch via Australia Post. Allow approx 9 days from day you post order to when you receive goods.
OVERNIGHT JETSERVICE Up to 3Kg is $10.00, 3Kg to 5Kg is $23.00 — We process your order the day received and despatch via. **Overnight Jetservice Courier** for delivery next day Country areas please allow additional 24-48 hours.

HEAVY HEAVY SERVICE — All orders of 10Kgs or more must travel Express Road — Please allow 7 days for delivery. $12.00 to 10Kgs. $15.00 over 10Kgs.
INSURANCE — As with virtually every other Australian supplier, we send goods at consignees risk. Should you require comprehensive insurance cover against loss or damage please add $1.00 per $100 of order value (minimum charge $1). When phone ordering please request "Insurance".
TOLL FREE PHONE ORDER — Bankcard, Visa, Mastercard Holders can phone order toll free up to 6pm Eastern Standard Time. Remember with our **Overnight Jetservice** we deliver next day.

ALTRONICS RESELLERS Chances are there is an Altronic Reseller right near you — check this list or phone us for details of the nearest dealer.
Blue Ribbon Dealers are highlighted with a ■ These dealers generally carry a comprehensive range of Altronic products and kits or will order any required item for you.

WA COUNTRY ALBANY BP Electronics ■ (098) 412681 Micro Electronics (098) 412077 **BUNBURY** Micro Electronics (097) 216222 **ESPERANCE** Esperance Communications (090) 713344 **KALGOORLIE** Todays Electronics ■ (090) 215212 **MANDURAH** Lance Rock Retravision (09) 535 1246 **PORT HEDLAND** Ivan Tomek Electronics (091) 732531 **ROCKINGHAM** TV Joe's (09) 5271806 **NT ALICE SPRINGS** Farmer Electronics (089) 522388 **DARWIN** Ventronics (089) 853 622 **VIC** All Electronic Components (03) 6623506, TECS (03) 6706474 **BORONIA** Ray Cross Electronics ■ (03) 7622422 **CHELTENHAM** Talking Electronics (03) 5842386 **COLLINGWOOD** Truscott Electronics (03) 4198208 **CROYDON** Truscott Electronics ■ (03) 7233860 **FOOTSCRAY** G.B. Telespares (03) 3179100 **PRESTON** Preston Electronics ■ (03) 4840191 **COUNTRY BAIRNSDALE** LH & LM Crawford (051) 525677 **BALLARAT** Ballarat Electronics (053) 311947 **CRANBOURNE** Mart's Electronics (059) 968200 **MILDURA** McWilliam Electronics (050) 236410 **QLD** Delsound PL ■ (07) 8396155 **WEST END** B.A.S. Audiotronics (07) 8447566 **WOODRIDGE** David Hall Electronics ■ (07) 8082777 **COUNTRY GLADSTONE** Gladstone Electronic Services (079) 724459, Electronic Enterprises (079) 726660 **MAROOCHYDORE** MALS Electronics ■ (074) 436119 **MARYBOROUGH** Keller Electronics (071) 214559 **NAMBOUR** Nambour Electronics (074) 411966 **PIALBA** Keller Electronics (071) 283749 **ROCKHAMPTON** Access Electronics (East St.) (079) 221058 **TOOWOOMBA** Hunts Electronics (076) 329677 **TOWNSVILLE** Super Solex ■ (077) 724466 **SA** Force Electronics ■ (08) 2125505 **BRIGHTON** Force Electronics ■ (08) 3770512 **CHRISTIES BEACH** Force Electronics ■ (08) 3823366 **FINDON** Force Electronics ■ (08) 3471188 **HOLDEN HILL** Force Electronics ■ (08) 2617088 **LONSDALE** Force Electronics ■ (08) 3260901 **ENFIELD** Aztronics ■ (08) 3496340 **COUNTRY WHYALLA** Eyre Electronics (086) 454764 **TAS HOBART** George Harvey ■ (002) 342233 **LAUNCESTON** George Harvey ■ (003) 316533 **NSW** David Reid Electronics ■ (02) 2671385 **REVESBY** Revesby Electronics (02) 7922295 **SMITHFIELD** Chantronics (02) 6097218 **COUNTRY COFFS HARBOUR** Coffs Habour Electronics (066) 525684 **NEWCASTLE** Novocastrian Elect.Supplies (049) 621358 **WARNERS BAY** Vilec Distributors (049) 489405 **WINDSOR** M & E Elect. and Communications (045) 775935 **WOLLONGONG** Newtek Electronics ■ (042) 271620, Vimcom Electronics (042) 284400 **WOY WOY** Alphatran Electronics (043) 434919

PHONE ORDER TOLL FREE 008 999 007

[illegible]

AUTOMOTIVE ELECTRONICS

with MAJOR AL YOUNGER (USAF, Ret.)

Engine basics - 1

After all your years of training, how often have you made that profound statement 'back to basics'? To launch this new column, our subject this month is about auto engines; but the real message is going to be about where one starts to fix *any* problem: the basics. That's why we're going right back to auto engine basics — the starting point for any real understanding of automotive electronics.

What kind of knowledge must one have in order to fix the modern motorcar, with its sophisticated electronic equipment — electronics, or automotive engineering? The reality is, of course, that to fix a car in a timely manner you need to know the basics in *both* fields. Changing all the parts until it works is not an expression of expert knowledge.

OK then, is it easier to train an electronics technician in engine basics, which the auto tradesman already knows — or train the tradesman in electronics, which the electronics technician already knows? This question will most likely never be answered to anyone's satisfaction.

Why? It's very simple. In the real world, people have to make a living. This means that nowadays they have to expand their knowledge, in a field that they probably never liked — or they would have chosen it as their vocation. Either way, it can be pretty difficult.

This problem will continue until adequate schooling is provided, for the field of Automotive Electronics in its own right — where the basics of *both* fields are taught at the same time. Then no one will have to pick up the 'other half' of the knowledge they're going to need.

At this point the electronics technician and the automotive tradesman are probably both exclaiming "Yeah, sure — sure!"

OK — tell me this: Number 1 cylinder has just fired. Where is No.3 and what is it doing?

Here's another one. A customer enters your shop; he explains he mucked around and stuffed a LED and a resistor in the instrument panel. He then hands you a LED in a pack, which reads 30mA maximum current. What value resistor (ohms and wattage) is required to operate the LED from the car battery?

Both of these questions have simple answers!

Faults labelled as the most difficult, in the automotive repair industry, represent only 17% of the total required repairs. But only 10% of the tradesmen possess the knowledge to fix that 17%, so the field is wide open for new talent.

If you are in a field of industrial electronics, automation or any job that encompasses computerised control of mechanical devices — welcome, it's all under the bonnet. Learn the engine basics and as you Aussies say, "you'll be in like Flynn".

Let's now talk about engine basics. Forget about your electronics knowledge, for the present; we'll discuss that subject, as it applies to the motorcar, in the future.

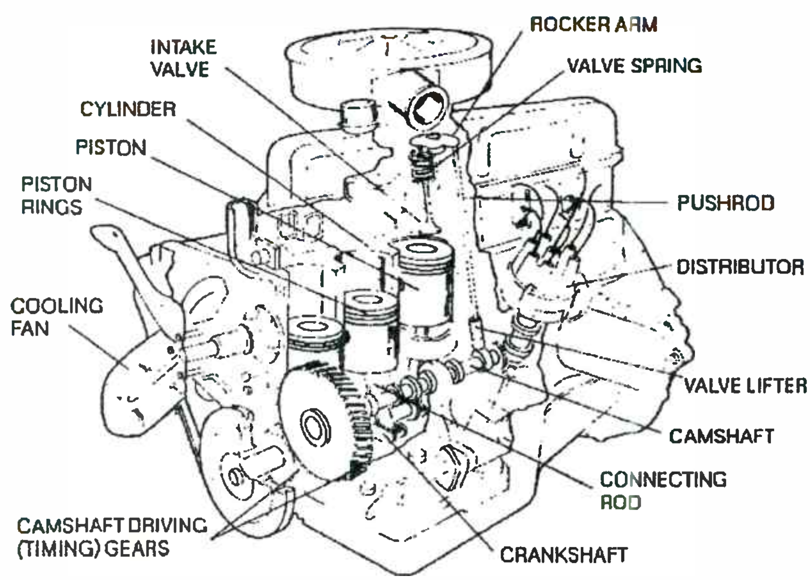


Fig.1: A typical four-cylinder car engine, with some of the main parts identified.

Fig.1 shows a typical car engine. Now the function of an engine is to convert fuel to work. Doesn't that sound simple? This conversion process is actually complex — and very inefficient.

Think about the efficiency of the various classes of electronic amplifier, and take note: the thermal efficiency of a car engine is about 27%. In both, we talk of thermal losses (dissipation).

Thermal efficiency

The heat value of a fuel (gasoline) can be directly converted into useful energy of work. Each BTU (British Thermal Unit) of heat energy can be considered equivalent to 778 foot-pounds of work. One gallon of gasoline is theoretically capable of being converted into about 89,000,000 foot-pounds of work. This is equivalent to 2700 horsepower for one minute.

The higher the proportion of this heat energy converted by an engine into use-

[illegible]

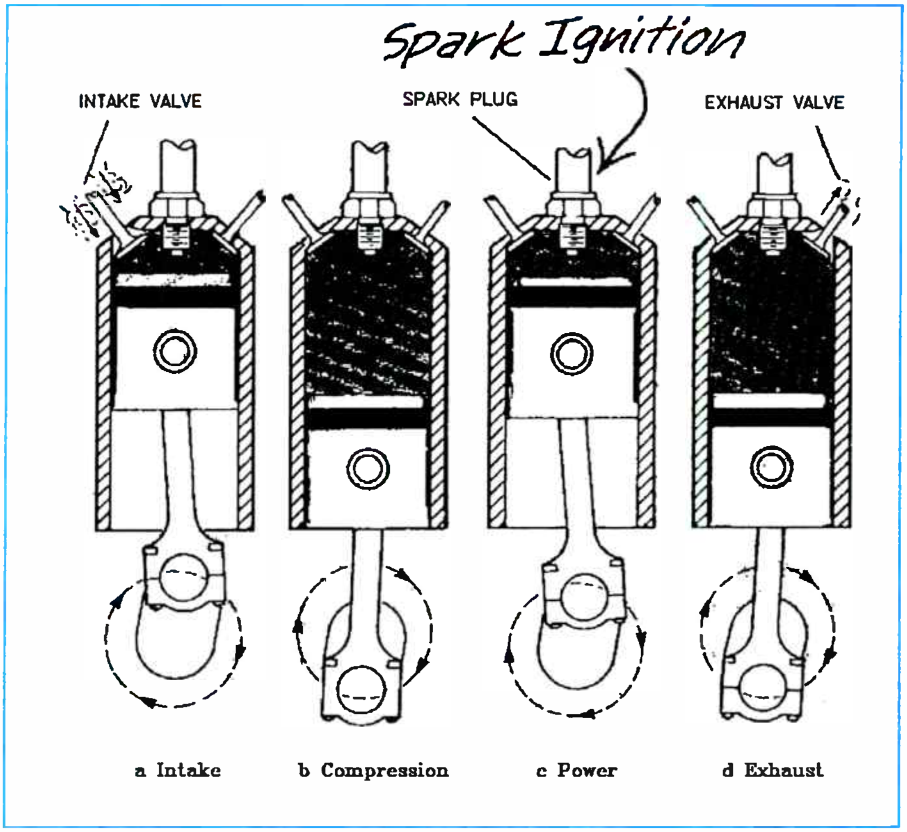


Fig.2: What happens during each stroke of a four-stroke per cycle IC engine.

ful mechanical energy, the higher the engine's thermal efficiency.

In practice, of course, much of the fuel is wasted in the complex process of placing a car in motion. First, chemical energy is converted into heat energy and gas pressure. The pistons and crankshaft change these elements into mechanical rotation, to finally produce torque and motion of the car.

Present-day gasoline engines reach a thermal efficiency of about 27%. This means that only 27% of the heat value of the fuel is converted into useful energy. The cooling system carries off about 30%, while another 33% or so is blown out the back in the exhaust gases. The cooling fan and pumps absorb about 3%. This last 'overhead' increases with the addition of air conditioning, pumps, fans, and other comfort options.

In some luxury automobiles or one with added accessories, these losses will be even greater. Think about it! A double air conditioner (that means two fans), a stereo system at 300 watts per channel, etc. I like to say that 'some cars have so many accessories, if they were all turned on, the car would go backwards'. Meaning that there's not much power left to move it forward!

The demand for comfort items, which all use more power, has the industry looking at 24-volt automotive electric systems. This is already the standard for heavy vehicles, especially those with diesel engines.

There are also friction losses, which vary with engine speed but are typically about 3%. Then there are pumping losses of about 4%, which are *not* proportional to engine speed.

The exhaust stroke is negative work. The highest pumping loss, of course, is the intake stroke. With such a low efficiency, the internal combustion engine is a 'gas guzzler' by nature.

The engine designers must deal with these inherent losses. Innovative designs never overcome a loss, just diminish it. For instance an overhead camshaft lessens the mechanical losses of a push-rod system. A roller camshaft lowers friction losses.

Of course most such innovations cost more money — it's a trade-off. Sounds like electronics, doesn't it?

The 4-stroke cycle

The biggest error made in fixing something — or anything, in any field — is overlooking basics. Why? Because basics must be the starting point for all diagnosis (trouble-shooting). So we will start with the basic operation of a four-stroke-per-cycle, four cylinder, normally aspirated engine, with Dr Kettering's ignition system.

This is where many people become confused, and remain confused forever. Many use the word 'cycle', when they mean 'stroke'. Electronics people know what a cycle is. Take a simple sine wave: when it has completed its journey of 360°, it has travelled one *cycle*. The time it took is the period, and the number of periods in a second is the frequency. The latter is equivalent to RPM (revolution per minute), in an engine. The cycle of an engine is different, however; — read on to find out.

In the explanation of a four-stroke/cycle engine, we deal with degrees also, with the reference point being the angular position of the crankshaft when piston #1 is at 'top dead centre'. And the degrees we're talking about are degrees of crankshaft rotation.

The operation of the engine can be understood by considering the actions in any one cylinder, during a complete cycle of the engine. One complete cycle in the four-stroke/cycle engine requires TWO complete rotations of the crankshaft — in other words, it lasts for 720° of crankshaft rotation.

As the crankshaft rotates, the pistons move up and down in the cylinders. In the two complete revolutions of the crankshaft that make up one cycle, there are thus *four* separate strokes of each piston — from the top of the cylinder to the bottom, or vice versa.

Fig.2 illustrates the four strokes for a four-stroke/cycle engine, which are called (1) intake, (2) compression, (3) power and (4) exhaust.

There are two valves for each cylinder. The left valve in Fig.2 is the intake and the right is the exhaust. The crankshaft rotation assumes a clockwise direction.

The action of the engine during the four strokes is as follows:

INTAKE: During the intake stroke (Fig.2a), the piston is moving from top to bottom and the intake valve is open. As the piston moves down, a vacuum or suction is created, which draws a mixture of air and vapourised fuel through the intake valve into the cylinder. The intake is closed after the piston reaches the bottom. This position is BDC (bottom dead centre).

COMPRESSION: During the compression stroke (Fig.2b), the piston moves upward and compresses the fuel/air mixture against the cylinder head. When the piston is near TDC (top dead dentre), at the top of this stroke, the ignition system produces an electrical spark at the tip of the spark plug. The spark ignites the air/fuel mixture, and the mixture burns rapidly

('explodes') — causing a rapid and extreme rise in the pressure in the cylinder.
POWER: During the power stroke (Fig.2c), the high pressure created by the burning mixture forces the piston downward. It is only during *this* stroke that actual usable power is generated by this cylinder of the engine.
EXHAUST: During the exhaust stroke (Fig.2d), the piston is again moving upward. The exhaust valve opens and the piston forces the burned gases from the cylinder through the exhaust port, into the exhaust system and out the tailpipe into the atmosphere.

This four-stroke cycle is repeated continuously as the crankshaft rotates. The power strokes from the various cylinders are staggered (according to the firing order), so power is produced during a larger fraction of the cycle. The sequence of firing — the firing order itself — is determined by the engine's crankshaft design.

Power is produced almost continuously by the separate power strokes of the four (or six, or eight) cylinders. A flywheel is added to provide the inertia needed to keep the crankshaft rotating smoothly. In Fig.3, the shaded area indicates which cylinder is producing power for each 180° of crankshaft rotation. (So can you now answer that question about piston number 3?)

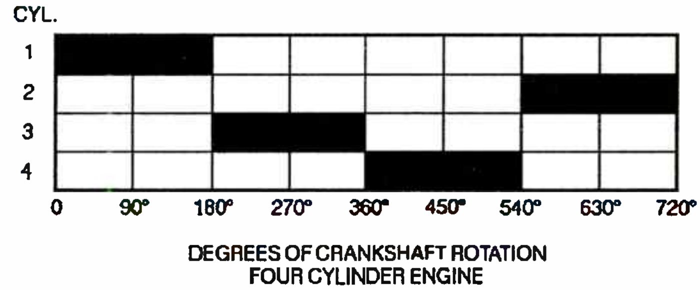


***Fig.3:** Each cylinder of an IC engine delivers energy only during its power stroke, but the cycles of the cylinders are staggered in timing so that the engine produces continuous torque. The shading shows the power stroke for each cylinder.*

Review

One complete cycle of a four-stroke engine requires two complete crankshaft rotations of 360° each, for a total of 720°. During this period, each cylinder has fired only once. An engine cycle has taken place when (1) all cylinders have fired and exhausted; (2) the crankshaft has rotated twice; and (3) the crankshaft has turned from 0° to 720°, with respect to TDC (intake) of cylinder #1. Note that the *crank angle* reference point is defined as when the #1 piston is at TDC, on the *intake* stroke; this is 0° of crank angle.

Finally, the four strokes of a four-stroke/cycle engine are: Intake, Compression, Power and Exhaust. Memorise 'em, because they're important!

In the next column we'll discuss engine efficiency, spark timing, compression and fuels. These subjects are most often overlooked when discussing engine operation. ❖

[illegible]

[illegible]

SHORTWAVE LISTENING

by Arthur Cushen, MBE

Radio Japan to use BBC transmitters

Some interesting aspects of modern broadcasting include the leasing of transmitters by different countries — in this case, Radio Japan having time on the BBC, and the BBC having time on Radio New Zealand. Details are also given on Kuwait's return to shortwave, as well as frequency changes for our winter reception.

Radio Japan in the past has used a relay base in Gabon, West Africa to attempt to provide a signal into Europe. Since this has not been very successful, from next month it will be using two BBC transmitters at Skelton, in the UK.

These transmitters are 250kW, and two will be used — one for a 10 hour service and the other for seven hours. They will carry broadcasts in Russian, German, French, English and Japanese.

Radio Japan, in return, will provide the BBC with transmissions from Japan into China, when the Yamata complex is complete. This will overcome any problems due to the Chinese accession of Hong Kong in 1997, and the possible closure of the two 250kW units which the BBC uses to cover Asia. Also, the BBC is making arrangements with the Government of Thailand to install two 250kW transmitters in Bangkok which can be used if the Hong Kong transmitters close.

As well as an agreement with the BBC to broadcast in Europe, Radio Japan has also had discussions with the Russian Government concerning the use of a transmitter site at Pushino Station, which houses some 16 250kW transmitters.

Radio Japan says that it is not confident that stable relay broadcasts will be possible via this former Soviet station over a long period of time, in view of the current chaotic political situation. More time will be needed to realise this plan.

BBC uses RNZI service

Because of its difficulty in serving Asia, the BBC has leased time on RNZI to provide a signal into that area. Radio New Zealand International has signed an agreement with the BBC World Service to lease its 100kW transmitter. The initial agreement is for six months, and RNZI is relaying the BBC 'Newsdesk' programme from 1100-1130UTC on 9700kHz.

RNZI is already reported to be well received in China, and recordings which I have received from a listener confirm this. With a gap between 1200-1650UTC, when Radio New Zealand International is not in operation, it could well be that the BBC will take up this time also to expand its transmission to Asia.

At the moment, the BBC can only serve Asia from East or West, with no southerly transmission into that area. This makes the NZ transmission an ideal means of covering South East Asia.

