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Electronics Australia

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AUSTRALIAN PUBLICATION

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SEPTEMBER 1992

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FLEXIBLE NEW DESIGN FOR A HIFI STEREO AMPLIFIER USING VALVES

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BUILD OUR NEW ECONOMY VHF-UHF SPECTRUM ANALYSER/RECEIVER

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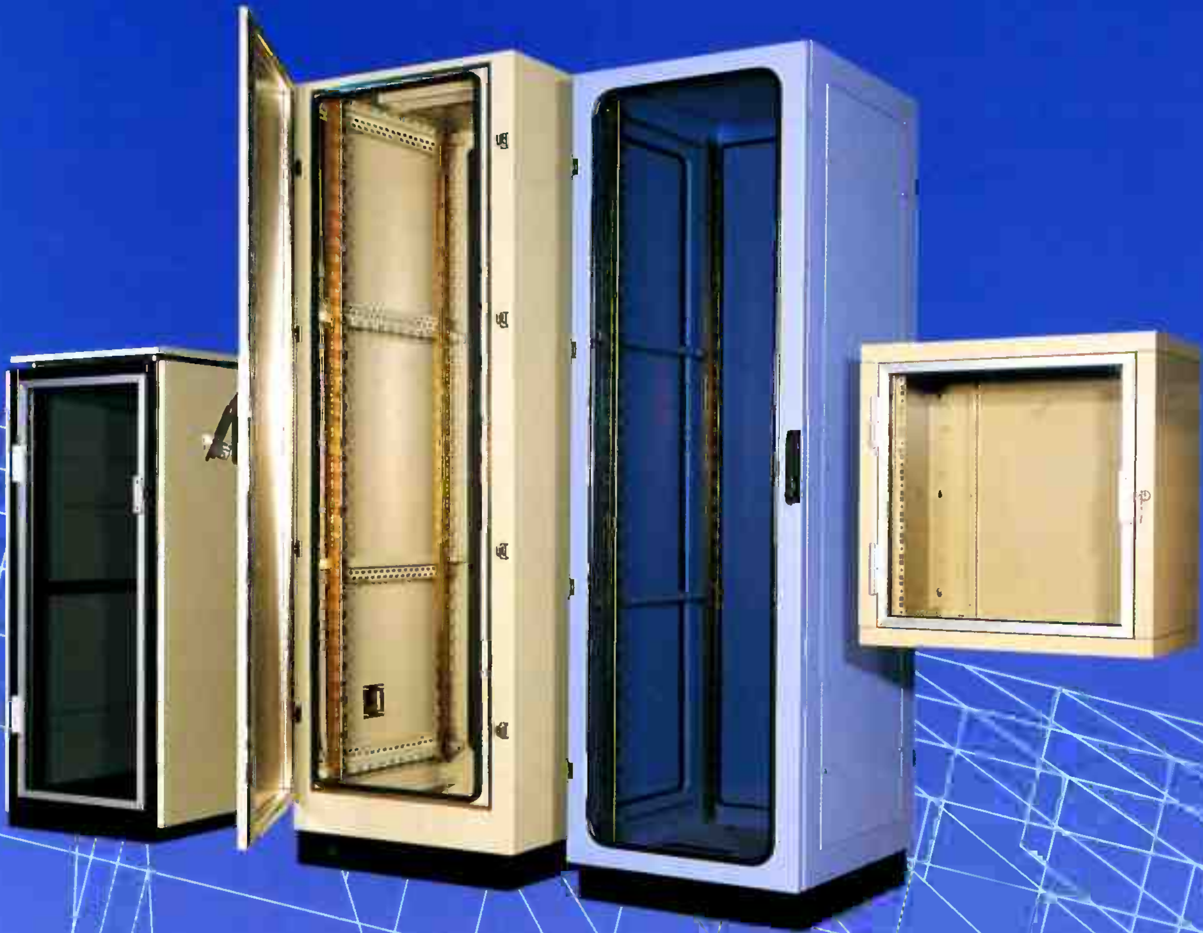

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READER INFO NO. 1

Volume 54, No.9

Electronics Australia eti

September 1992

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Authentic, but updated:

It's not easy to build a valve-type hifi amplifier nowadays — apart from the valves themselves, many of the other parts are either hard to find, or surprisingly expensive. But Melbourne engineer Tean Tan accepted the challenge, and has come up with both a modern high performance design, and a reasonably priced kit. The first of two articles presenting his 'old but new' amplifier starts on page 34. It's an excellent way to find out how 'valve sound' really sounds!