ZL2XAL on 7290kHz

A new transmission from New Zealand, is ZL2XAL, operated by Print Disabled Radio in Levin. For many years, this organisation has used ZLXA 3935kHz for evening transmission of its reading for the visually impared. Now this has been extended into daylight hours with the higher frequency.

ZL2XAL will operate Sunday to Thursday, from 2200 through to 0600 the next day. ZLXA 3935kHz will then carry the balance of the transmission to the sign off at 1000. All broadcasts will also be on the mediumwave outlet 2XA at 1602kHz.

The station is keen to receive reception reports on this experimental broadcast on 7290kHz, which is licenced until November. Reports should be sent to PO Box 360, Levin, New Zealand.

AROUND THE WORLD

CROATIA: Radio Croatia in Zagreb has been heard on 9830kHz from 0700 on Sunday, with local language programming. At 0705 it has a four minute news broadcast in English, and at 0709, a closing announcement indicates that the next broadcast will be at 11.00am local time. Signals are well received on this frequency and popular music follows the English broadcast.

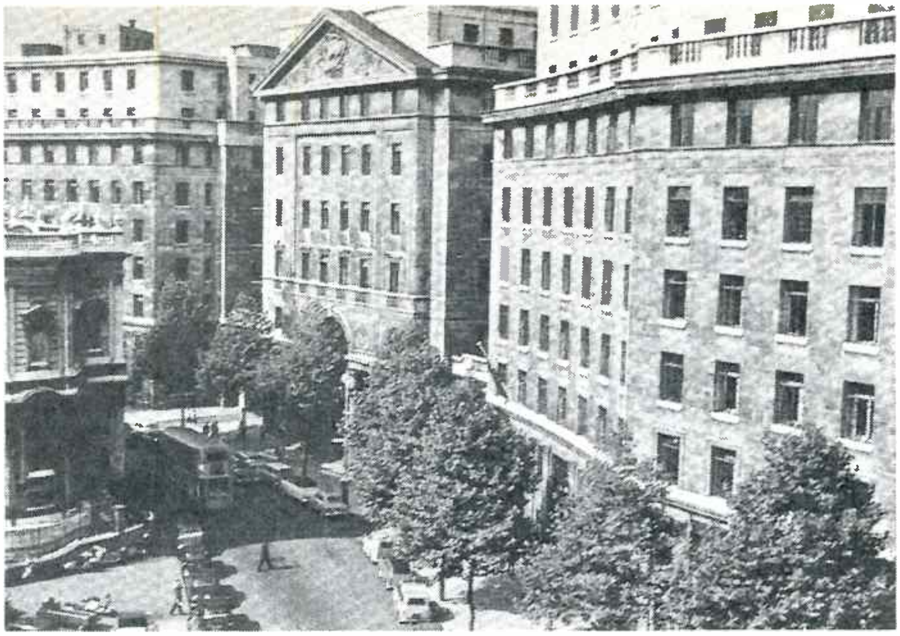
KUWAIT: Radio Kuwait has resumed its transmissions in English, and the service is 1800-2100 on 13,620kHz. Our reception has been best at 2045, when there is Arabic music. At 2055 there is an English news summary and this is followed by the National anthem and sign-off. Local time is given at midnight and reference is made only to a mediumwave frequency.

NETHERLAND: Radio Nederland at Hilversum, Holland, is running a three hour block to Australia and New Zealand, at 0730-1030. The first and last hour are the same programme content, but the 0830 broadcast has a different feature. All transmissions are on 11,895kHz. At 0730, 9630kHz is used as an additional channel and at 0930, 9720kHz is used. A service to Asia during our afternoons is also well received from 0030-0330 using the frequencies of 9860, 11,655 and 13,700kHz. Two of the frequencies are direct from Holland and the other is relayed from Madagascar.

PALAU: The Voice of Hope had plans to establish a gospel station on Guam but was unable to secure suitable land. It has now constructed a transmitting site on Palau, 1000 miles east of the Philippines, and is in operation. Earlier broadcasts were carried on 11,980kHz at 2000-0800 and on 9830kHz at 0800-1600. It is using a low powered 5kW transmitter, pending the completion and putting into service of a 1000kW unit. The station is operated by High Adventure Ministries, which also broadcasts in Lebanon and from its base in Los Angeles, California.

SWEDEN: Radio Sweden Stockholm has an additional service to the Pacific during our afternoons, at 0100-0130 on 9685 and 11,730kHz. This broadcast is in English. At 0200 a further service is directed to North American and is heard on 9695 and 11,705kHz. The regular transmission for our evening listening, 1200-1300, is on 15,170 and 17,740kHz.

[illegible]



BBC Studios in Bush House, London, from which all transmissions are centred — including the outgoing signal from Japan to the transmitter at Skelton.

Signals on 49 metres

During our winter the 49-metre band is active between 5950 and 6200kHz, with signals from North, Central and South America around 0800 and onwards.

Most are broadcasting in Spanish, but around 0800 Portugese is heard in many signals from Brazil. Some of the interesting broadcasts noted recently come from Bolivia, Brazil, Canada, Costa Rica and Columbia.

CANADA: CRFX Toronto, relaying CFRB, is heard on 6070kHz and is the best signal of the private commercial Canadian stations heard during our evenings. The frequency is generally clear and news is heard at 0800.

CHNX Halifax, Nova Scotia which has not been heard for some months, is again providing fair reception on 6130kHz at 0900. News is presented, followed by the weather, and then the programme continues with country and western music.

Vancouver is heard on 6160kHz from CKZU, which has CBC news at 0800 and then carries a classical music programme from the CBC stereo network. Shortly before 0900, the DW relay in Antigua opens on the same channel, making further reception difficult.

COLUMBIA: The major Columbian network, Caracol, is heard on several frequencies with continuous Spanish news and music. Two frequencies, 6075 and 6150 carry the same programme service. Identification is frequently given and, though in Spanish, listeners should find 'Caracol' the key word in the station announcement.

COSTA RICA: After several months of inactivity, Radio Reloj, San Jose has returned to shortwave on 6005kHz. It operates a 24 hour a day service, with time announcements after each recording as well as the station slogan.

News in Spanish is at 0800, followed by a jingle used by many stations to indicate weather. Following that information, the music programme resumes. Radio Reloj is clearly received not only on 6005, but also on its alternative frequency of 4832kHz.

ELWA back on air

The missionary radio ELWA at Monrovia, Liberia was destroyed in the recent fighting, which also put out of action the giant Voice of America relay base. ELWA has commenced operation from a new site at Benin, Nigeria, where its programmes are being prepared. It hopes to broadcast later on from its own station in Benin, pending authority from the State and Government for permission to broadcast on a new transmitter.

Meanwhile the rubble of war is being cleared away in Monrovia, in preparation for rebuilding ELWA on its old site.

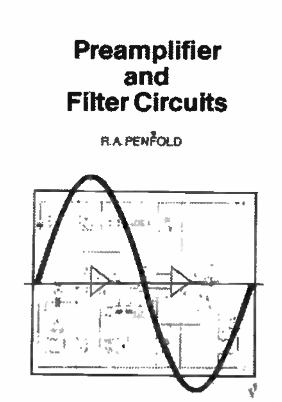
The new station will be low powered, and it is planned to build several others of a similiar type in Liberia. ❖

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

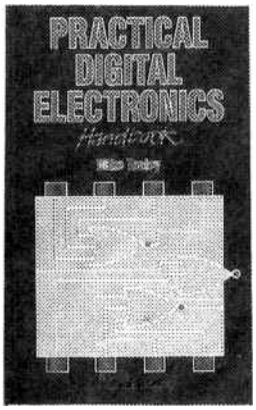
MOVING CLOSER

Electronics Australia

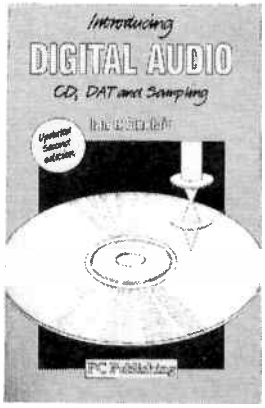
BOOKSHOP



Preamplifier and Filter Circuits
This book provides circuits and background information for a range of preamplifiers, plus time controls, filters and mixers. The circuits described are simple and previous experience of electronic project construction is not needed.
CODE: BP 3090 PRICE: $11.00



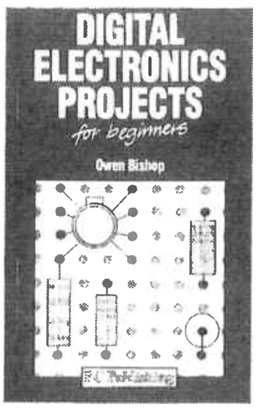
Practical Digitial Electronics Handbook
This book introduces digital circuits, logic gates, bistables and timers as well as microprocessers, memory and input/output devices. It will prove invaluable to anyone involved with the design, manufacture or servicing of digital circuitry.
CODE: PC 1004 PRICE: $21.95



Introducing Digital Audio, CD, Dat and Sampling. - Second Edition:
This book bridges the gap for the technician and enthusiasts who have worked with audio circuits. It includes oversampling methods and bitstream techniques and technical terms.
CODE: PC 1007 PRICE: $19.95

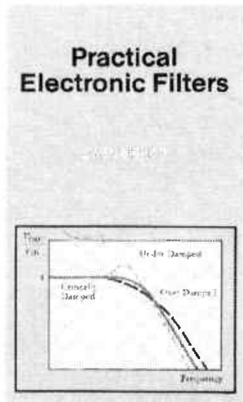
Computers and Music - An Introduction:
This book explains how to simply set up your own computer music studio. It covers the basics of computing, running applications programs, wiring up a MIDI system plus everything about hardware and the programs.
CODE: PC 1006 PRICE: $23.95

Practical MIDI Handbook
Refers to the powerful capabilities of MIDI and how to exploit it, with no knowledge of electronics or computing. It reviews the latest developments in MIDI covering keyboards, drum machines, sequences, mixers, guitars etc.
CODE: PC 1002 PRICE: $21.95

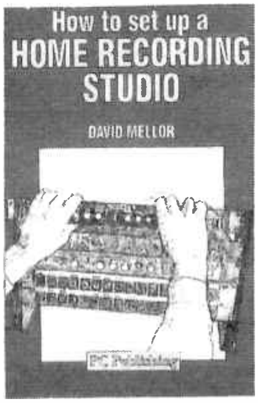


Digital Electronic Projects for beginners
This book provides simple, yet detailed instruction on practical projects. Covering instrumentation to home security plus circuit diagrams, this reference book also offers 'fun' projects for newcomers to electronic construction.
CODE: PC 1011 PRICE: $18.95

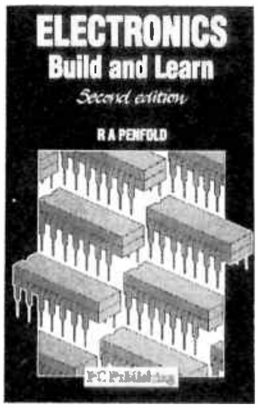
Synthesizers for Musicians
Written especially for musicians, this book explains how to get the best from your synthesizer or sampler. If you want to go beyond using the factory presets or the random poking of buttons, then this is the book for you.
CODE: PC 1003 PRICE: $18.95



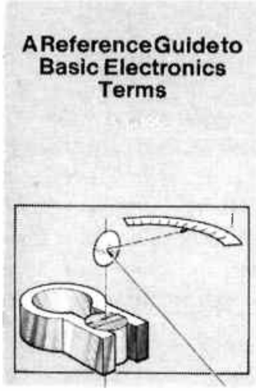
Practical Electronic Filters
Practical Electronic Filters explains in a simple form, the understanding of how to work a filter. It presents projects to apply in and around the home, including diagrams that are suited to the beginner and a more advanced constructor.
CODE: BP 2990 PRICE: $13.00



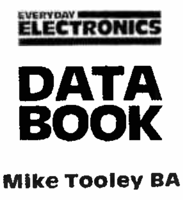
How to set up a home Recording Studio
If you have a studio at home or are about to set one up, this book is for you! It describes the setting up of an 8 to 16 track studio with an outline of the musical and recording gear needed.
CODE: PC 1009 PRICE: $21.95



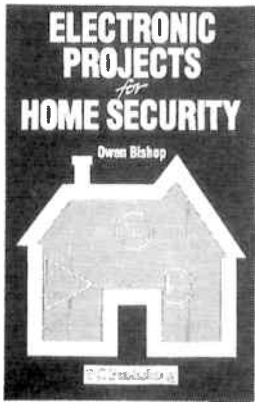
Electronics - Build and Learn
This book is the perfect balance of theory & practice. It introduces common electronic components and how they are built into useful circuits. An essential for the beginner, providing practical tests and experiments.
CODE: PC 1008 PRICE: $18.95



A Reference guide to Basic Electronic Terms
A comprehensive A to Z guide of electronic terms. This book chooses and explains some of the more important fundamental terms (over 700), making the explanations easy to understand and avoiding high level mathematics.
CODE: BP 2860 PRICE: $16.00

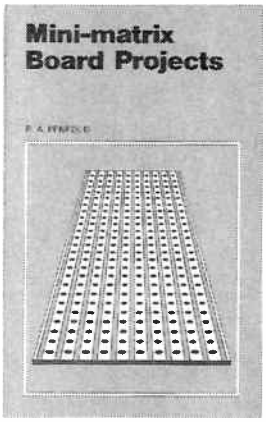


Everyday Electronics Data Book
This book is an invaluable source of information of everyday relevance in the world of electronics. A must for everyone involved on electronics who wants to put theory into practice.
CODE: PC 1012 PRICE: $26.95



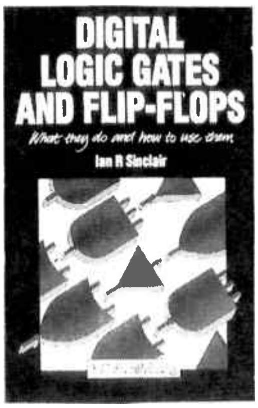
Electronic Projects for Home Security
This book deals with the many aspects of home-security and how to construct your own security system. It covers the latest in technology, whilst remaining simple and reliable in its instruction.
CODE: PC 1010 PRICE: $21.95

Electronic Power Supply Handbook
This book covers the topic of electronic power supplies, including batteries, simple AC supplies, switch-mode supplies and inverters. Subjects dealt in detail are devices, their operating principles and typical circuits.
CODE: PC 1001 PRICE: $23.95



Mini Matrix Board Projects
This book provides you with 20 useful and interesting circuits, all of which can be used on a mini matrix board, which is just 24 holes by 10 copper strips.
CODE: 8P 9900 PRICE: $6.50

Coil Design and Construction Manual
A unique book for both the professional and home constructor on 'How to Make' your own R.F., I.F., Audio and Power coils, chokes and transformers etc.
CODE: BP 1600 PRICE: $6.50



Digital Logic Gates and Flip-Flop
Intended for enthusiasts, this book aims to provide a firm understanding of gates and flip-flops thoroughly and from the beginning. It is for the user who wants to know more than a few rules of thumb about digital circuits.
CODE: PC 1013 PRICE: $26.95

The PC Music Handbook
This book takes the reader through the creative possibilities of the personal computer. Full of practical tips on equipment plus explanation of sequencing, sampling and notation.
CODE: PC 1005 PRICE: $28.95

HOW TO ORDER

To order, simply fill in the coupon, remembering to include the code numbers and $5.00 postage and handling. If the coupon is missing, write down the names, code numbers and prices of the books you require. Include your name, address, phone number, plus cheque, money order or credit card details (card type, card number, expiry date and signature) and send it all to Federal Publishing, Reply Paid No. 3, PO Box 199, Alexandria, NSW 2015. Please allow at least 28 days for delivery and please sign all orders.

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.

July 1942

Measuring soil moisture: Moisture in the soil is measured by means of a new device which consists of a block of gypsum in which a pair of electrodes is embedded. It is set in the soil in such a way that soil moisture passes into the gypsum.

The resistance to the passage of an electric current becomes lower in accordance with the amount of moisture the soil is able to deliver to the block. It is thus possible to calculate the amount of water available for the plant.

Drying paint with infra-red: A new trick, used in some US factories, is the drying of paint by infra-red rays in twelve minutes, to a finish so tough that it will take the pounding of a machinist's hammer without cracking.

An automobile manufacturer started it about five years ago when he used it first to touch-up painting on car bodies damaged in shipment. Subsequently he used it for finishing entire bodies.

The process consists of passing painted articles slowly through a tunnel of lights, principally carbon filament lamps, which give off infra-red rays.

Whereas glass often cracked under the old method of baking in an oven, it passes through the lights tunnel without harm.

July 1967

Electronic telephone exchange: Europe's first regular electronic telephone exchange was opened at Ambergate in England recently.

The British Post Office has placed further orders for similar exchanges but, at the same time, has placed large orders for electromechanical cross-bar equipment.

For future projects, it has standardised on electronic exchanges for up to 2000 lines.

The exchange at Ambergate is not fully electronic in the sense that there are no moving parts.

All control circuits are electronic, but the mechanical crosspoint still depends on physical movement for operation.

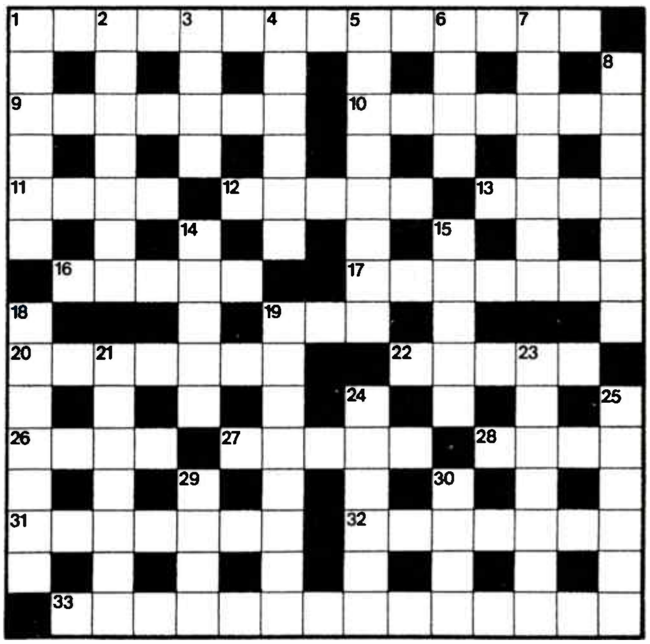
Totally electronic exchanges with no moving parts have been tested under operating conditions in the US and Britain, but Australia will not see their introduction for several years.

More light on colour TV: Your serviceman was wandering around the recent IREE convention displays and noted a photographer getting all set to take some pictures off one of the colour television screens.

A few minutes later, the program began to roll and the photographer started systematically to snap the best scenes — with the aid of a flashlight!

What a set of pictures would be his reward — a whole roll of pictures of a colour set with a blank screen! ❖

EA CROSSWORD



ACROSS

1. Department of correction listed in EA. (5,3,6)
9. Bring to more modern standard. (7)
10. Said of one of Einstein's theories of relativity. (7)
11. Successful recordings. (4)
12. Calculator key. (5)
13. Colour cast. (4)
16. Interface for signals. (5)
17. Improve characteristics. (7)
19. A TV gun colour. (3)
20. Often recorded oratorial composition by Handel. (7)
22. Atoms are held together by these. (5)
26. Atomic mass units. (4)
27. Popular software package. (5)
28. Stroke of lightning. (4)
31. Dissolving substance. (7)
32. Problem with old cells. (7)
33. Regular feature article in EA. (2,1,5,4)

DOWN

1. Zero. (6)
2. Bring to state of high tension, perhaps. (7)
3. Kind of TV show that could wash over you. (4)
4. Pointer on an analog instrument. (6)
5. Cut into a surface. (8)
6. One of a phone's tones. (4)
7. State of untwisting. (7)
8. Unwanted radar images. (7)
14. Said of certain frequency band. (5)
15. Molecular disorder. (5)
18. Building often electronically eavesdropped. (7)
19. Variable resistor. (8)
21. Suppressing circuit. (7)
23. Realistically illuminated miniature scene. (7)
24. Atomic cores. (6)
25. Colour of abraded crystal. (6)
29. Element used in electric signs. (4)
30. Plug. (4)

SOLUTION FOR JUNE

EA with ETI marketplace

ADVERTISING RATES FOR THIS PAGE

SMALL ADS: The minimum acceptable size of 2 centimetres x one column costs only $50. Other sizes up to a maximum of 10 centimetres are rated at $30 a centimetre. **CLASSIFIEDS:** $4 for 40 letters. Just count the letters divide by 40 and multiply by $4, ROUND UP TO THE NEAREST WHOLE NUMBER. **CLOSING DATE:** Ads may be accepted up to the tenth of the month two months prior to issue date. **PAYMENT:** Please enclose payment with your advertisement. Adress your letter to: **THE ADVERTISING PRODUCTION MANAGER, ELECTRONICS AUSTRALIA, P.O. BOX 199, ALEXANDRIA NSW 2015 FAX: (02) 693 9997**

Amateur Radio News

Pleasant day at Mt Pleasant

Steve Johnston VK5ZNJ, president of the Barossa Amateur Radio Club, reports that the Club's third annual Mt Pleasant Radio Picnic Day in April was a success — despite poor weather, which probably deterred some potential attendees. A total of 450 people attended, including many CB operators and vintage radio enthusiasts. BARC had deliberately widened the scope of the event this year, and had invited the CB radio organisation ACBRO to participate along with the Historical Radio Society of Australia, Outback Communications (RFDS), ALARA and various vintage military radio groups.