Digital cellular radio

Australia's AOTC is currently trying out European GSM digital cellular radio technology. Robert Owen explains what's involved, in his article starting on page 128...

On the cover

The Audio Design/Micromega Professional Solo-R is one of the first CD recorders to reach our shores. Louis Challis was able to review one this month, and his report begins on page 12 (Photo by Anthony Wolff). Also shown is our new Spectrum Analyser project (Photo by Kevin Ling).

Video and Audio

Features

Projects and Technical

Professional Electronics

Columns and Comments

Departments

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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
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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 by Federal Publishing Company, which is owned by 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

Postage, etc.

I refer to the letter from Peter Crowcroft PhD, in the May edition of *EA*, and his comments regarding your January editorial on the matter of increasing postage rates and *EA's* future viability.

No one could argue against Peter Crowcroft's assertion that Australian business is crippled by a failing infrastructure and the high costs imposed by successive governments. In fact, Australian governments collect a much higher proportion of revenue from tax on incomes and profits. Australia's proportion (57.3%) puts Australia in a minority of countries, with Denmark, Finland and New Zealand, to collect more than 50% of revenue from this source. Also, there is ample evidence to suggest that the economic policies of successive Australian governments are designed to drive a large proportion of business offshore, to satisfy the world trade policies of the OECD nations.

So Peter Crowcroft has surely missed the point of your editorial when he claims to have no sympathy for your concerns on future postage rates. I felt that the intent of your editorial was to express your desire to remain viable as a commercial publication and in doing so remain within Australian shores. In fact, there would be no impediment to *EA* to continue, or even expand its coverage of new technology in Asia or anywhere else in the world, while based in Australia. It's also ironical that in an attempt by *EA* to become more efficient by promoting subscriptions as against newsagency purchases, you have fallen foul of Australia Post's own efficiency drive in its removal of subsidies on Category B publications.

While Peter Crowcroft contends that *EA* shouldn't look to others for salvation, and I would contend certainly not from a government, I feel that *EA's* desire to remain unashamedly Australian, and not 'fly the coop' and become, for example, Electronics Asia, will be fully supported by readers. Such loyalty from readers could be seen as a reflection, in their opinions, as to the quality of *EA* as Australia's top selling electronics magazine.

Christopher Hankin,
Millicent, SA.

Comment: Thanks for your vote of support, Christopher.

Computer projects

I enjoy reading your magazine and the varied construction projects presented. I was delighted when I found a simple serial interface described last year. I would very much like to see many more projects for this interface, specifically (UHF distance measurement, speed sensing etc.) and computer projects in general.

For example, would it be possible to design a simple speech processor for an IBM compatible computer? I have an old schematic for one based on an SP0256-AL2 IC with MPS2907 PNP transistors — rather hard to find.

Would it be possible to connect a device like this to a port (say serial) as well as another device (the interface?).

Finally, would it be difficult to modify the interface to be connected to the computer via a non-cable link? I would also be very interested in any robotic-based projects (you could present a base project with the above ideas created/modified for a robot where the constructor could add which parts he/she chose, to the base).

EA is a great magazine and I enjoy reading every part — keep up with the projects!

Julian Lincoln,
Chapel Hill, Qld.

Comment: We'll see what we can do, Julian. Speech synthesiser chips are a little harder to get nowadays, and a digital recording/playback system may be a better proposition.

Pandora's box

Would it be possible to press whatever coloured buttons are required to put Mr Challis into 'Expand' mode?

In his May 1992 review of the new Philips 28" Matchline TV set, he states it 'epitomises the Pandora's Box of modern marketing'.

He then proceeds to outline some of the features found in this treasure-chest of technology, making it appear to be a veritable cornucopia overflowing with the fruits of achievement.