Major sponsors of the event were Dick Smith Electronics and Castrol Australia, with other sponsors including Countrywide Mobile Communications, Electrophone, Johnstone Electronic and Audio Visual Services, ZCG Antennas and the WIA Equipment Supplies Committee. Most of the sponsors had displays offering new equipment for sale at a discount, as also did Microwave Developments and Stewart Electronic Components.

Activities began with a 2m foxhunt, which was won by Andrew VK5EX from the South Coast Amateur Radio Club. Later there was an interclub 'tug of war', which was won by a team made up from ACBRO club members. Throughout the day there were many activities for both adults and children, with total prizes in excess of $1000. There was also a raffle, with prizes worth over $500.

The day also provided a good opportunity for second-hand bargain hunters, as a large area had been set aside for buying and selling used equipment. A large number of people were seen leaving with newly-purchased 'goodies' under their arms.

Based on the success of this year's event, planning is already under way for the 1993 Picnic — to be held on Sunday March 28. As this event is expected to be 'bigger and better', a booking has been made for the Agricultural and other pavilions. This will allow all trade stands and club displays to be under cover, so that the event will be less dependent upon the weather.

Further information on either the BARC or next year's picnic is available from Barossa Amateur Radio Club, PO Box 356, Angaston SA 5353. Steve Johnstone VK5ZNJ can also be contacted on (08) 287 1061, or fax (08) 287 0422.

Remembrance Day Contest

Writing in the latest *Amateur Radio* to reach our office, Neil Penfold VK6NE (WIA Federal Contest Manager) advises that this year's 'RD Contest' will be held on the weekend of August 15-16. The contest rules will be the same as those which applied last year.

Book on WW2 sigs intelligence

During World War 2, many amateur radio operators served in Wireless Units around the Pacific, intercepting coded Japanese radio transmissions and providing Allied military intelligence with important information on enemy activities. Now Australian Jack Bleakley, one of those operators, has written a book describing these activities.

Titled *The Eavesdroppers*, Mr Bleakley's book took him almost six years to research and write. Based on his service with No.1 Wireless Unit at Townsville, Port Moresby, Nadzab, Owi and Biak, and then No.5 Wireless Unit in the Philippines, the book contains many personal photographs and formerly secret documents.

According to Q.F. Foster, formerly VK6QF and now L30720, the book tells an enthralling story which maintains a fine balance between the training and anecdotal experiences of Wireless Unit operators, and Allied military history in the South-West Pacific. As a result many of our readers are likely to find the book of interest and value — especially those who served in these units along with the author.

Published by the Australian Government Publishing Service, *The Eavesdroppers* is a paperback selling for only $12.95 including postage. It is available from Commonwealth Government bookshops in each capital city, and also from AGPS Mail Order Sales, GPO Box 84, Canberra ACT 2601. ❖

Electronics Australia's

Professional Electronics

S · U · P · P · L · E · M · E · N · T

SUCCESS FOR NASA'S ENDEAVOUR TEAM: INTELSAT VI F3 BIRD CAPTURED & REPAIRED!

DATA ACQUISITION PRODUCTS FEATURE

REVIEW OF NEW SINGLE CHANNEL DATA LOGGER

INTEL'S NEW FLASH MEMORY CARDS: CHASING HARD DISKS

Professional Electronics

NEWS HIGHLIGHTS

IREE VIDEO NOW AVAILABLE

Videotapes of the 'Hypothetical' held at the IREE's 1991 Convention are now available. Titled *Australia, the Clever Country? What if all the engineers died?*, the taped debate covered important topics dealing with the future of electronics manufacturing in Australia, and is designed to stimulate further discussion. The panel included academics, engineers, scientists, business managers, a banker and a technical journalist.

Copies of the videotape, which is on VHS and runs for approximately 60 minutes, are available for $135 including postage, from the Institution of Radio and Electronics Engineers Australia, PO Box 79, Edgcliff 2027; phone (02) 327 4822.

NZ LAB OFFERS AUSTEL TESTING

Wakefield Laboratories, of Auckland in New Zealand, is able to offer a complete electrical safety and telecommunications testing service to both Australian and New Zealand requirements for fax machines, modems, answering machines, telephones and power supplies.

The laboratory was founded in 1966 and has conducted over 15,000 testing assignments in this area. It is accredited with New Zealand Telecom for testing most types of telecommunications products to PTC 101, PTC 211, PTC 212 and PTC 202, and also with Austel for testing to TS001 (including AS 3260), TS002, TS004 and TS006. In addition, it has an agreement with an Austel accredited laboratory in Auckland to conduct EMI tests to AS 3540.

Further information is available from A. Hope or I.W. Whittet at Wakefield Laboratories, PO Box 4512, Auckland 1, NZ; or phone (64 - 9) 379 5768.

VIDEOS FOR TECH TRAINING

The first two titles in a new series of training videos for electronics technicians have been released, under the general title *TETIA Training Films*.

A Tasmanian initiative, the videos are being produced by a partnership of Jim Lawler, an experienced Hobart technician, and Eric Baynes — a lecturer in electronics at Hobart College of TAFE. Although not directly sponsored by TETIA (The Electronics Technicians' Institute of Australia), the videos are being made in close association with the organisation, which has licensed the use of its name.

Designed for use primarily in technician training courses at TAFE and other colleges, the video programmes cover practical subjects and provide students with insight into areas which cannot be covered adequately by textbooks, course notes or laboratory experiments/ demonstrations. The need for them was first realised by Eric Baynes, and after discussions with Jim Lawler they decided to tackle this previously neglected training area themselves.

The first two titles in the series cover 'The Use of Logic and Pulser Probes in Digital Troubleshooting', and 'Dry Joints and Their Effects'.

In order to keep the cost of the videos down, and thereby make them accessible to as many colleges and trainee technicians as possible, they are being produced on high grade 'domestic' rather than professional equipment. This has allowed the cost per copy to be kept at $49.50, including postage anywhere in Australia.

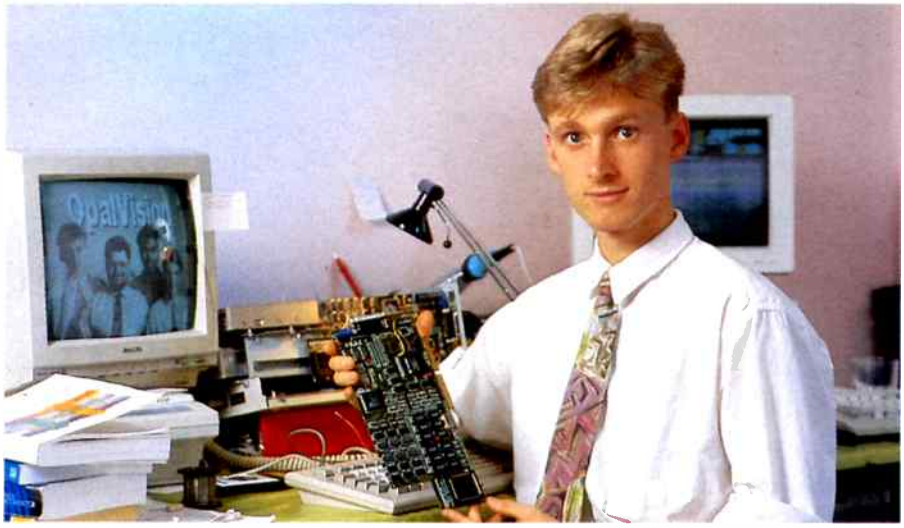
Copies of the videos are available from Jim Lawler, 16 Adina Street, Geilston Bay; Tasmania 7015.

BRIGHT PROSPECTS FOR YOUNG INVENTOR

Gary Rayner, a 1990 winner of the 'Nescafe Big Break' competition, has set up a company to market internationally his 'OpalVision' system for achieving special video effects and image manipulation on a low-cost Amiga computer. Although the system has a base price of only $995, it produces results which are said to be comparable to those costing hundreds of thousands of dollars, and has aroused considerable interest overseas.

The prize of $20,000 from Gary's 1990 win has allowed him to set up a company, Opal Technology, which now employs three 'computer whiz-kids'. The firm hopes to sell at least 10,000 OpalVision systems world wide over the next 12-18 months.

Winners of this year's 'Nescafe Big Break' competition will be announced later in the year. There will be eight winners in 1992, each of which will win $20,000. The competition is designed to allow young Australians with imagination, drive and initiative to achieve their goals.



INTEL ANNOUNCES 8Mb FLASH CHIP

Intel Australia has announced a new 8-megabit flash memory chip priced, on a per-memory-bit basis, equivalent to DRAMs — commonly thought of as the

NEWS HIGHLIGHTS

DARING NASA RESCUE SUCCEEDS

After delays and a number of unsuccessful initial attempts, NASA astronauts on the new space shuttle *Endeavour* were finally able to capture and repair the ailing Intelsat VI F-3 satellite, on May 14. The successful capture involved astronauts Pierre Thuot, Rick Hieb and Thomas Akers all working outside the shuttle, and grabbing the 3.9-tonne satellite in their hands after the spacecraft was positioned alongside it.

Initial attempts by Thuot working alone, attached to the end of the shuttle's manipulator arm (see our April feature story), failed when the satellite would not mate with the specially- designed 'capture bar' — and instead moved away.

After at last securing the satellite to a cradle in *Endeavour*'s cargo bay, the astronauts then attached a new rocket engine — designed to carry F-3 into its correct orbit above Brazil. The satellite had been useless for two years, due to a launching problem which had lobbed it too low.

The *Endeavour* team thus successfully completed 'one of the most daring space missions ever planned', and saved Intelsat almost $200 million.

lowest priced semiconductor memory. Priced at US$29.90 in volume, Intel's 28F008SA FlashFile memory stores one megabyte of code or data in a single chip. It is packaged in an advanced 40-lead TSOP (thin, small outline package) or 44-lead TSOP (plastic SOP) to provide the extremely small form factor required for today's handheld, pen-based and sub-notebook mobile computers.

"Our new FlashFile memory products take advantage of Intel's third-generation 0.8-micron EXTOS (EPROM tunnel oxide) process technology to provide high speed performance, unprecedented reliability and cost effective high density at DRAM-level pricing," said Geoff Healey, general manager of Intel Australia.

The 28F008SA's FlashFile memory architecture features sixteen 64-kilobyte individually eraseable blocks, each of which can be cycled 100,000 times resulting in 1.6 million total cycles per chip. This block-erase, high cycling capability is optimised by Microsoft's Flash File System Version 2.0, that allows the 28F008SA to emulate the file storage capabilities of disk drives while substantially improving system-level performance. In addition, the 28F008SA's 85-nanosecond access time and flash memory's inherent non-volatility combine to take full advantage of ROM executable versions of operating systems such as MS-DOS and Windows, providing instant access to programs or data.

The 28F008SA consumes just 20mA in read mode, 30mA in standby and 2mA in deep power down 'sleep' mode, to extend system battery life well beyond that of disk based systems. It requires a 5-volt power supply to read and 12-volts for write/erase. To further extend battery life, Intel also offers a 3.3-volt read version of the 28F008SA for designing lower power mobile PCs.

In addition, the company introduced a new flash memory card that holds 20 megabytes of information, at prices comparable to many of today's state of the art 1.8" hard disk drives. The card will drop the price premium of solid-state memory versus magnet disk memory to just 2:1 (from 10:1 previously).

The card's density and pricing could rapidly open the widespread use of solid-state memory for new highly portable items such as palmtop computers. The 20MB credit card sized package is capable of storing the equivalent of a standard English language dictionary. Intel now claims to offer the densest non-volatile read/write memory chips and cards available today.

WAFER-THIN LITHIUM BATTERIES

Japanese battery maker Yuasa has unveiled a prototype lithium battery using a solid polymer electrolyte, which can be made in almost any shape and less than a millimetre thick. The new battery is expected to be available in non-rechargeable form within a year, with rechargeable versions following within three years.

The battery's cells use a cross-linked polymer electrolyte, with polyethylene oxide and a variety of polyether in a 'network' structure. The cross-linking is said to inhibit crystallisation, and allow operation at temperatures down to 0.1°C. The electrodes are lithium and a mixture of lithium salts and vanadium oxide, in very thin layers supported by sheets of stainless steel foil.

Like other solid state lithium batteries under development around the world, the new Yuasa battery has a significantly greater power density than existing types. The goal is to achieve power densities of 150-200 watt-hours per kilogram, five times the densities currently available.

FOURTH INMARSAT-2 SATELLITE LAUNCHED

The fourth and final Inmarsat-2 mobile communications satellite has been successfully launched from Kourou, French Guiana, on an Ariane 4 rocket.

The satellite will provide a wide range of global mobile communications for ships at sea, aircraft and mobile users on land over an area stretching from western Europe and western Africa to South America and the east coast of North America. Services include telephone, telex, electronic mail, facsimile, data and position reporting and safety and distress communications.

The satellites have been built by a consortium headed by British Aerospace for Inmarsat, the 64-member country international cooperative. Inmarsat already operates a global satellite system of nine spacecraft.

"The successful launch of F4 completes our second generation satellite configuration," said Olof Lundberg,

Inmarsat's Director General. "In addition to vital commercial and safety and distress communications, Inmarsat-2 satellites will also make a major contribution to providing capacity for a growing number of new services that Inmarsat is planning to introduce in the coming years."

Once in orbit, Inmarsat-2 F4 was to undergo a series of tests by engineers at Inmarsat's headquarters in London and its tracking, telemetry and command station at Fucino, Italy, before being moved to its final operational location at 55° West longitude.

Inmarsat has also commissioned its 20,000th satellite terminal, which is fitted to an Italian Iveco truck. The terminal, which operates with the Inmarsat-C system, will allow the truck driver to send and receive text and data messages of up to several pages in length, anywhere in the world.

Iveco will use the truck to trial the performance of the Inmarsat-C system, and if the trials are successful, will consider offering trucks already fitted with Inmarsat-C terminals. During a six month tour, the truck will be in constant contact with Iveco's head office in Turin, Italy.

Truck operators represent a large market for Inmarsat-C, of which there are already nearly 3500 terminals in use all over the world. This includes, 2000 on ships at sea and 1500 land mobile users on land.

BLENDAIR MAKING COMPUTER CASES

Sydney based manufacturer of air conditioning components, Blendair, has successfully diversified its manufacturing operations to take on foreign competition in the hi-tech world of computers.

The company recently won a lucrative contract to supply an order of computer cases to Osborne Australia.

Blendair worked closely with Osborne to develop the computer case to specific design requirements, and is currently supplying about 1000 a month.

The computer cases are made from Zincseal electrolytic galvanised steel, supplied by BHP Steel Sheet & Coil Products Division in thicknesses ranging from 1.00mm to 1.6mm.

NEW STANDARD FOR ELECTRONICS DRAWINGS

Standards Australia has recently published the following standards which will be of interest to the electronics industry.

AS 1103 Diagrams, charts and tables for electrotechnology, Par 4: Guiding principles for the preparation of circuit diagrams.

This standard provides guiding principles to assist in the preparation of circuit diagrams for electrical and electronic fields. Numerous examples are given to demonstrate the variety of methods which may be used. It supersedes the 1978 edition of the standard.

STANILIGHT BUYS US TELECOMMS MAKER

Australian electronics firm Stanilite Pacific has bought a 30% share in telecommunications company QWEST Technology of California, for A$4 million (US$3 million). QWST specialises in new generation two way radio technology known as trunked radio.

QWEST manufactures in California, but gears production entirely towards the export market. Stanilite's deal with QWEST allows it to take a strong position in international telecommunications for the first time.

The company have already won contracts worth some A$14 million (US$10 million) for trunked radio networks in Canada and China, with other ventures poised to go ahead soon.

Stanilite and QWEST will cooperate on R&D and new product development. The Australian firm expects to refine trunked radio for niche markets, using 'ruggedisation' techniques developed on Stanilite's major defence contracts. Stanilite will also act as the sole marketing and distribution agency for QWEST systems within the Asia-Pacific, and will commission, service and maintain these products. Some radio assembly and base station manufacture will take place at Stanilite's plant at Lidcombe, Sydney and Stanilite will increase its manufacturing and sales workforce to cope.

NOKIA LICENSES CDMA TECHNOLOGY

Nokia Mobile Phones, the world's second largest manufacturer of cellular telephones, has signed a multi-million dollar licensing agreement for Californian firm Qualcomm Inc's Code Division Multiple Access (CDMA) digital cellular technology. This follows an earlier signing of a support agreement between the two companies in November 1990.

Nokia's earlier support agreement provided it with access to QUALCOMM's technology in order to respond to industry requests for CDMA cellular phones.

The licensing agreement entitles Nokia to make and sell cellular telephones using QUALCOMM's CDMA technology. Previously announced licensees include AT&T, Motorola, OKI telecom and Northern Telecom.

Nokia was a participant in the recently completed large-scale field trials of CDMA technology.

According to Kaj Linden, senior vice president, research and development for

NEWS BRIEFS

- ***RVB Products*** of Melbourne was recently signed as a distributor for the Schrack line of components, which include low profile PCB power relays, plug-in and stepping relays and modular timers.
- ***Marconi Instruments*** has a new address in both Sydney and Adelaide. These new addresses are: Unit 1/38 South Street, Rydalmere 2116 — phone (02) 638 0800; and 1st Floor, 154 Angas Street, Adelaide 5000 — phone (08) 232 5333. Call Marconi for its free 1992 catalogue.
- ***Electronic Development Sales*** has announced that it is now the Australian distributors for Racal-MESL of Scotland. The company produces various ferrite and SAW components and microwave, satellite TV and video subsystems.
- ***Alpha Kilo Services*** has been appointed Australian agent for the Data International Company, which manufactures 'Data Vision' LCD modules.
- ***Tencon '92***, the 1992 Region 10 International Conference, will be held at the World Congress Centre in Melbourne, from 9-13th November. The conference theme is 'Computers, Communications and Automation towards the 21st Century'. For more information ring (03) 646 4122.

Nokia Mobile Phones, the results of these trials were a key factor in the company's decision to pursue a licensing agreement.

"We've been in the mobile communications business for more than 65 years. During that time we've established a number of industry firsts. Agreements with industry innovators such as QUALCOMM are very important to our success, and help keep us at the forefront in the cellular industry," said Mr Linden.

"In keeping with this philosophy, and based on our analysis of data garnered during the field trials, we believe it makes good business sense to assume a leadership position as a provider of CDMA-based digital cellular equiment," he continued.

FIRST AUSTRALIAN TRUNKED MOBILE

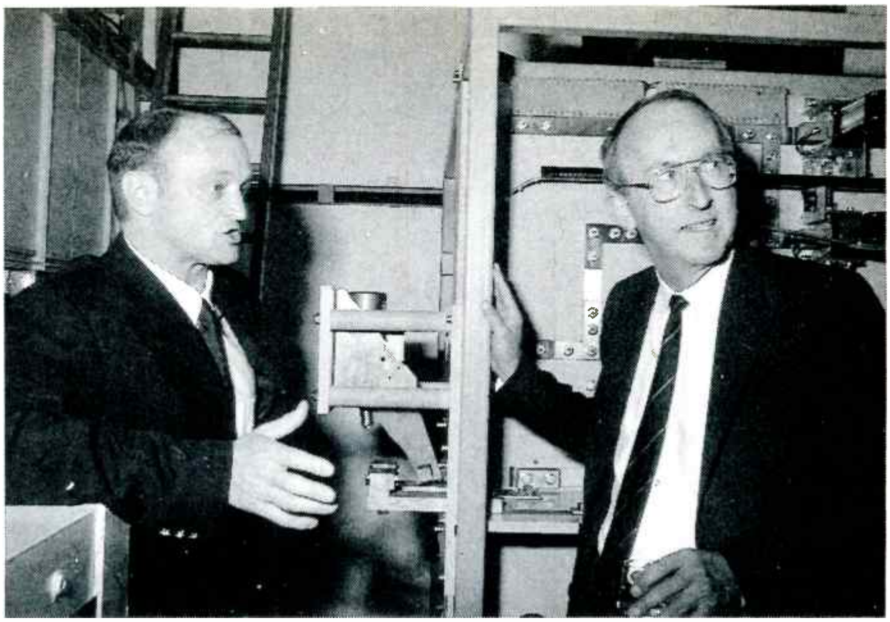
The only Trunked Mobile Radio made in Australia - the PRM8020T - has just been launched by Philips Mobile Communication Systems.

Based on the MPT1327 industry standard, the PRM8020T is an extension of the popular Philips Australian designed PRM80 Series, meeting the demands of Trunked Mobile Radio, and is specifically designed to take advantage of single site or wide area public trunked systems, including OTC Fleetcoms.

In Trunking, a number of radio channels are shared between the users on a system. The system controls access and allocates a channel to the users. With many people sharing the same resources, it is economical to build an infrastructure covering a much wider area than for conventional private systems.

SIEMENS AWARDS ARMY GRADUATE

As part of its sponsoring of engineering education in Australia, Siemens annually offers an award to an outstanding Army student completing the Royal Melbourne Institute of Technology's (RMIT) Associate Diploma of Engineering (Electronics) course. The recipient of the 1991 Award was Sergeant David Maurice Smith. Sergeant Smith is currently serving with 2 Signal Regiment, Simpson Barracks, and is preparing for an assignment in Cambodia. RMIT's Associate Diploma of Engineering (Electronics) is attended by Senior Royal Australian Corps of Signals technicians.



Professor Clark (left) explains details of the working of the National Pulsed Magnet Laboratory to Mr Free outside the reinforced concrete 'bomb shelter' which houses the capacitors that supply the power to create the laboratory's magnetic pulse. (Photo courtesy: Dr Peter Elliston, UNSW School of Physics.)

SCIENCE MINISTER OPENS NATIONAL PULSED MAGNET LAB

Federal Science Minister Mr Ross Free has opened the National Pulsed Magnet Laboratory (NPML) located in the School of Physics at the University of NSW.

The NPML has been constructed under the direction of UNSW's Professor of Experimental Physics, Professor Robert Clark, following 18 months of intense effort by Professor Clark and his team. Professor Clark is now the Director of the laboratory.

When officially opening the laboratory, Mr Free stressed the international collaboration in modern scientific research and development and the absolute necessity for Australia to keep in close contact with international developments.

Mr Free also stressed that the National Pulsed Magnet Laboratory was a national research facility that would be available to Australian researchers from other universities, institutes and industry.

"It is also an international facility which can be expected to attract a steady stream of scientists from overseas," Mr Fee said.

Close links had long been established with the Catholic University of Leuven in Belgium and the University of Oxford.

"Through this link, Australia has a part in the European Community's EUROMAGTECH program of magnetic field technology, with other participants in France, the Netherlands and Germany," Mr Free said.

The research to be conducted at the National Pulsed Magnet Laboratory will be on a broad range of new materials, especially semiconductors but also superconductors and organic systems.

Professor Clark said that the semiconductor research could concentrate on the characterisation and design of 'nanostructures'. These structures exploit technologies, based on quantum effects, which have never before been used, and whose dimensions go down to an atomic scale. They are expected eventually to involve single electron events.

Professor Clark said that while future electronic devices would not be expected to operate under the extreme of termperature, pressure and magnetic field his laboratory could produce, these extremes were necessary to probe for the fundamental science which would govern how these devices of the future would operate.

A single channel 'mini' data logger

Just recently, Melbourne firm Data Electronics has produced a new addition to its range of very successful microprocessor-based data loggers. The new Datataker 5 is a very compact single channel unit, well suited for unattended operation in dedicated, remote and/or mobile applications. A variety of versions are available, to measure different parameters.

by JIM ROWE

Last year, you might recall, we reviewed the most elaborate model in Data Electronics' range of Australian designed and manufactured data loggers: the Datataker 600. This time we're looking at the smallest member of the family, which is also the most recent addition — the Datataker 5.

It wouldn't be easy to find a more compact data logger than the model 5, which measures a mere 210 x 50 x 25mm and weighs only 550g. This tiny size, plus its ability to run for a year on a standard 9V alkaline '216-type' battery, should make it very suitable for use logging data in vehicles — or in remote locations well away from power sources.

Of course a data logger this tiny must

inevitably have fewer features and facilities than its larger brothers. In fact the model 5 is described by Data Electronics as a single-channel logger, and as having the ability to store a maximum of only 2000 readings from a single sensor, or contact closure events. However within these limits it actually offers a surprising degree of flexibility.

Four versions

For a start, there are four different versions of the design — two designed to make temperature readings, one to make voltage readings and the fourth to record contact closures.

The model 5T logger records the temperature at each sampling time, using a calibrated LM34HC solid state temperature sensor. The sensor can be either mounted in the end moulding of the logger itself, for ambient monitoring, or mounted in a probe at the end of a 2m cable.

The 5T provides two user-selectable ranges, one covering from -16°C to +120°C, with a resolution of 0.6°C, and the other from -16°C to 50°C with 0.3°C resolution.

However the case-mounted sensor effectively limits the measuring range to -10° - 55°C, which is the operating range of the logger itself.

The model 5TK logger also records temperature, but in this case using a type K thermocouple — connected to the logger via the usual leads, attached to screw terminals. This model actually provides six user-selectable ranges, again with varying resolution:

- -50°C to +50°C (0.4°C resolution);
- 0°C to 100°C (0.4°C resolution);
- 0°C to 250°C (1°C resolution);
- 0°C to 500°C (2°C resolution);
- 0°C to 1000°C (4°C resolution); and
- 0°C to 1200°C (5°C resolution)

The model 5V logger records DC signal voltage, again providing two screw terminals for this input. In this case there are two user-selectable ranges, covering from 0 to 1.25V DC with 5mV resolution, or from 0 to 2.55V DC with 10mV resolution.

Finally, the model 5E logger counts the number of 'dry' contact closure events, or NPN transistor conduction events, during each logging interval. It can count at rates of up to 15 events per second, and has a debounce delay time of 20ms.

This model provides a 'captive' 1m shielded cable for connection to the switching device, although longer cables can be supplied if required.

The 5E again provides two user-selectable ranges, one with a maximum count of 254 per sample, and the other with a maximum count of 65,000 per sample. The former stores each reading as an 8-bit word, and allows the 5E to provide an internal memory capacity of 2000 records, while the latter uses a 16-bit word for each reading and this halves the capacity to 1000 records.

With all four models, the data logging interval can be set anywhere from 1 to 65535 seconds (18.2 hours). In the logging modes that provide a capacity of 2000 records, this range of intervals corresponds to a logging capacity of from 33 minutes to three *years* — although the latter period may well be limited by battery life.

The Datataker 5 is said to run for up to a year with a standard 9V alkaline battery, or up to five years with a 7.5V lithium battery. But battery life depends on whether or not the logger is called upon to deliver significant power to a sensor — or in the case of the 5E, connected to contacts that are closed for a significant proportion of the time.

Even when the battery is exhausted, the logger's setup information and previously logged data are not lost. The main effect is that the logger can no longer continue accepting new data, and also cannot be programmed with new setup information.

Micro based

Needless to say, the Datataker 5 is based on a microprocessor and hardware clock-calendar combination. It also features a 'non volatile' memory for internal storage of both its setup information and logging data — described in the manual as retaining the data for 'more than 100 years' without power. Presumably this is either flash memory, or an EEPROM.

The memory is organised as a FIFO (first in-first out) stack, as far as logging data is concerned. Logging ceases when this memory becomes filled — there is no over-write mode.

The Datataker 5 has no inbuilt 'user console'; all configuration programming is performed by downloading from a computer, and logged data is retrieved by uploading to the same computer. Hardware interfacing is performed via a standard Centronics parallel port, so that the host computer's serial ports are not tied up and may be used for communication with a mouse and/or modem.

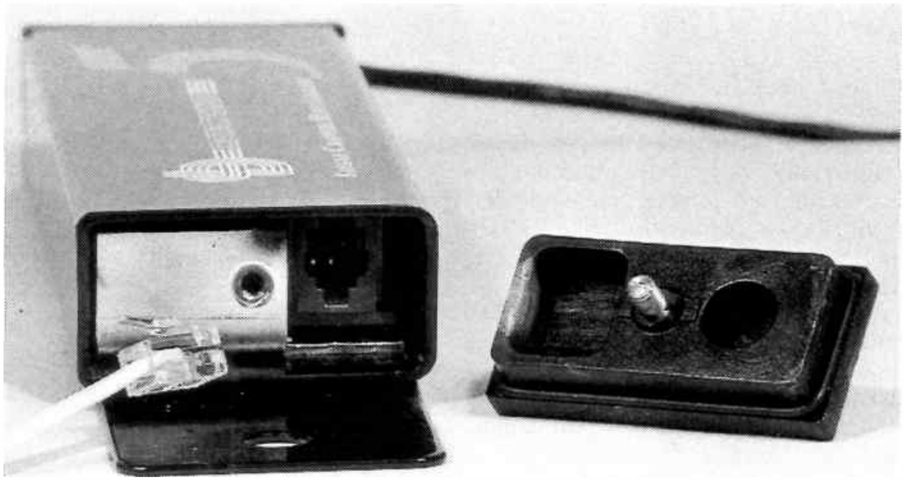
The programming/data retrieval interface of the Datataker 5 uses a four pin RJ-11 'modular' socket, accessed by removing one end cap from the protective case. A connecting cable with a matching RJ-11 plug at one end, and a DB-25 plug at the other, is provided (with the host software).

The software for programming the logger and retrieving data from it is designed to run on IBM PC's, AT's and compatibles.

The minimum hardware configuration is 256K of RAM, one floppy disk, a CGA video card with mono monitor and a parallel printer port; recommended, though, is a system with 640K of RAM, a hard drive as well as a floppy, a clock/calendar and either an EGA or VGA video card with colour monitor. DOS version 2.1 or later is required.

As well as programming the logger and uploading data from it, the software also allows the data to be presented in either tabular or graphical form.

Needless to say it can be saved on disk



Communication between the Datataker 5 and the host computer is via a serial line, which connects to the logger itself via an RJ-11 modular plug and socket. The socket is accessed by removing the logger's end cap.

as well, in either raw tabular form or as '.WKS' files which are compatible with *Lotus 123*, Microsoft *Works* or *Excel*, and many other spreadsheets. For producing hard copy of graphs and data listings the software also provides support for Epson compatible 8-pin (FX) and 24-pin (LQ) dot matrix printers.

Logging normally commences one minute after a new configuration is downloaded into the logger from the host computer. However the Datataker 5 can also be programmed to start logging at a later time/date, if desired.

All versions of the Datataker 5 come in a rugged stainless steel case, which is fitted with solid plastic end plugs. These have 'O-ring' seals, and when the unit is assembled it is virtually sealed against moisture.

However if it is to be operated in very damp environments, the moisture proofing can be enhanced by smearing the O-rings with silicone grease.

The logger case also has a firmly attached 'universal mounting tab', designed to allow easy and secure mounting to walls, posts, machinery or equipment surfaces.

In practice

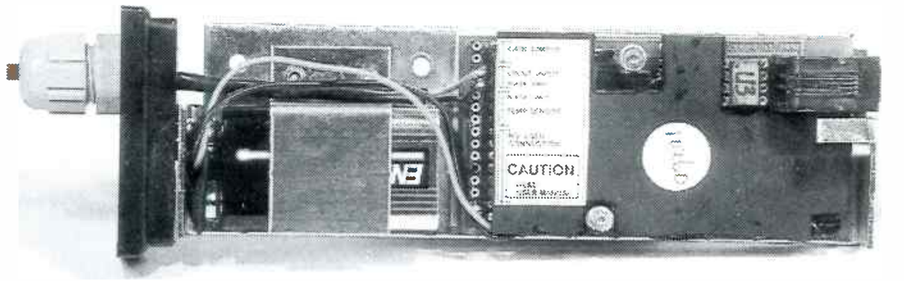
Data Electronics supplied a sample Datataker 5E unit, with matching software and interface cable, for us to try one out for ourselves. The only component that wasn't included was a 9V battery — these are not normally supplied, perhaps because they might be 'flat' before the purchaser started to use the logger.

After fitting a battery, we set up a simple source of 'digital events' with an audio generator modulating a function generator, in turn driving an NPN transistor connected across the logger's signal input. Then we turned our attention to communicating with the logger, via a PC running the supplied software.

At first we tried using an elderly twin-floppy IBM PC, with an 8088 running at 4.77MHz, 256KB of memory and a Hercules monochrome card. According to the Datataker 5 manual, this configuration should be capable of running the matching software, running DOS 2.1 or later.

What we found, though, was that on this machine the main 'DT5.EXE' program wouldn't even load, running under DOS 3.3. Every time you tried, you'd get a 'Runtime error 203 at 2149:0013' message and the machine would hang.

Guessing that this might be due to the relatively high memory requirement of DOS 3.3, we ferreted out a disk with DOS 2.1 on it, and tried booting up on this. The software would happily load and run, except that later it turned out to be unable to plot a graph of data we had logged — again due to memory problems.



Inside the logger, the electronics occupies only about half of the available space — leaving the rest for the 9V battery and sensor cable entry. This shot shows the interior of the model 5E, but the other models are apparently very similar.

Next we tried a 12MHz 286-based 'AT clone' machine, fitted with 640K of base memory, 2MB of EMS, a hard disk and a VGA monitor with matching monitor. This machine was also running with DOS 5, and as you'd predict there were no problems at all. The software ran immediately, and performed all functions correctly.

Incidentally the Datataker 5's support software seems to be able to automatically recognise what kind of video graphics card is fitted to the system, and also finds which printer port the logger is connected to.

The only thing it doesn't seem to be able to determine is whether or not you're using a monochrome or colour *monitor* — you're asked to specify which is being used, each time the program starts up.

Basically the software is very intuitive in its operation, with a series of menu screens leading you through the various options and functions available.

You can check the logger's current setup configuration, program it for a new setup, save the 'battery installation date' in its non-volatile memory (for later reference), monitor the logging as it's occurring (to check the programming), upload logged data from the logger and save it on disk, list it on screen or print it out as a table, graph it on screen and/or print out the graph, or export data as a spreadsheet-compatible file.

In general the software leads you through all of these functions very smoothly and effortlessly, so that in most cases there's little if any need to refer to the manual.

The only area where we found it a little confusing was the 'zoom' facility in the graph plotting option — the technique used here to adjust the zoom view limits and produce a new plot seems less intuitive than any other part of the package.

This is a minor point, though. On the whole, we found the software commendably easy to use.

It makes both setting up the Datataker 5 for logging, and retrieving its logged data, very straightforward and convenient. The main point to note is that it really doesn't seem too happy with only 256KB of memory — especially with DOS 3.3. As the manual suggests (probably not quite strongly enough), you really need the 640K found on most modern machines...

Summary

Despite its tiny size, the Datataker 5 is a flexible little unit and one that is surprisingly easy to use. For applications where only one data parameter needs to be logged (apart from time and date), it should be very well suited — especially where size and weight must be minimised, as on vehicles. The ability to run for periods of a year or more on a single 9V battery should also make it very attractive for remote field logging, security and access monitoring and similar applications.

The quoted price for the Datataker 5E is $400, and this is also the price for the 5T temperature logger. The 5V voltage logging version is priced at $450, while the 5TK thermocouple-based temperature logger is $500. These prices are all plus tax where applicable.

The software and interface cable package is sold separately for $135 plus tax, as in many cases one such package will allow support of a significant number of loggers. The same software supports all versions.

Further information is available from Data Electronics (Aust.), 7 Seismic Court, Rowville 3178; phone (03) 764 8600. ❖

The latest products in Data Acquisition

LabWindows enhanced

LabWindows Version 2.2 features many new enhancements to the analysis libraries for real-time digital signal processing (DSP), to the user Interface Library (UIL) for interactive graphics, and to the data acquisition library for support of the SCXI signal conditioning system. With the new AT-DSP2200 Analysis Library in Version 2.2, scientists and engineers can simultaneously acquire and analyse data — in real time — using the company's AT-DSP2200 DSP/accelerator and dynamic signal acquisition board.

The new library has functions that execute on the AT-DSP2200 board for signal processing, linear and matrix algebra, statistics, curve fitting, and managing memory. The AT-DSP2200 board and library are optimised to perform computation-intensive operations, such as FFT's and power spectra, on large amounts of data much faster than the host processor.

Version 2.2 has also incorporated interactive graph cursors and dynamic control of attributes into the UIL. Up to 10 cursors can be defined and display on LabWindows graphs. Cursors can be controlled interactively with a mouse or keyboard, or programmatically with library functions. Each cursor can be configured to move freely throughout the graph area, or snap to the nearest curve trace and follow it when moved.

Additionally, users can now change control attributes, such as colour, label, visibility, or font during the execution of a LabWindows program.

The Data Acquisition Library is enhanced to include drivers for the company's new SCXI signal conditioning system. Thirteen high level, easy to use functions for configuring both the 4-slot and 12-slot SCXI chassis for data acquisition operation have been added, plus functions to perform signal conditioning conversion algorithms for thermocouples, RTDs and strain gauges. The Data Acquisition Library also now has drivers for the company's new AT-AO-6/10, AT-A2150, and AT-MIO-16X data acquisition board.

For further information circle 201 on the reader service card or contact National Instruments Australia, PO Box 466, Ringwood 3134; phone (03) 879 9422.

Hi-res frame grabber

The OC-500 is a high resolution, high performance image capture card for PC-AT/386 computers, with full image processing capabilities. It is capable of capturing resolutions from 256 x 256, up to 2048H x 4096V, and is also capable of a display overlay of 2048 x 1024, with four or 8MB memory option.

Capture is in 8-bit or 16-bit, grey scale, with expansion option. High speed image processing is provided by a 15MIPS, 16-bit ALU and a 60MHz Texas Instrument TMS 34010 graphics system processor with TIGA support.

The card can also choose its source via software, with a choice from four analog cameras or one digital camera. It can operate as either a slave, or a master, to the video source, and has an A/D pixel clock rate of 10, 12.5 or 15MHz.

The unit drives its own output monitor to show you what you are capturing, with resolution of output being selectable from 640 x 480 interlaced to 1280 x 1024 non-interlaced.

Fibre-optic link

Integrated Networks has announced the release of Broadband Networks Transport 2000 fibre-optic communications link. This unit is a laser optical transmitter/receiver which provides up to 32 different service channels, with a combined bandwidth of 450MHz on single mode fibre at 1300nm and over a distance of 10km.

Three models have been released: the TR2000-XXX-04 which operates with up to four channels, while the -08 and -32 models operate with up to eight and 32 channels, respectively. The number of service channels needed is determined by the specification of the semiconductor laser used in each model.

The Transport 2000 can be used to transmit and receive television quality signals via an affordable two way video communications network. As well, it has many applications in Local Area Networks, providing a high speed backbone for delivery of combined data and video services, replacement of outdoor CATV equipment in broadband LANs, and applications requiring electromagnetic interference (EMI) hardness.

As well as running in house video conferencing system for everyday meetings, the system can be linked into Telecom or OTC services for interstate or international communications.

For further information circle 203 on the reader service coupon or contact Integrated Networks, 26 Tepko Road, Terrey Hills 2084; phone (02) 486 3066.

The computer monitor and computer are thus left free for other purposes, such as display of capture configuration, file control etc.

The OC-500 can also provide pseudo colour images by replacing the capture graphics grey scale with 256 colours from a palette of 16.7 million colours.

Cine looping is another display/capture feature of the frame grabber. For example, with the 8MB option, it can capture 128 images at a resolution of 256 x 256 at high speed, and then display these images at 10 frames per second to produce about 13 seconds of dynamic display.

For further information circle 209 on the reader service coupon or contact Boston Technology, PO Box 415, Milsons Point 2061; phone (02) 955 4765.

Analysis software

EASYEST LX from TCG is a powerful icon-driven PC-based data acquisition, graphics and analysis software package, that combines high levels of data acquisition and analysis capability with facilities for high user convenience. The package is designed for use by engineers and scientists involved in research and development, on IBM PC/XT/AT or 100% compatible computers.

All tools, features and functions are displayed as icons around the parameters of the screen, so that they are always in view and immediately accessible.

Data can be acquired over as many as 16 channels, each from up to 10 boards, allowing users to monitor many different signals at once.

There is no limit on acquisition speed, so users capture high frequency signals at the maximum speed their hardware permits. Users can view and interpret their data instantly, can overlay an unlimited number of plots,

produce semi-log and log-log plots, create waterfall plots, etc., or complete waveforms can be processed rather than point-by-point comparisons. A useful FLOW utility can create a graphical flow chart of a sequence, making it easy to spot errors or omissions in a sequence's order.

For further information circle 210 on the reader service coupon or contact TCG, 30 Balfour Street, Chippendale 2008; phone (02) 699 8300.

Low cost S-H card

A 16-channel simultaneous sample-and-hold analog multiplexer board for high speed PC data acquisition applications is available from Novatech Controls. The CIO-SSH16 eliminates channel -to-channel skew associated with multiplexed A/D inputs.

A fast A/D board sampling at 100,000 samples per second will exhibit a minimum channel-to-channel skew of 10us. Since the skew is additive from channel to channel, the 16-channel total scan skew is 160us. The total aperture uncertainty for all 16 circuits on the Novatech CIO-SSH16 is less than 15ns.

There are 16 separate, fully differential amplification and sample-and-hold circuit blocks on the SSH16. The board acts as a front end signal amplifier for Novatech's CIO-AD16, 16-channel analog input board.

The 16 differential amplifiers have nine switch selectable gains providing very flexible amplfication of individual signals.

For further information circle 202 on the reader service coupon or contact Novatech Controls, PO Box 240, Port Melbourne 3207; phone (03) 645 2377.

Data acquisition design software

Elmeasco, distributors for National Instruments, has a software package available at no charge to help users of IBM-PC/XT/AT/EISA, or compatible computers, design a complete data acquisition system using NI hardware and software products.

The package, called DAQ-DESIGNER, takes the user step-by-step, through the design process, to build up a data acquisition system comprising I/O boards, signal conditioning, cables and connectors. It includes acquisition, analysis and presentation software.

The software keeps track of requirements such as isolation, number of channels, whether analog, digital or timing, etc., to guide the user to the correct choice of National Instruments products for an entire system. Once a design has been configured, the package presents the user with a listing of hardware and software requirements, together with pricing information to give a total system cost.

For further information circle 204 on the reader service coupon or contact Elmeasco Instruments, PO Box 30, Concord 2137; phone (02) 736 2888.

Dual serial, parallel ports

Quatech has released dual serial, dual parallel port PC/XT/AT boards. Model DSDP-100 is a dual RS-232, dual parallel port card, while DSDP-402 is a dual parallel, dual service port card, where the serial ports can be any combination of RS-232, RS-422 and RS-485.

The DSDP-100 has two RS-232 channels using the 16450 UART. Optionally available are 16550 UARTs, for transfer rates up to 256k baud. The parallel ports are Centronics compatible interfaces, consisting of an eight bit bidirectional data port, with five bit status and command ports.

Both the serial and parallel interfaces are address selectable (any where from 0000H to 03F8H), allowing the ports to be installed in the computer without conflict.

Each may be individually enabled or disabled. Versatile interrupt circuitry allows each port access to IRQ2-IRQ7. Additionally, it has interrupt sharing capabilities allowing it to share interrupts with other Quatech adaptors.

The DSDP-402 has the same interrupt circuitry and addressing capabilities as the DSDP-100, and each port can be individually enabled/disabled.

However, the DSDP-402 comes standard with only two parallel ports — the

Continued on page 136

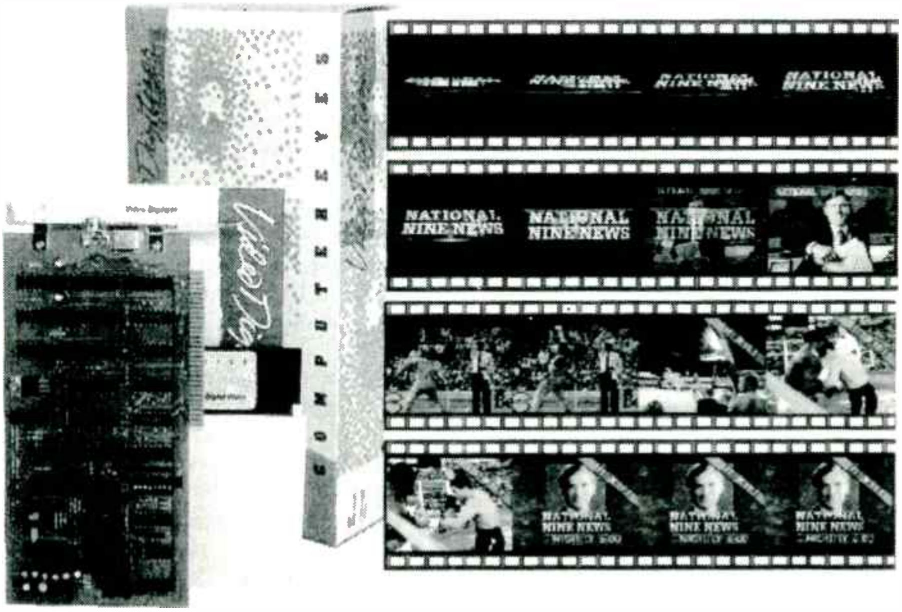
Real time frame grabber

The ComputerEyes RT is a real time 24-bit video frame grabber which can capture high quality images from any video source — which can include a domestic VCR, video camera, TV set or still video camera.

The RT comes with four software interfaces: 'EYES' captures images in standard VGA resolutions of 320 x 200, with 256 colours or grey scales; 'SEYES' captures in Super VGA (SVGA) resolution of 640 x 480, with 256 colours of grey scales; 'HEYES' capture in 640 x 480 resolution with up to 16.7 million colours given the right graphics display card and 'CINE MAKER', which can capture a series of video frames in real time and play them back as an animation. Other functions offered with these software interfaces are brightness, contrast and saturation control, with some image editing features including smoothen, sharpen, invert, flip, enlarge and reduce.

ComputerEyes RT is price at $1350.00 (inc tax), with MS Windows 3.0 software drivers at $150.00. Reseller enquiries are welcome.

For further information circle 240 on the reader service coupon or contact Lako Vision, 1/45 Wellington Street, Windsor 3181.



PROGRAMMABLE CONTROL

EXTENDED VERSION OUT NOW! CONTROLS 128 INPUTS AND 120 OUTPUTS

Programmable control from your IBM-PC or compatible? Imagine being able to write and test logic control programs as easily as switching on a light bulb. Procon Technology has done just that with its PLC version 2.0 software. This program provides a relay ladder logic style of programming – shown above – that's easy to learn and easy to understand. What's more, it's the style of language used in multitudes of industrial controllers worldwide!

Together with our I/O board, this software turns your PC at home or in the office, school or laboratory into a powerful, yet flexible, programmable controller. Your computer becomes the centre of the control system – it monitors the inputs, scans and solves logic and performs other special functions to determine and set the output conditions.

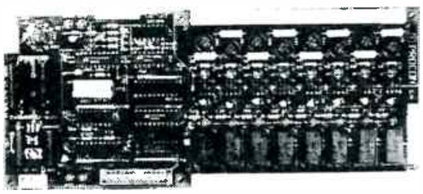
The PLC editor facilitates the entering, deleting and altering of comments and ladders off-line or on-line. On-line editing allows modifications to be made to the program without disruption to the control operations. E.g. You could adjust a time delay, correct a logic error or add more functions whilst the program continues to run – uninterrupted.

Unlike other programming languages, PLC version 2.0 also provides real-time indication of logic conditions continuously on the screen – again with no interruption to program execution. Each closed contact or activated output is highlighted on the screen and each timer's remaining duration is displayed. Monitoring and debugging control programs couldn't be easier!

Once a program has been debugged, it can then be loaded for execution in background whilst the computer is used for other things (such as word-processing or spreadsheets).

With additional I/O boards, numerous PLC application programs may run in the background providing an economical means of controlling many different items of equipment.

Applications include: Home or business automation and security systems, model control, laboratory automation and educational and training needs.



The NR-12VAC I/O board is mounted externally (up to 30 metres from the computer) and provides 8 isolated 12 Volt AC or DC inputs and 8 independent relay outputs. LED indication is provided on all inputs and outputs and all connections are via screw terminals. The system is capable of expanding to 240 I/O from one PA-BUS card inserted into a single card slot in the computer.

Other I/O options are available, including an industrial version. The I/O boards may also be controlled from other high-level languages.

VISA, BC, MC accepted.

PROCONtechnology

9 Wendover Crt.
P.O. Box 655
Mt. Waverley, Vic 3149

Phone: (03) 807 5660
Fax: (03) 807 8220

READER INFO NO. 29

Data Acquisition

Continued from page 134

serial ports are optional drivers, in any combination of up to two RS-232/422/485 signals.

For further information circle 205 on the reader service coupon or contact Interworld Electronics, 1G Eskay Road, Oakleigh South 3167; phone (03) 563 7066.

Video delay unit

Imparja Television has developed a video Tape Turn-around Unit (TTU) using IBM-PC interface boards and software from Procon Technology. The TTU is designed to control three BVW 75 SP Beatcam video tape recorders, but can accommodate other VTRs such as S-VHS and BV 3100.

The three VTRs can delay any programme commencing at any time, without operator intervention, for a period of 24 hours. The delay can be any one of eight durations ranging from 20 minutes to 90 minutes, in increments of 10 minutes.

The TTU has been operating at Imparja Television in Alice Springs since early February 1962 to turn-around such programmes as the Winter Olympics (90 minutes delay), Hey Hey It's Saturday (60 minutes delay) and the Sixty Minutes programme (30 minutes delay), plus others — with complete reliability and an accuracy of +/-2 frames.

The system uses an IBM-AT or 'computer', together with three PC-IO-NR-12V AC real world interface units from Procon Technology. PCL (programmable logic control) software runs in background on the computer and provides real time control. The PLC control logic and foreground programs were written by technical staff at Imparja TV and allows simple keyboard control of the TTU.

Further information regarding the tape turn-around unit can be obtained from Peter Knights, Imparja TV, PO Box 52, Alice Springs 0871.

For further information on the I/O boards and software, circle 205 on the reader service coupon or contact Procon Technology, PO Box 655, Mt Waverley, 3148; phone (03) 807 5660.

Modular PC-based D-A card

The PCL-814, released by Priority Electronics represents a new generation of modular PC Compatible Data Acquisition Cards.

The card's task-oriented design offers the user greater flexibility when customising their data acquisition system. This is achieved by plugging in only the modules that are required for the application.

The card comes equipped with a 14-bit resolution 100kHz high performance A/D module, which provides 16 channels of differential analog signal measurements.

Its D37 connector provides protection for shielded input signals, and the A/D circuit is enclosed in a protective cover to provide excellent signal shielding and noise immunity. The onboard 16 digital inputs, and 16 digital outputs allow the user to perform on/off process control and monitoring.

The special feature of the PCL-814 is that it has two 64-pin piggy-back connectors, for function expansion using plug in modules. There are currently three different I/O plug in modules available all of which can be added to the PCL-814 as a mix/match combination.

For further information circle 211 on the reader service coupon or contact Priority Electronics, 23-25 Melrose Street, Sandringham 3191; phone (03) 521 0266. ❖

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Shorter wavelength red laser diodes

Toshiba Corporation has released three types of new red light visible laser diodes. Featuring high optical output power, short wavelength and high temperature operation, the new lasers are suitable for use in a number of areas, including optical disk recording systems, handheld bar-code readers and sensors for measuring equipment.

Type 1, the TOLD9150(S) is a high output power (30mW), short wavelength (690nm) device, whose power is 50% higher than that of the company's current red light semiconductor lasers. The 30mW output power allows the device to read and write approximately one gigabyte of data on a 5.25" optical disk.

Type 2, the TOLD9412(S), has the shortest wavelength (650nm), with a rating for high temperature operation (50°C).

This breakthrough of short wavelength and high operating temperature not only allows the development of highly reliable, compact bar-code scanning systems at a competitive price, but also broadens potential applications to include measuring equipment and machinery controls where visibility of the beam is important.

Type 3, the TOLD9111(S), can operate at temperatures up to 60°C, while offering a lasing wavelength of 680nm. It is suitable for applications in sensors such as those used in factory automation equipment.

INMARSAT chip guide

A 12 page technical brief, 'Successful Integration of QUALCOMM VLSI Products into INMARSAT', describes the application of frequency synthesis and forward error correction technology for INMARSAT digital communication services.

QUALCOMM's new Technical Brief provides a comprehensive and accessible introduction to the fundamentals of INMARSAT digital services, as well as ASIC solutions available from QUALCOMM. System performance and configurability, low power dissipation, full duplex operation and cost effectiveness are among the topics examined for today's INMARSAT design requirements.

For further information circle 272 on the reader service coupon or contact Veltek, 18 Harker Street 3125; phone (03) 808 7511.

80C51 with on-chip RAM

The 83C528 microcontroller from Philips Semiconductors is claimed to be the first 80C51 compatible micro-controller to feature 32Kbytes of ROM and 512 bytes of onchip RAM.

This allows the 83C528 to run compiled application programs written in high level languages such as PL/M and C. (The limited RAM and ROM capacity of existing 80C51 compatible micro-controllers often require programs to be handcrafted in assembly language, resulting in higher software development costs, and programs which are more difficult to debug).

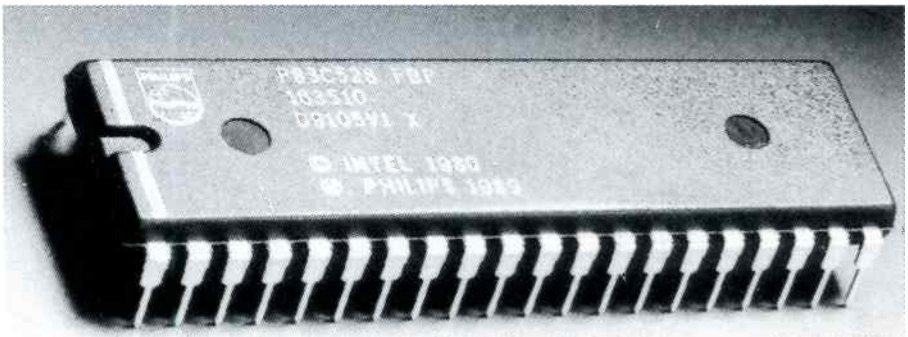
The 512 byte RAM also provides enough space for context switching, especially with regard to stack enhancements in internal memory. The stack enhancement capability also gives advantages when using a high level language such as C.

Another feature of the 83C528 is a watchdog timer, with its own onchip oscillator. This configuration makes it possible to run the WDT during power down mode, and to wake the 83C528 up when a WDT overflow occurs.

This microcontroller can also be woken-up by an external interrupt, allowing it to continue program execution from the status of the last program instruction executed, before it entered the power down mode.

Fabricated in 1um CMOS, the 83C528 operates at clock frequencies as high as 24MHz.

For further information circle 271 on the reader service coupon or contact Philips Components, 34 Waterloo Road, North Ryde 2113; phone (02) 805 4455.



High isolation DC/DC converter

Burr-Brown's PWR13XX is a DC/DC converter designed for any applications requiring extremely high isolation voltages, including Medical Grade Applications.

It offers 4000V of isolation and is in compliance with IEC 601-1 and UL544 standards with an isolation barrier that is 100% tested. The unit is even capable of withstanding 10 exposures at 8000Vpk.

The 1.4 watts or unregulated output power can be used in applications such as patient monitoring, where high isolation and low barrier capacitance (10pF) are critical for systems integrity and reliability.

The product is suitable for high density PC boards where unregulated power must meet safety standards.

The PWR13XX is a complete self contained converter, and does not require external components to make it work or perform to specifications. Its Dual-In-Line package uses only one square inch of PCB space and features built-in stand offs. Voltage inputs are 5, 12 and 15V DC and outputs are 5, 12, 15, +/-5, +/-12 and +/-15V DC.

For further information circle 273 on the reader service coupon or contact Kenelec, 48 Henderson Road, Clayton 3168; phone (03) 560 1011.

Flash memory has sector erase

Advanced Micro Devices has announced a new Flash architecture that features 5V-only programming and full sector serase operations. This one megabit flash memory, organised 128K bytes x eight bits, is economical enough to use in volume applications where cost is a factor.

The device features access speeds as fast as 45 nanoseconds and 100,000 write endurance cycles, with completely automated program and erase operations. The Am29F010, the first member of the family to be announced, will be shipping in volume by the third quarter of 1992.

Single-supply programming and AMD's flexible 16KB section erase architecture provide significant value in applications that selectively reprogram portions of the Flash memory array, while leaving the rest of the memory contents fixed.

AMD's 5V-only architecture uses a single transistor Flash memory cell to achieve low cost. Its Negative Gate Erase technology uses a single supply to provide the erase current when negative voltage is applied to the gate. Using this approach minimises the internal power requirements of the device, and therefore results in a negligible impact on die size.

The Am29F010, based on 0.85um CMOS design technology, requires approximately one third the system level power of 12.0 volt Flash devices during code updates. This power reduction means that current AA battery powered palmtops will now be able to use Flash technology.

For more information circle 276 on the reader service coupon or contact VSI Promark Electronics, PO Box 578, Crows Nest 2065; phone (02) 439 4655.

Low cost clock/stopwatch

The DS1603 Elapsed Time Counter from Dallas Semiconductor serves as a real time clock, with a stopwatch function which can measure equipment use conditions.

System designers can now use this simple, low cost, solution to provide both a highly accurate real time clock, and also measure a system's operational time in the field — providing event measurement, warranty and service information. The DS1603 module measures only 21 x 16mm and requires only five pins to be fully interfaced.

Once enabled, the DS1603's continuous time counter provides an accurate time base in seconds, to within +/-2 minutes per month, for more than ten years. The power active counter counts the time, in seconds, that power has been applied to the DS1603, creating a record of how long the system has been in operation.

This highly accurate time base is created from a temperature compensated clock oscillator which is contained in the module.

For further information circle 275 on the reader service coupon or contact Veltek, 18 Harker Street, Burwood 3124; phone (03) 808 7511.

Engineering coprocessor

Intel's 'RapidCAD' engineering coprocessor makes technical, engineering and scientific applications run from 20% to 170% faster on Intel386DX CPU based computers.

It is comprised of two chips. The first, the RapidCAD-1 chip, combines the system's Intel386DX CPU and the Intel387 math coprocessor logic into a single device. This eliminates the time consuming I/O cycles between the two chips. The second chip, the RapidCAD-2 device, with 68 pins, drops into the socket normally reserved for the math coprocessor. It contains the interface logic needed to manage the floating point exceptions, such as dividing by zero, on PC compatible systems.

The RapidCAD coprocessor is said to run such tasks as three dimensional rendering nearly 70% faster than an Intel 386DX CPU/Intel387 math coprocessor combination. In general, it is claimed to improve performance on other technical software applications like CAD by 30 to 70%, and scientific mathematical and statistical analysis by 20 to 30%. Performance of extremely mathematics intensive software such as FEA (finite element analysis) is claimed to increase by as much as 170%.

For further information circle 277 on the reader service coupon or contact Email Electronics, 15-17 Hume Street, Huntingdale 3166; phone (03) 544 8244.

GaAs MMICs

The Microwave Products Division of Hughes Aircraft has released the following circuits which are all fabricated at its GaAs foundry facility (USA) using an 0.5um MESFET ion implanted process.

The J-Band GaAs MMIC low noise amplifier chip, model M3040H-110 is a low noise GaAs monolithic amplifier circuit for receiver applications. This two stage circuit provides a noise figure of less than 4dB (10.2 - 12.8GHz), and a gain of greater than 14dB. Power output level is typically about +7dBm depending on frequency and biasing implementation.

The Ku-Band GaAs MMIC high power amplifier chip, model M1027H-1400 is a high power, high efficiency GaAs monolithic amplifier circuit. This three stage circuit provides greater than 1W of saturated output power across the 14 - 14.5 GHz frequency range. Greater than 25% power added efficiences have been achieved.

And the X-Band GaAs MMIC high power amplifier chip, model M1030H-0900 is another high power, high efficiency GaAs monolithic amplifier circuit. This two stage circuit can provide greater than 2W of saturated output power from 8.5 - 10.5GHz. Greater than 22% efficiency can be achieved depending on actual frequency and biasing implement ation.

For further information circle 278 on the reader service coupon or contact Laser Electronics (Operations), PO Box 359, Southport 4215: phone (075) 73 2066. ❖

Software emulates basic CPU operation - 2

In the first of these articles we finished by summarising the EMUL-8R instruction set. This article will go on to look at one type of instruction, the MRI or memory reference instructions, in a fair amount of detail. These instructions plus others are then used to make a complete demonstration program.

by FRED STRATFORD

As you will hopefully recall, the MRI class includes a several instructions such as TAD, DCA, ISZ, AND, JMP and JMS. The principles involved in these instructions will be demonstrated quite well by looking in detail at the TAD (Add instruction). All of these instructions reference the memory and hence some time must be spent on memory addressing and numbering systems.

EMUL-8R has 4096 words each of 12 bits wide, addressed between 0 and 4095 and it must be possible for each of these words to be accessed individually. We must now digress a little more to look at binary numbers to understand how this is achieved.

We are assuming here that it is understood why digital computers deal with binary numbers (i.e., numbers which can take on values of either 0 or 1). If this is not clear, then there are numerous excellent publications on the subject — including the volume on digital logic published by *Electronics Australia* some time ago, entitled *An Introduction to Digital Electronics*. I must refer you to such a text, as it is not intended that these articles cover all the ground necessary to understand the operation of this type of logic.

We have said that the EMUL-8R word is 12 bits wide. What values are possible within these 12-bits? Each binary position can take on a value which is a power of two, depending on its position. Taking the 12-bit word as an illustration, Fig.1 shows the various weightings.

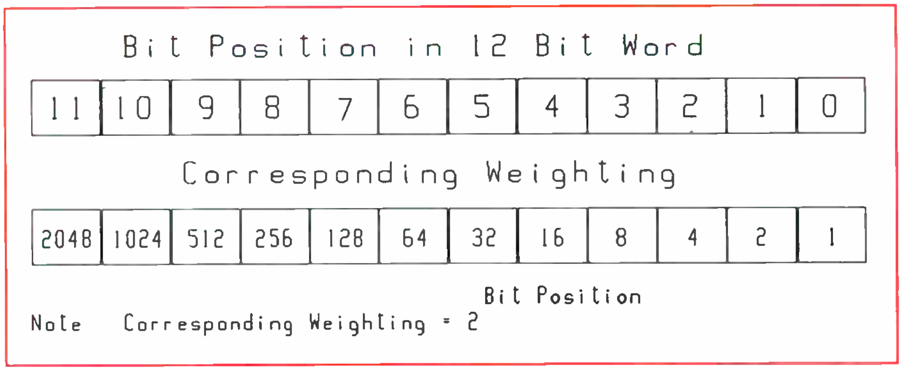


Fig.1: A 12-bit word and the weightings which correspond to each bit position.

An example sometimes makes thing clearer. Take a simple one first. Look at the binary number 000 000 101 010. (The collecting of bits into groups of three is significant, but discussion will be deferred to later.) The equivalent value in decimal can be established by using the weightings from Fig.1. The example is calculated as follows, working right to left from bit 0:

(0 x 1) + (1 x 2) + (0 x 4) + (1 x 8) +
(0 x 16) + (1 x 32) + (0 x 64) + ...

(all of the remaining terms are 0) which adds up to 42. It is suggested that readers try other examples for themselves.

An illuminating example arises for the case of 111 111 111 111, which is of course the largest number which can be stored in 12 bits. This evaluates into decimal as follows:

(1 x 1) + (1 x 2) + (1 x 4) + (1 x 8) +
(1 x 16) + (1 x 32) + (1 x 64) +
(1 x 128) + (1 x 256) + (1 x 512) +
(1 x 1024) + (1 x 2048)

Which adds up to 4095 — what a surprise!

Hence it takes 12 bits to address the 4096 words individually.

It was noted above that the bits were grouped into threes. There is no doubt at all that binary numbers are difficult for people to handle. They consist of often long strings of zeroes and ones, and are tedious to say and prone to error in reading and copying. A system more like the familiar decimal one would be better.

Why not *use* decimal? Well unfortunately, the decimal and binary systems

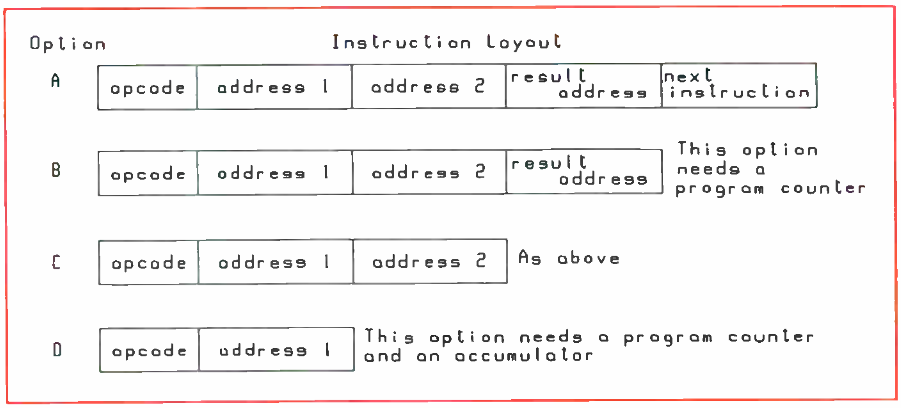


Fig.2: The main types of computer instruction word layout.

[illegible] - 2

[illegible]

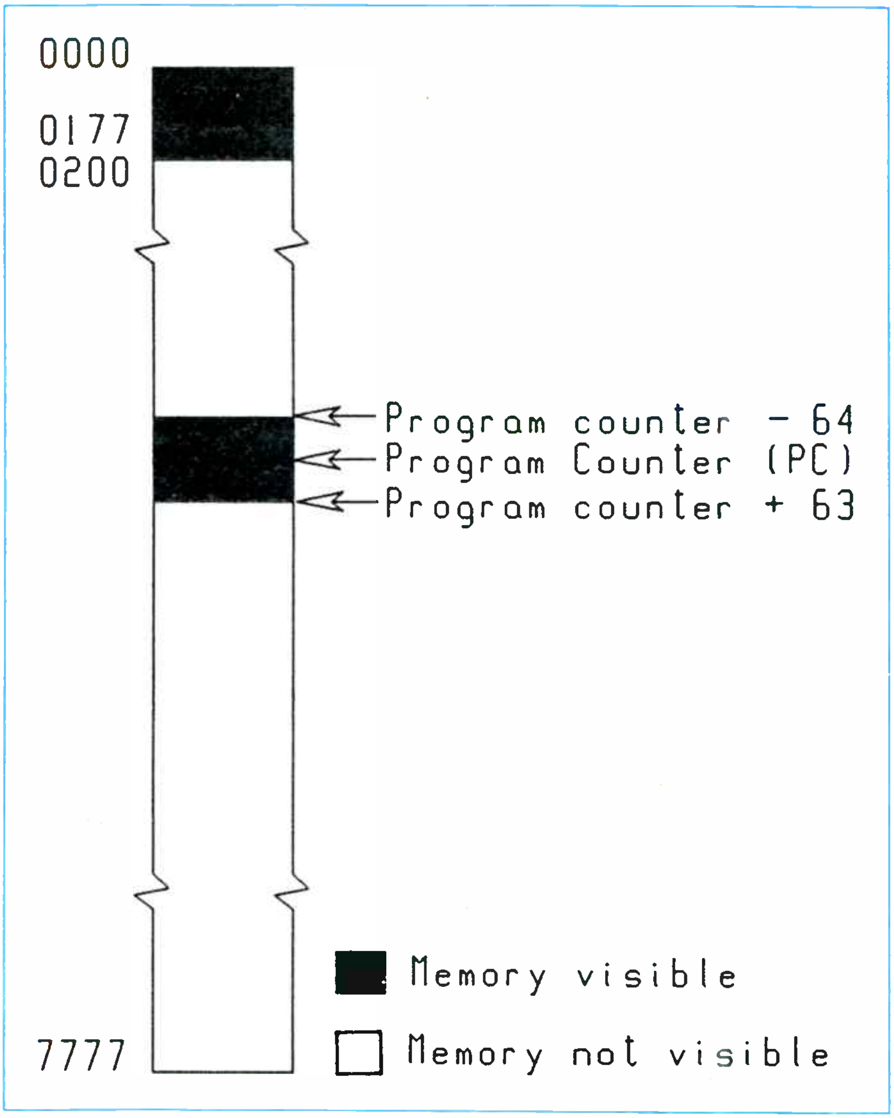


Fig.3: The memory ranges that are 'visible' to the EMUL-8R processor, when direct addressing (M = 0) mode is being used.

do not match very well as 10 is not an integer power of two.

But there have been a couple of compromises developed over the years, which work well once they are familiar. One of these systems is the *octal* system based on eight, where one octal digit can be used to represent groups of three bits.

In octal, numbers are formed by grouping bits from the RIGHT hand side of the number in groups of three, adding zeroes at the left if required to complete the 3-bit groupings. These 3-bit groupings are then converted to familiar numbers using the following lookup table:

Binary	Octal
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

Thus the number quoted in our first example above could be written in octal as 0052. Now that is a lot easier to read and say, is it not?

The alternative method is to group four bits together, beginning again at the RIGHT hand side of the word and once again adding 0 bits to the left as required to complete the 4-bit grouping. Each group of four bits can then be represented by the equivalent *hexadecimal* (often abbreviated to hex) or base-16 digit, according to the conversion table is shown below:

Binary	Hex
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

It should be noted that there are letters (A to F) in this numbering system, as there are 16 symbols required — but only 10 symbols are available from the decimal system. The letters are used as convenient and familiar symbols, next in the sequence.

Both the octal and hex systems are in common usage, with hex having the edge more recently as it fits in better with the 8-bit, 16-bit and even 32-bit systems around today.

However octal is still in use and it is often simpler to grasp initially as it doesn't use confusing letters. The 12-bit word of EMUL-8R and the layout of the instruction lends itself to the octal system, so that is what is used.

Instruction sets

Enough of binary numbers for the moment. The discussion will now turn to the subject of computer instruction sets and the types of computers.

Broadly there are a number of types of computer, based on the structure of their instructions. If a computer is to add two numbers, it must know a number of things.

Firstly, it must know that it is to add (rather than do some other operation with the numbers). This is an essential part of all computer instructions and is called the *operation code* (usually opcode).

Secondly it must know where to *find* the first and second numbers, and where to put the answer. Finally it must know where to find the *next instruction*. There are various options which can apply to these areas, which are shown in Fig.2.

The first of these is option A, in which all of the addresses are stored in the instruction, along with the opcode. This is very powerful and flexible, as the data can be obtained from anywhere, the result can be stored anywhere and the next instruction can come from anywhere.

(By the way these addresses are often called *operands* as the instruction operates on them.) However this instruction will take more than four words (depending on the size of the opcode component) and is wasteful.

In fact one simple assumption about the sequence of instructions can reduce this dramatically.

CPU operation - 2

This assumption is that most of the time, one instruction follows another. This is largely true, and is well worth the loss of flexibility. The sequence of instructions can then be controlled by a simple counter, usually called the program counter. This is shown in option B.

The resulting instruction format is still expensive to implement, as it requires a lot of words to store it. It can be reduced by assuming that the result is stored in the same place that one of the operands came from — usually operand 2's address. This option is shown in option C.

If this idea of the source and destination being the same for one of the operands is taken one further step, the concept of a standard place for one operand to come from and the result to go to emerges quickly.

This standard place is called the *accumulator*, and the resultant instruction format is typical of most machines in use today in the commercial sphere. This option is shown in D, and is very like the EMUL-8R instruction layout.

It should be noted that the layout of the instruction is idealised in the discussion here. Sometimes the opcode comes in several parts and is spread across the word. Also it is possible that there is more than one accumulator.

This simple change means that the destination is not so fixed and that the instruction is a little more like option C. That is, it is possible to partially vary one of the operands and the destination, although this is not a complete memory address but is instead an *accumulator* address.

Returning to EMUL-8R now, the instruction layout goes one step further by putting the opcode and the address into one 12-bit word. The opcode occupies three bits at the left-hand end of the word, while the address fits in the remaining nine bits.

Some readers will no doubt be already objecting that with nine bits, only 512 words of memory can be addressed. This is indeed true, and some tricks are required to reach the full 4096 words.

Part of these tricks is done by reducing the address component even further down to seven bits (127-word addressing), and using the other two bits to change the interpretation of the remaining seven. This discussion is best illustrated by looking at a concrete example for the TAD instruction.

The TAD instruction is laid out in the general manner of the MRI class as follows:

```
Bit      11 10 9  8 7 6  5 4 3 2 1 0
Meaning <opcode>M P<    address    >
                | |
                | P = Page control
                M = Mode of
                    addressing
```

In the case of the TAD instruction, the opcode is 001 or 1 octal. This is part is simple. The M and P bits are particularly of interest. For the moment the M bit can be assumed to be 0, and the discussion concentrated on the effect of the P bit. Fairly obviously there are two possibilities, P being either 0 or 1.

Consider the 0 case first. This is called *base page addressing*, and the 12-bit effective address is formed by taking the low seven bits of address from the instruction and appending five zero bits at the top end to give a full 12 bits.

About negative binary numbers

There are three common methods which are used to represent binary numbers. Probably the commonest in the computer area is 2's-complement, which has been discussed. The others are 1's-complement and signed magnitude.

The 1's-complement method has similarities to 2's- complement, in that the negative is formed by converting all 1's to 0's and all 0's to 1's; but that's all. This method has some advantages in that it is simpler and quicker to execute, but has the odd problem of having a -0, which is 111 111 111 111 in a 12-bit system.

The signed magnitude system is the one which most people can identify with most easily. In this system the number remains the same except for the left-most bit, which is usually 0 for positive numbers and 1 for negative numbers. Thus -5 would be 100 000 000 101. Unfortunately this system does not suit binary logic very well, and usage is restricted to specific applications such as calculators and some analog-to-digital converters.

Thus the base page mode is capable of addressing only the first 128 (being locations 0 to 127) of the memory. Incidentally the address that the instruction finally ends up using is sometimes called the 'effective' address.

Before the discussion can proceed to look at the P = 1 case, there must be must be some diversion to examine the concept of signed binary numbers, and in particular the 2's-complement system.

Please see the box note on the subject of signed numbers, which gives a look at some of the alternatives. In the 2's-complement system the negative of any particular number is defined as the complement of that number (i.e., with all the 1's changed to 0's, and all the 0's changed to 1's) plus 1.

Note that the size of a 2's-complement number must be specified — e.g., a 12-bit 2's-complement number or an 8-bit 2's-complement number — or it will not be known where to look for the sign bit.

A concrete example should help make this clear. Take for example the number 5 in a 7-bit system. This is represented as 0 000 101 in binary. To negate this number we first complement it, to give 1 111 010, and then add 1 to give the result 1 111 011.

The acid test of any negative number is to add it to the positive version of itself and see if the result is 0. That is, +5 plus -5 = 0. Taking the above case,

0 000 101 = +5
1 111 011 = -5
10 000 000 = binary sum of the above numbers. Remember that the number system here is only seven bits wide, and the 1 in the eighth position of the sum 'falls off' the edge and is discarded.

Note that for negative numbers the most significant bit of the number is always 1 and for positive numbers it always 0. Hence computers always consider 0 a positive number, although mathematicians tend to consider it as neither positive or negative.

There is one other odd effect which should be given a quick airing. It is agreed that 0 000 101 is 5, without a problem. However 1 111 011 could be read another way, from the weightings in Fig.1. This then seen as 123.

Now 123 + 5 = 128, which in binary happens to be 10 000 000. That number is oddly familiar, and is the sum of the previously noted numbers — taking into account the bit which 'fell off'.

This makes two points. Firstly that the length of the number is significant, and secondly the hardware which does

[illegible]

[illegible]

[illegible]

addition knows nothing about this 2's complement business, and does not care about it in any way.

It is the user's responsibility to take care of the way numbers are represented and interpreted.

There are other methods of representing signed numbers, and these are looked at briefly in the box 'About negative binary numbers'.

Just one more small topic, and this discussion can return to the TAD instruction. If for example a small 2's-complement number is to be converted into a larger word size signed binary number, then a process called 'sign extension' must be undertaken. This simply involves copying the sign bit across the word to the left, until the new left-hand edge is reached.

For the example above to be converted into 12-bit numbers, this would be done thus:

7 bit 0 000 101 = +5
12 bit 000 000 000 000 101 = +5
(0 copied across word)
7 bit 1 111 011 = -5
12 bit 111 111 111 111 011 = -5
(1 copied across word)

Finally the discussion can return to the TAD instruction. The above all pertains to the case where P = 1. In this case the address is regarded as a 7-bit *signed* number, which is sign extended and added to the program counter to obtain the effective address. This is called *program counter relative addressing*.

It should be noted that the program counter will be 1 larger than might be expected. When each instruction is 'fetched', i.e., brought down into the CPU for execution, the program counter is incremented ready for the next fetch operation.

This saves some time, as the increment can be done in parallel with the instruction execution to some extent. In any case the program counter value used by the instruction will not the one where the instruction itself was stored, but one more.

Taking the cases of P = 0 and P = 1 together, this means that at any one time there are two windows open on the memory for access.

One is the base page, from 0 to 127, and the other is a band 128 locations wide which 'follows' the program counter as it moves around. This is shown diagrammatically in Fig.3.

This amount of memory addressing does seem very limiting, but in fact is reasonably powerful. The base page can be used to store data which must be accessible from anywhere, while program counter relative addressing is used to form local routines. Naturally some frugality is required in programming when this approach is used.

But how does the system go about addressing the remainder of memory, when 256 words simply are not enough? This is where the M bit comes in. So far this bit has been set to 0. If this bit is set to 1, another step called *indirection* is added to the instruction being executed.

The instruction behaves the same way as noted above, at the beginning. That is, the P bit determines whether the access is base page or program counter relative.

The change comes after the data at that address has been obtained. Instead of using that data directly, the CPU uses it as an *address* to go and get another word, which is used as the data.

Because the intermediate step retrieves a full 12-bit word, the whole of memory is now accessible. An example is probably best to illustrate the process.

To make the example more authentic, a simple program will be developed as shown in the listing, which adds three numbers and saves the answer in memory. But before embarking on the example, further explanation about instructions is required.

LISTING 1
Sample program in hexadecimal

Location	Contents	Comment
0010	0003	First number to add, say 3
0011	1000	Has address of third number
....		
0200	7400	Clear the accumulator
0201	1010	Add the number in 0010
0202	1215	Add the number in 0220
0203	1411	Add the number in 1000
0204	3414	Save the number in 2000
0205	7402	Stop
....		
0220	0004	Second number to add
0221	2000	Has address of final sum
....		
1000	0006	Third number to be added
2000	0000	Final sum is written here

As might be gathered, the construction of an instruction can be a tedious business as the instruction must be built from the opcode, the M and P bits and the address.

The address can be quite difficult, for the program counter relative case. This will be best appreciated by actually doing it to create our program, which adds the numbers at locations 0010, 0220, and 1000 and stores the result at 2000.

A couple more instructions need to be looked at before the program can be examined in detail. A method is required to clear the accumulator before using it. The opcode for this instruction is 7200. Note that this instruction does not obey the layout rules for the MRI class, as it is not a memory reference instruction.

Another useful instruction stops the EMUL-8R processor running, and prevents it from continuing to execute past the end of the program. This opcode is 7402.

Next a quick look at another MRI is needed. This instruction stores the data in the accumulator at the effective address, and then clears the accumulator back to zero. This opcode is 3, with the M and P bits and the address following as per the TAD instruction.

One final note. All programs in EMUL-8R must begin at 0200. All computers (and microcomputers in particular) have a startup or reset address, at which programs must begin execution.

This varies from one computer to another, but in the case of EMUL-8R it is 0200.

Sample program

The example program can be returned to and dealt with now. The first instruction at 0200 will be a clear accumulator instruction, with the opcode of 7200.

The next chore is to add the number at location 0010 to the accumulator. This instruction will be at 0201, and its construction is relatively simple.

The effective address (0010) is on the base page, hence M and P can both be 0. The opcode part is 1 (octal), and the address is made up of the low seven bits of the address.

This address is 0010, which in binary is 000 000 001 000 — the low seven bits being 0 001 000. The final instruction is therefore 001 000 001 000, or 1010 in octal. The next task is to add the number at 0210 to the accumulator.

This instruction will, of course, be at

[illegible]

CPU operation - 2

location 0202. Now 0220 is within program counter relative range of the program counter, so M can be 0 but P must be 1.

The effective address is the seven-bit signed difference between 0220 and 0203 (one more than the instruction program counter value). 0220 - 0203 is equal to 15 in octal. Put into 7-bit binary this converts to 0 001 101, giving a final instruction of 001 010 001 101, or 1215 in octal.

The next step is to add the number at 1000. The program counter is now at 0203, consequently it is not possible to directly reach 1000 either by using base page addressing (since 1000 is not in the base page), or program counter relative addressing — since the maximum offset possible is only 63. Indirection is therefore required, via a location which *is* accessible.

This can be done either base page or program counter relative, but for this example base page will be used with location 0011 containing the intermediate address.

The instruction is very simple. In binary it becomes:

```
001 100 001 001
     | |
     | P is clear
     M is set for indirection
```

In octal the instruction is 1411. When it executes, the sequence is as follows. The instruction calculates the base page address in the normal way, but instead of using the data at 0011 (hex) as data, it uses it as an address. This address is then accessed to obtain the data. Consequently it is vital that location 0011 contains 1000, the desired address.

The additions are now completed, and the store operation must be undertaken. The destination of the sum is 2000, which like 1000 is out of range of the direct base page or program counter modes. This time, however, an indirect program counter relative reference will be used.

The intermediate location will be 0221. This of course means that 0221 must contain 2000. The mechanism to access 0221 from 0204 is similar to that described above and the resultant instruction is 3414. It is left to the reader to determine the detail on the construction of this one.

The final operation is to halt EMUL-8R, or it will continue to execute. This is done with the 7402 instruction. The final program, in octal form, is as shown in Listing 1.

LISTING 2
Assembler's 'Pass 2' listing of sample program

Loc	Octal	Label	Mnemonic	Operand	Comment
0010	0010		*	10	/ Start at 10
0010	0003	num1,	3		/ First number
0011	1000	inum3	num3		/ Address of third
0200	0200		*	200	/ Now start at 0200
0200	7200		cla		/ Acc = 0
0201	1010		tad	num1	/ Add first
0202	1215		tad	num2	/ Add second
0203	1411		tad i	inum3	/ Add third
0204	3614		dca i	isum	/ Save answer
0205	7402		hlt		/ Stop
0220	0220		*	220	/ Start at 0220
0220	0005	num2,	5		/ Second number
0221	2000	isum,	sum		/ Address of sum
1000	1000		*	1000	/ Start at 1000
1000	0007	num3,	7		/ Third number
2000	2000		*	2000	/ Start at 2000
2000	0000	sum,	0		/ Result saved here
2001	0000		$		/ The end
Symbol Table					/ Defines labels
NUM1		0010			
INUM3		0011			
NUM3		1000			
NUM2		0220			
ISUM		0221			
SUM		2000			

These numbers can be keyed into the memory of EMUL-8R with the memory editor and then the program executed, either at full speed or one step at a time. When you do this, it will probably be noted that the process of writing programs like this is somewhat tedious and prone to error.

Fortunately the EMUL-8R package also has the facility to translate a more easily written and understood 'English' version of each instruction, into the appropriate binary bits.

It calculates whether the address should be base page, program counter relative or impossible, in which case it reports an error.

It does however require a flag (an i between the mnemonic and the operand) if indirection is required.

In line with the rest of the computer industry, this translator software is called an *assembler*. EMUL-8R's assembler happens to be of the *two-pass* type, which simply means that it needs to run through the source code version twice before it can produce the final object code.

The way most assemblers work is as follows. First the program is typed into an editor. This is an 'English version' of the program, called the *source code*, which will ultimately be converted by the assembler into the real instructions — the *object code*.

Part of the source code instruction, usually the first part (or the second part if 'labels' are used), represents the part which will be converted to the opcode.

This part is called the *mnemonic*, as it is intended to remind the programmer of the function performed by the opcode. One mnemonic has been mentioned already, namely TAD, which represents the left hand 001 in the instruction concerned. Others are DCA, CLA and HLT.

EMUL-8R's assembler is no different to this, and a text editor is built in to allow changes to the source code. An example of the assembler's complete 'Pass 2 Listing' output is shown in Listing 2.

Note that this shows both the source code version of the program (the third 'Label' column, and all the others to the right), plus the 'translated' or object code version produced by the assembler (represented by the second 'Octal' column).

Well, that completes this article and the series. There is obviously more that could be said about EMUL-8R, to develop the concepts of programming and the internal operation of a computer.

But these articles are intended to 'test the water', to determine if there is enough interest to continue with the series in the future.

So it's over to you. ❖

[illegible]

What's the big idea?

NEW PRODUCTS

Active SCSI terminator

Unitrode has released its UC5601 Small Computer System Interface Active Terminator, which provides active pull-up for all 18 lines in a Small Computer Systems Interface (SCSI) bus cable.

The SCSI-2 standard recommends active termination at both ends of every cable segment using single ended drivers and receivers.

Internal circuit trimming reduces resistor tolerances to +/-2% and adjusts the regulator's output voltage to ensure termination current accuracy of +/-2.5%.

The UC5601 provides a disconnect feature which, upon logic command, disconnects all terminating resistors, and turns off the regulator — greatly reducing standby power.

Other features include negative clamping on all signal lines, regulator current-limiting, and thermal shutdown protection.

For further information circle 243 on the reader service coupon or contact Priority Electronics, 23-25 Melrose Street, Sandringham 3191; phone (03) 521 0266.

Barometric pressure transmitter

Vaisala has introduced a new product, the PTA 427 barometric pressure transmitter. Designed for accurate and stable measurement of barometric pressure in industrial and meteorological applications, the PTA 427 makes an ideal solution for weather stations, environmental data logging applications, and industrial applications where barometric pressure has to be monitored for improved process control.

The PTA 427 is based on Vaisala's patented silicon capacitive absolute-pressure sensor, which uses the outstanding elasticity properties of single crystal silicon to measure pressure.

As a result the transmitter achieves excellent repeatability, low hysteresis, very good temperature and long term stability. In addition, the pressure sensor can withstand high overpressures and mechanical shocks with no effect on performance.

The transmitter offers high accuracy of +/-0.5hPa (mbar), adjusted from 800 - 1060hPa, including traceability to international standards. A special pressure range version adjusted from 600 - 1060hPs is also available. It can also be modified to measure any absolute pressure from 50 - 2000hPa.

Compact and easy to install insideother equipment, the PTA 427 has an 0 - 5V DC output, and operates over a wide supply voltage range (11 - 30V DC) with low current consumption (7mA).

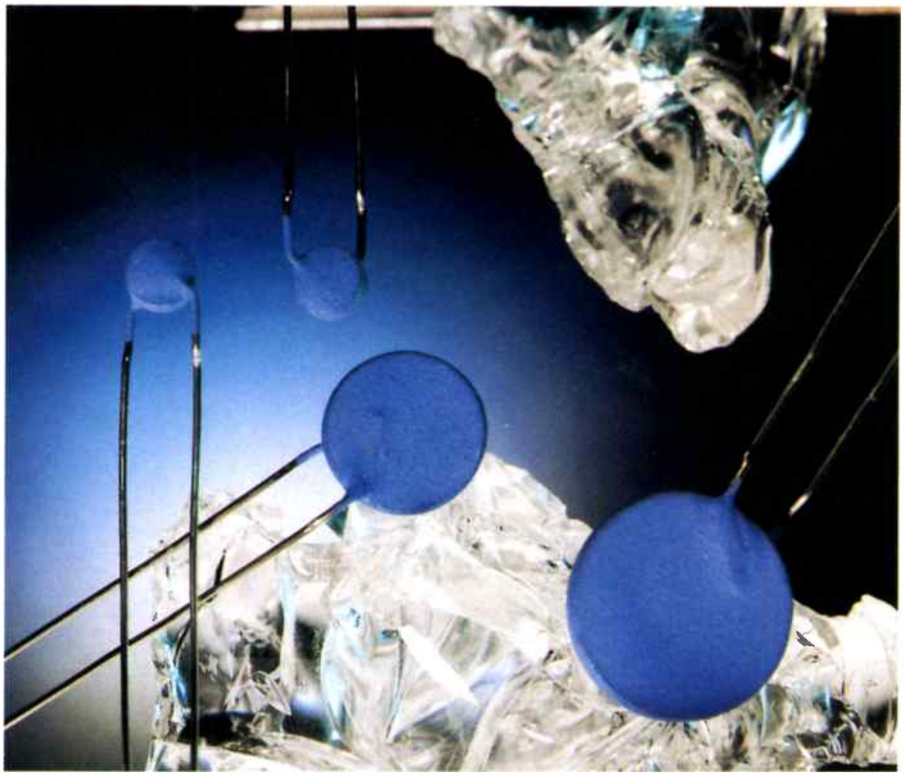
For further information circle 244 on the reader service coupon or contact Vaisala, 8-12 Sandilands Street, South Melbourne 3205; phone (03) 696 5699.

High temperature line protection

Siemens now offers a range of line voltage overload protection PTC thermistors with a reference temperature of 135°C, for applications where increased ambient temperatures are the norm.

The C811 through C891 range is for rated durrents of 30 - 690mA, and for switching currents of 65 - 1430mA. The size of the PTC thermistor discs varies between 4 and 26mm. The new range of PTC thermistors provides new overload protection components for consumer electronics, data processing and domestic appliance technology, particularly as short circuit protection — for halogen lights, for example.

For further information circle 241 on the reader service card or contact Siemens Electronic Components, 544 Church Street, Richmond 3121; phone (03) 420 7716.



PTFE insulation

Gore and Associates pioneered the use of polytetrafluoroethylene (PTFE) as an insulating material for wire and cable.

The stable fluorocarbon structure results in chemical and physical properties which make it an ideal insulation for reliable high performance cable: virtual immunity to lubricants, wide use temperature range (-273 to +260°C), and non flammable.

Gore-Tex expanded PTFE improves the already low dielectric constant and low dielectric loss of PTFE.

NEW PRODUCTS

Five-in-one fax/TAM

Panasonic Australia has launched a 'big brother' model to its five-in-one faxtam, the KX-F50BA. Known as the KX-95BA, the new model is aimed squarely at the small business market, as it includes a number of useful features not previously found on an integrated telecommunications unit.

The faxtam gives the benefits of a fax, telephone, phone answering machine and copier, without the inconvenience and expense of an extra phone line and equipment. One AC wall outlet and a single telephone line are all that are needed to operate the entire system.

Apart from its obvious economical advantages, the automatic telephone answering/facsimile switching feature makes it easy for small operators to leave their office unattended with the faxtam in the TAD/FAX mode, to automatically receive telephone messages or facsimile.

The faxtam also features a fast 15-second page tarnsmission time, polling reception and transmission capability, delayed transmission and 120 station memory for frequently dialled numbers. The KX-F95BA uses a recordable outgoing message chip instead of tape and has a recommended retail price of $1749.

For further information circle 247 on the reader service coupon or contact Panasonic Australia, 95-99 Epping Road, North Ryde 2113; phone (02) 886 0202.

This new material is a uniform microporous PTFE mesh with an air content of about 70%, giving it a dielectric constant of only 1.3 — one of the lowest available for electronic signal transmission. Hence Gore is able to produce flexible microwave cables with superior electrical performance, in comparison to those which use conventional dielectrics.

From being a supplier for over 30 years of high performance wire and cable, Gore has now announced its commitment to the advanced interconnect business. It defines this to mean a high performance, high fidelity, high density product used to interconnect two systems.

These products are further defined to mean: coaxial interconnects, cable assemblies, microwave cable assemblies (DC to over 60GHz), composite pre-preg laminates, electromagnetic interference shielding, fire-optic interconnects and transmission lines.

For further information circle 242 on the reader service coupon or contact Gore (Australia), 98 Old Pittwater Road, Brookvale 2100; phone (02) 938 5755. ❖

Silicon Valley NEWSLETTER

Judge scraps most of Apple's case

In a surprise move that stunned Apple Computer, Federal District Court Judge Vaughn Walker threw out most of the copyright violation claims Apple had listed in its landmark lawsuit against Microsoft and Hewlett-Packard.

The decision, which came in the form of a highly unusual oral ruling from the bench, all but destroyed Apple's case and the company's chances to collect any of the $5.5 billion in damages it is seeking from Microsoft.

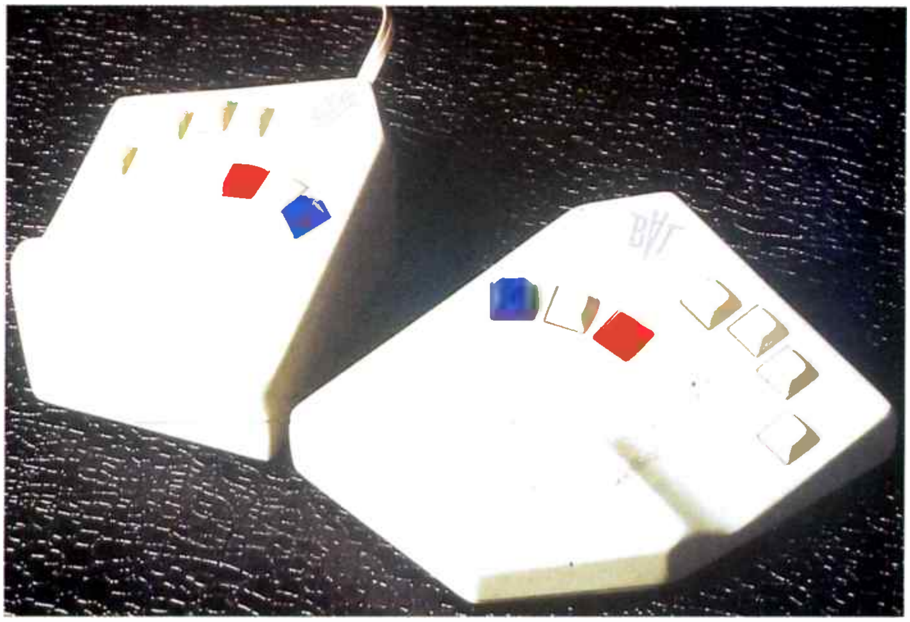
Walker dismissed 46 of Apple's 69 claims of copyright infringement, saying that many of the 46 dismissed claims didn't infringe on any Apple copyrights, including the use of icons and windows.

Other aspects of the Windows and New Wave displays are not covered by any US copyright laws, he said, and still others were covered under the 1985 Apple-Microsoft technology license agreement.

Until this decision, it was expected that Apple and Microsoft were heading for a spectacular trial this summer and that the outcome would set new legal standards by which corporations can protect their intellectual property — particularly the vague 'look-and-feel' of their products.

Now even a trial on the remaining claims appears in doubt, as does Apple's chance of dealing a devastating blow to Microsoft and its ability to market Windows programs.

At Microsoft and Hewlett-Packard, as well as on Wall Street there was relief and jubilation at the judge's ruling. "Apple's case has been gutted. There is nothing left," said attorney John Stark, who represented H-P. On Wall Street, Microsoft shares shot up US$11 to US$129 per share, adding another half billion dollars to Bill Gate's stock value.



So called 'chordic' keyboards have been around ever since late last century as an alternative to the almost universally used 'qwerty' keyboard. Their developers have claimed all kinds of advantages for them, but somehow they've never found much favour. The latest company to try its luck is Infogrip of Baton Rouge, La, which has unveiled this Macintosh compatible model.

New 'smart' appliance control chip

National Semiconductor launched a new class of smart controller circuits, designed to diagnose electrical problems inside home appliance equipment.

The so-called 'Cop820C' chip can shut off or reset the system. It also monitors and checks power sources such as the electrical outlet, to ensure they are working properly. In case of brown-outs or power surges, the chip will instantly vary the voltage setting to prevent shorts.

"In a human sense, this chip can diagnose if an appliance is feeling bad, and figure out what needs to be done to fix it," explained Tom Harper, who manages National's microcontroller marketing department.

Because of its low cost of just US$1.35 in large volumes, appliance manufacturers can easily justify incorporating the chip into their products. So far, none has committed to the chip, but Harper said a number of large US and European companies are testing the device.

"It would be fantastic to have some safety device built in that could detect, or shut down, and correct electrical problems," said Lee Baxter, regional direction on the West Coast of the US Consumer Product Safety Commission.

In time, Baxter said, these type of chips will be able to prevent many of the thousands of house fires that occur each year due to malfunctioning appliances. In 1989 alone, 110 people died and 900 were injured in 31,000 house fires in the US caused by faulty appliances.

An additional 480 people died and 990 were injured in 42,000 house fire caused by faulty outlets.

Panel recommends US$5Bn R&D fund

A 15 member panel of the US National Academy of Sciences has called on the Congress and Bush Administration to invest at least US$5 billion into a joint government/private industry corporation, which would help fund corporate research into high technologies with significant commercial potential.

The panel, chaired by former Secretary of Defense Harold Brown and comprised of leading figures in industry and the academia, urged that their plan be put into effect in order to help US industries compete more effectively in world markets.

The plan calls for the establishment of a so called 'Civilian Technology Corporation', which would invest up to US$1 billion a year into corporate and

university research projects that have promising commercial potential.

Although praised by most industry executives, many doubted the plan would be supported by President Bush, who has stubbornly resisted supporting any program that appears to suggest some form of industrial policy.

Two years ago, the presidential Advisory Commission on Semiconductors proposed a similar $1 billion government funded venture capital company. Those plans, while supported in Congress, feel on deaf ears at the White House.

Senate Committee demands report

In the first step that could lead to a full blow trade conflict between the US and Japan, the powerful US Senate Finance Committe has asked Trade Representative Carla Hills to provide a formal review of the US-Japanese Chip Trade Agreement within 60 days.

The letter was signed by all 20 members of the committee, including many of the most powerful members of the US Senate (chairman Lloyd Bentsen, majority leader George Mitchell, and minority leader Robert Dole).

The Senate action could set the stage for the swift imposition of trade sanctions against Japan, which appears to be failing to fulfil its obligations under the terms of the agreement.

In particular, foreign market share in the US$21 billion Japanese chip market is supposed to reach 20% by the end of this year. But the level currently stands at 14.3%, the same level it has been for much of the past two years.

Hills has been critical of the trade agreement and, until now, has shown little interest in enforcing it. But the pressure from the US Senate will likely change the White House attitude, which has been overly careful not to offend the Japanese trading partner.

In their letter, the Senators have asked Hills to spell out the government's plans for taking action, if any, based on its findings.

Sematech boosts chip equipment business

In what will be a major boost to lobbying efforts in support of the continued funding and operation of the Sematech chip technology consortium, the latest survey of the US semiconductor equipment industry has shown a remarkable recovery.

In fact, the US share of the world equipment market tied that of their Japanese competitors for the first time since 1989.

VSLI Research, the San Jose market research company that specialises in the equipment market, said that its 1991 market survey shows US companies controlled 47% of the US$9.9 billion equipment market, up from 44% in 1990.

The Japanese industry on the other hand suffered its first even decline in market share, dropping from 49% to 47%.

The turnaround, according to VSLI president Jerry Hutcheson is no accident, as it coincides precisely with the progress made at Sematech and the ability of a large number of companies working with Sematech to bring advanced new products to market faster.

"Every way I look at the data, I come back to the belief that this has got to be a Sematech drive increase," Hutcheson said.

AEA plans legal assault on Japan

The American Electronics Association is expected to mount a major legal offence on Japan's cozy vendor-supplier relationships, which are highly illegal under US antitrust law.

As part of the program, the AEA has reportedly developed a 'Japan Trade Initiative,' that would set new guidelines for Japanese companies doing business in the United States.

A cornerstone of the AEA program will be the filing of an antitrust suit against Japan, aimed at breaking up the so-called 'keiretsu' system in which electronics manufacturers maintain long term cartel-like relationships with their suppliers, in many cases owning part of the supplier. Apparently, the keiretsu system is not limited to Japan, but reaches across the Pacific to the US plants of Japanese companies.

Rather than using local US suppliers, the AEA has found that many Japanese vendors continue to rely on their Japanese keiretsu partners to supply their US operations.

The AEA said the keiretsu system is costing US electronics companies an estimated US$7.5 billion in annual sales to the US plants of Japanese companies.

Toshiba 'spy' caught at LSI

An industrial spy working for Japan's chip maker Toshiba allegedly infiltrated the Canadian chip design centre of LSI Logic, with the alleged intent to steal the latter firm's trade secrets.

In confidential letters between LSI and Toshiba's US division that were leaked to the press, LSI chairman Wilf Corrigan alleged that a Toshiba engineer entered the LSI facility in Alberta, Calgary posing as an employee of an LSI customer.

In his letter, Corrigan threatened Toshiba with legal action in the case. But spokesmen for both companies insisted the dispute has been settled to both companies' satisfaction.

Toshiba refused to comment on the case, other than to say that the engineer in question operated without the authorisation of his supervisors.

In a letter to Corrigan, Robert Brown, the senior vice president of Toshiba's US semiconductor operations called the incident "deplorable and inexcusable."

LSI and Toshiba are fierce competitors in the field of ASICs. LSI maintains more than 60 design centres around the world where customers frequently visit to work on the design of new chips. As such, customers often gain access to confidential design, test and processing technology.

Industry observers said the incident is not in character with Toshiba's way of doing business. The firm has an excellent reputation in the area of ethical conduct. Likely, the engineers may have been a maverick trying to gain knowledge to compensate for any of his own shortcomings.

TI may join 486 market

In a move that would drive yet another nail into Intel's once ironclad PC processor market coffin, Texas Instruments is expected to become the latest chip maker to manufacture and sell a clone of the Intel 486 microprocessor.

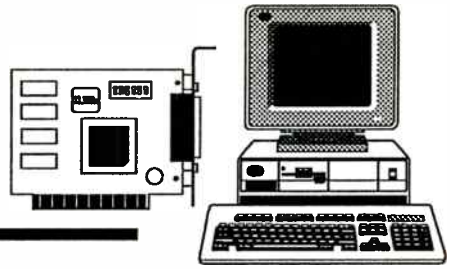
TI is expected to announce that it has agreed to licence a 486 design from Cyrix, the Dallas based chip company which announced recently that it would have a 486 chip ready for shipment by the middle of April.

TI said it will produce and market the Cyrix chip under its own label. Industry analysts said they are not surprised, and the deal represents a brilliant strategic move by Cyrix in its defence against Intel — which has already filed suit to prevent the company from putting its chip on the market.

With TI entering into the picture, Intel faces a formidable challenger — both in the market place and in the courts, where TI has considerable experience in challenging companies that have infringed upon its chip design patents.

Analysts speculate that a main part of the Cyrix-TI deal probably involves legal assistance in defending the Cyrix chip against the legal assault from Intel. ❖

Computer News and New Products



Analog signal workstation

Siemens will act as a distributor for a new Australian measuring instrument called Amlab — Associative Measurement LABoratory — which has been developed by a small local company, Associative Measurement.

Amlab looks like any conventional computer, apart from one of the 5.25" floppy disc nacelles being replaced by a connection panel consisting of four input sockets, two output sockets and a multipin connector. But it is actually a higher integrated computer based instrument to measure, compute and record analog signals.

Measurements are processed in real time, and the software package that comes with Amlab includes a set of icons which can be used to represent a task you wish to perform. The icons can represent a voltage source (power supply), current source, sine wave, square wave generator, filters, Fast Fourier Transform (FFT), etc. The tasks can be as simple as adding two signals together or as complicated as monitoring a patient's heart rate.

When the circuit is finished, a single click on the mouse changes the screen to the 'run display', where the results are displayed and can be measured, or they can be stored to disc for retrieval at a later date, or for export to an analysis package such as Excel or Lotus.

The perceived markets for the Amlab are the monitoring, recording and control of noise and vibration, bioscience and biophysical functions, mechanical and civil engineering transducers, and as a general laboratory measurement tool.

For further information circle 161 on the reader service coupon or contact Siemens Telecommunications Electronics, 885 Mountain Highway, Bayswater 3153; phone (03) 721 2509.

486 notebook with colour LCD

Toshiba has released a new notebook computer incorporating an advanced 486 microprocessor and a TFT colour LCD display into the Japanese market.

The new V486 is the latest addition to Toshibâ's popular Dynabook series of 32-bit notebook computers. Equipped with an i486 SX microprocessor running at 16MHz, it provides almost twice the processing speed offered by 386 notebook computers. The 8.4" high definition TFT colour LCD display offers VGA compatibility and a 640 x 480 pixel resolution, and can display up to 256

colours at the same time from a palette of 180,000 colours.

Four megabytes of main memory is standard, allowing full use of Windows 3.0's multi-tasking capabilities. Optional memory cards allow upgrades to 12MB.

Data storage is provided by an 80MB removable hard disk drive and a 3.5" 1.44MB floppy disk drive.

Cross assemblers

JED Microprocessors has available a wide range of low cost development software for a wide range of microprocessors.

There are three products in the family:

PseudoSam, cross-assemblers for a group for 21 different microprocessors; PseudoMax, cross-simulators for most of the range; and PseudoSid, cross-disassemblers for each device. The software runs on IBM compatible PCs with standard peripherals.

The Cross-assemblers conform to a common syntax based on the UNIX V assembler. The opcode and addressing syntax is, however, compatible with the processor manufacturer's syntax. They generate absolute hex files (Intel or Motorola) in a form suitable for PROM or downloading.

The Cross-simulators allow testing of the program even before the hardware exists. Each byte of the target memory has its own attribute byte to control functions such as memory mapped I/O, writeability and breakpoints.

The Cross-disassembler family can take an object file and, using a definition file, can create a source file with comments and code, data and ASCII areas identified. (The recreated code is compatible with the cross-assembler).

Cross-assemblers are $90 each; the other products are $180 each. A Developer's pack (all three products) is $360.

For further information circle 163 on the reader service coupon or contact JED Microprocessors, PO Box 30, Boronia 3155; phone (03) 762 3588.

Low cost fax modem

Avtek Data Communications has released the PC MegaData Fax Model, with a recommended retail price of $299. The modem can communicate with any Group III facsimile machine at user selectable speeds up to 9600bps, with automatic fallback to 7200, 4800 or 2400bps. In addition, the modem can communicate at data speeds of 2400bps with fallback to 1200bps.

The PC MegaData Fax Modem is compatible with CCITT and Bell standards. This full duplex modem also incor-

porates, auto dial, auto answer and auto disconnect for fast and efficient data transmission. In addition, the modem comes complete with a copy of AutoSoft communications fotware, as well as PC FAX System software.

For further information circle 164 on the readers service coupon or contact Avtek Electronics, 25 Paul Street North, North Ryde 2113; phone (02) 888 5533.

360dip from 24-pin dot matrix printer

The multi-font Star LC24-20 dot matrix printer produces high-resolution output of 360dpi from its 24-pin printhead. It also comes equipped with 11 resident print fonts (two draft fonts and nine letter quality fonts), allowing users to produce high quality, flexible output.

A further eight optional font cards provide 24 additional fonts (three of them super letter quality fonts for near laser quality output). Its draft print speed is 240 char/sec, while letter quality output is at up to 80 char/sec.

Another useful feature is Star's Automatic Emulation Change (AEC) mode; users don't have to reset the printer'd DIP switches every time they move from one software program to another — the printer automatically makes the necessary adjustments. The LC24-20's Electronic Dip Switch mode simplifies any changes even further.

The printer emulates Epson and IBM standards, as well as NEC graphics commands. Memory is a standard 16KB, expandable to 48KB as a print buffer or downloadable font area.

It also features both parallel and Centronics interfaces, with an optional serial-to-parallel converter. Mean time between failures has been rated at 50,000 hours, while the printhead is rated at 200 million strokes per pin.

The Star LC24-20 printer has a recommended retail price of $675, excluding tax. For further information circle 169 on the reader service coupon or contact Star Micronics, 107-115 Asquith Street, Silverwater 2141; phone (02) 748 4300. ❖

A3 colour PostScript printer

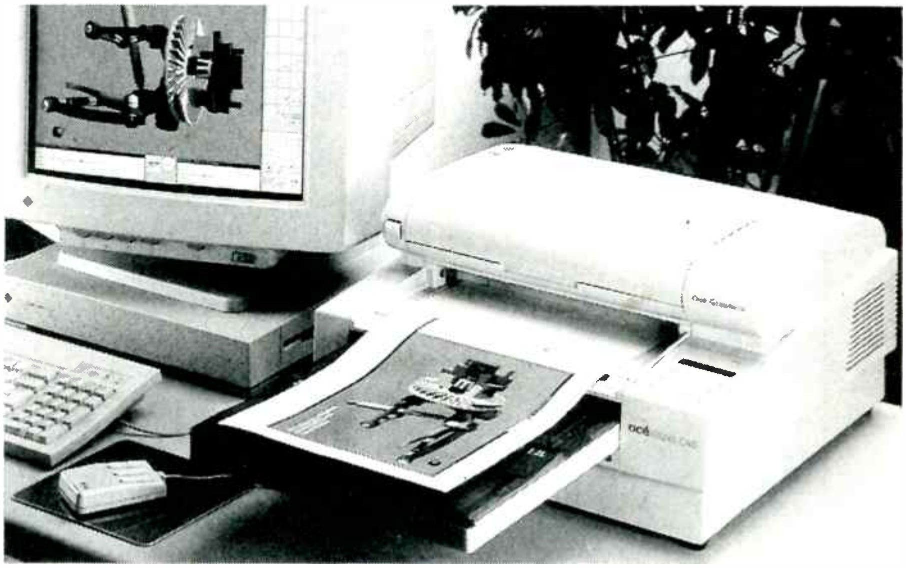
Oce Graphics' G5242-PS true Adobe PostScript colour printer provides a full A3 print size. This allows graphic designers and production artists to proof two page layouts, posters, and other designs at full scale.

The new printer is capable of producing a colour image of 297 x 434mm. Using a 300dpi colour thermal wax-transfer method, the G5242-PS produces Pantone-approved colour images and can print on both single sheet paper and overhead transparency film.

Driven by an Adobe-designed controller with 1.5MB of ROM and up to 16MB of RAM, the printer supports Apple LocalTalk, Centronics parallel, and RS-232/RS-423 serial interfaces.

Also included are the 35 industry standard Adobe outline typefaces. Off-the-shelf external hard disks connect to the printer's SCSI port, allowing for the downloading of large font libraries.

For further information circle 165 on the reader service coupon or contact Oce-Australia, 89 Tulip Street, Cheltenham 3192; phone (03) 581 1111.



EA DIRECTORY OF SUPPLIERS

Which of our many advertisers are most likely to be able to sell you that special component, instrument, kit or tool? It's not always easy to decide, because they can't advertise all of their product lines each month. Also some are wholesalers and don't sell to the public. The table below is published as a special service to EA readers, as a guide to the main products sold by our retail advertisers. For address information see the advertisements in this or other recent issues.

Supplier	State	A	B	C	D	E	F	G
Altronics	WA	●	●	●	●	●	●	●
Dick Smith Electronics	ALL	●	●	●	●	●	●	●
Emona Instruments	NSW						●	
Geoff Wood Electronics	NSW	●	●	●	●	●	●	
Jaycar Electronics	Eastern	●	●	●	●	●	●	●
Kalex	VIC			●				
RCS Radio	NSW			●				
Rod Irving Electronics	VIC	●	●	●	●	●	●	●
Scientific Devices	VIC						●	
TECS	VIC	●	●	●	●	●	●	●
Wagner Electronics	NSW		●		●	●	●	

KEY TO CODING:
- **A** Kits and modules
- **B** Tools
- **C** PC boards and supplies
- **D** Components
- **E** IC chips and semiconductors
- **F** Test and measuring instruments
- **G** Reference books

Note that the above list is based on our understanding of the products sold by the firms concerned. If there are any errors or omissions, please let us know.

Electronics Australia Reader Services

SUBSCRIPTIONS: All subscription enquiries should be directed to: Subscriptions Department, Federal Publishing Co, PO Box 199, Alexandria 2015; phone (02) 6939517.
BACK ISSUES: Available only until stocks are exhausted. Price A$7.50 which includes postage within Australia only. **OVERSEAS READERS SHOULD ADD A FURTHER A$2.50 FOR EVERY BACK ISSUE REQUIRED.**
PHOTOSTAT COPIES: When back issues are exhausted, photocopies of articles can be supplied. Price $7.50 per project or $15 where a project spreads over several issues.
PCB PATTERNS: High contrast, actual size transparencies for PCBs and front panels are available. Price is $5 for boards up to 100sq.cm, $10 for larger boards. Please specify negatives or positives.
PROJECT QUERIES: Advice on projects is limited to postal correspondence only and to projects less than five years old. Price $7.50.
Please note that we cannot undertake special research or advise on project modifications. Members of our technical staff are not available to discuss technical problems by telephone.
OTHER QUERIES: Technical queries outside the scope of 'Replies by Post', or submitted without fee, may be answered in the 'Information Centre' pages at the discretion of the Editor.
PAYMENT: Must be negotiable in Australia and payable to 'Electronics Australia'. Send cheque, money order or credit card number (American Express, Bankcard, Mastercard or Visa card), name and address (see form).
ADDRESS: Send all correspondence to: The Secretary, Electronics Australia, P.O. Box 199, Alexandria, NSW 2015.
PLEASE NOTE THAT WE ARE UNABLE TO SUPPLY BACK ISSUES, PHOTOCOPIES OR PCB ARTWORK OVER THE COUNTER.

METHOD OF PAYMENT: (Please circle correct method).

Credit Card: Cheque: Money Order: — Mastercard / American Express / Visa / Bankcard — Expiry Date: ....

|_|_|_|_| |_|_|_| |_|_|_|_| |_|_|_|_|_|_|

Name:...
Address:..
..................................Postcode:..............
Back Issues:..
....
....
Photostat Copies:...
....
....
....

No.of issues required:.....$7.50=..................
No.of copies required:.....$5.00=..................
No.of copies required:...$15.00=..................

Total Payment Enclosed $ ========

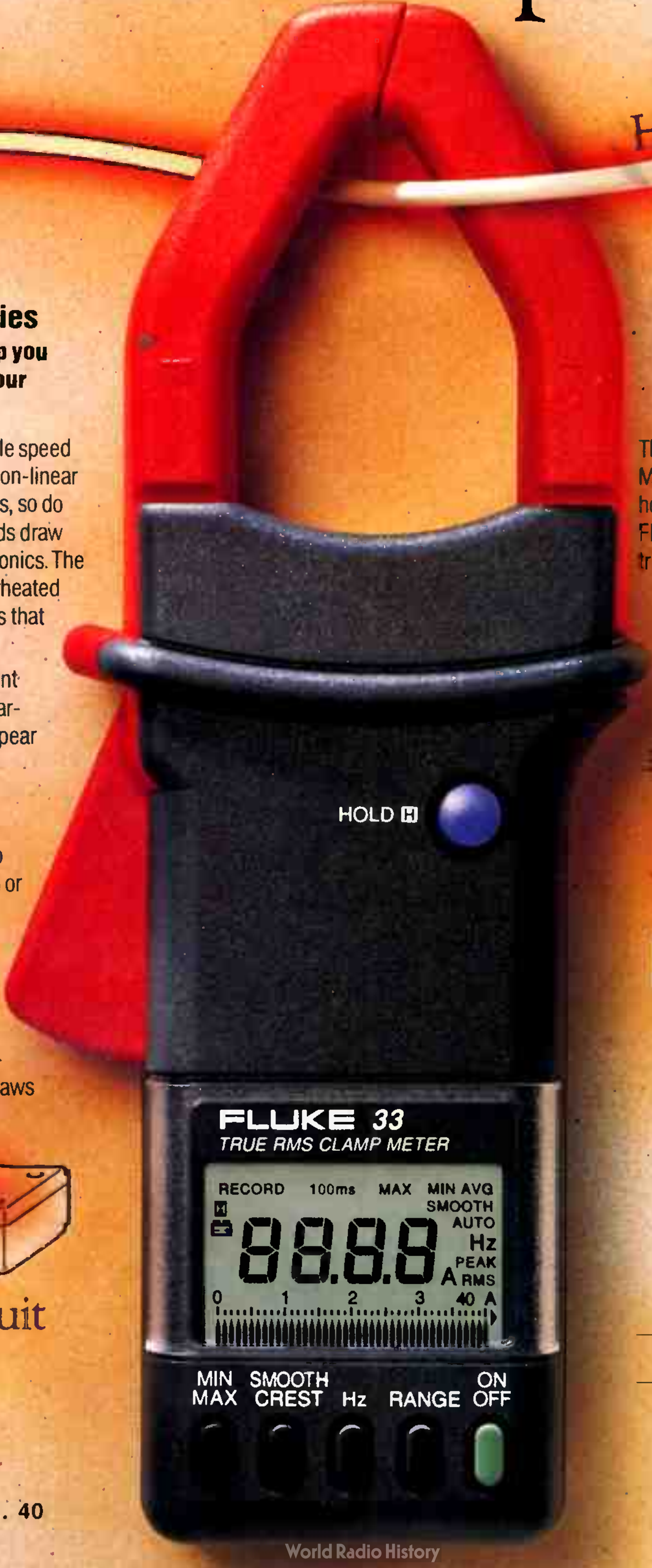
Signature:...
(Unsigned orders cannot be accepted).

ADVERTISING INDEX

This index is provided as an additional service. The publisher does not assume any liability for errors or omissions.

[illegible]

Get the true measure of your current problems.



Hot Neutral Wires

The new Fluke 30 Series Current Masters™ help you uncover the true cause of your current problems.

As personal computers, adjustable speed motor drives and other types of non-linear loads multiply in today's buildings, so do current problems. Non-linear loads draw peak currents which cause harmonics. The results are hot neutral wires, overheated transformers, and circuit breakers that trip for no apparent cause.

Traditional average sensing current clamps read inaccurately when harmonics are present. Readings appear normal, but may be as much as 50% low.

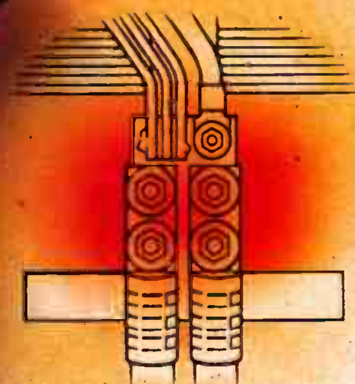
Fluke 30 Series Current Masters provide **true-rms** measurement, to accurately measure currents with or without harmonics up to 700A.

Both the Fluke 31 and 33 models measure frequency, have simple push-button controls for easy one handed operation, plus a full one-year warranty. And, their rugged, angular jaws let you pry into tight spaces.

Tripped Circuit Breakers

The Fluke 33 adds Crest, Smooth,™ and MIN/MAX/AVG recording. If things are heating up in your building, you need a Fluke 30 Series Current Master to get the true measure of your current problems.

Over-heated Transformers



For full details contact your local Fluke distributor or call Philips Test and Measurement on (02) 888 0416

FLUKE AND PHILIPS
THE T&M ALLIANCE

READER INFO NO. 40

FLUKE®