'The new Matchinline sets are clearly a significant departure and evolutionary advance... and all old TV sets (including those that I own) are now visually inferior', he writes.

As we all know (with the possible exception of your reviewer), when

[illegible]

Pandora's Box was opened all the ills of human life escaped, to punish mankind for the theft by Prometheus of heavenly fire. The only thing left in the box was Hope.

Is Louis Challis trying to tell readers this advanced design will be some kind of horrible affliction; some plague on owners, service personnel and business alike; perhaps their ultimate punishment for taming Fire stolen from the Gods? Or has he mistakenly plugged the wrong metaphor into the item reviewed?

Kevin R. Groom,
Oakleigh South, Vic.

Comment: Louis Challis advises that he hadn't intended his metaphor to be taken that deeply, Keith. Although the new Philips sets are in some ways a bit ahead of the available software, their performance and features are indeed very impressive.

Too expensive

After purchasing your magazine *Electronics Australia*, I would like to say on behalf of my friends and I that we find many of your projects are too expensive and far exceed our weekly allowance.

As we younger people (12 years) cannot make our own PCB's, could you possibly print a strip-board layout of the project? This would help enormously.

Hoping you may be able to assist us in some way.

Matthew Inman,
Narraweena, NSW

Comment: Sorry you find many of our projects too expensive, Matthew. We try to give a strip-board layout for our 'Exerimenting with Electronics' projects, and we'll try doing this with others, too!

Car stereo amp

Is it possible that you may be able to find or create for a future edition of *Electronics Australia*, an audio amplifier of a reasonable wattage, that runs off 12 volts DC?

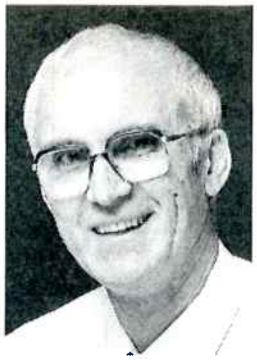
Are there any ICs that will deliver say 20 to 50 watts for remote/car battery type work, that are relatively easy to purchase, and assemble?

Thanks for a great magazine, and maybe even considering this suggestion?

Don Biggs,
Cartertown, NZ

Comment: We described a stereo design in the August/September 1985 issues, Don, delivering 50W per channel. Copies of the two articles are available from the Reader Information Service for A$10 posted. This design uses discrete components, but we're currently looking to see if there are IC's suitable for an amplifier of this type. ❖

EDITORIAL VIEWPOINT



Plenty to both read about — AND build — in this issue...

Hello again. I'm confident that you'll find plenty to keep you busy in this month's issue — wherever your electronics interests tend to lie. We've put a lot of effort into providing an issue that is jam-packed, with both feature stories to read and construction projects to build.

In terms of features, we have a special report by Tom King on the way satellite TV is really taking off in the countries to Australia's north and north-west. When you read it, I suspect that like me you'll begin to wonder if Australia is likely to be 'left behind' by our Asian neighbours, in this dramatically developing new technology.

There's also an interesting story by Barrie Smith, on Apple's new *QuickTime* software for editing and assembling real-time video and audio on the Macintosh. I believe this gives a good insight into the way computer technology and video/TV are coming together more and more, as we move inexorably towards a new era of fully digital recording, transmission and presentation of moving images.

Other features I can recommend include Robert Owen's introduction to the GSM system for digital cellular radio (now being trialled by AOTC), Neville Williams' first article describing the intriguing career of Tasma co-founder Fred Thom, and Louis Challis' review of one of the first of the new CD recorders to reach our shores.

There's plenty of good reading, then. But if you're more of a builder than a reader, we also have some really interesting construction projects. For example we've had a surprising number of people asking if we could publish the design for a high quality stereo amplifier using VALVES — so this month Melbourne engineer Tean Tan presents the circuit description of his flexible new 'Stereo Eighty' design, which combines many of the features of the best valve era amplifiers, with modern circuit techniques. Mr Tan has even lined up all of the components needed to build his design, so that building one shouldn't present any hassles...

At long last, yours truly has also been able to complete a design I've been working on for some time: an easy to build and low-cost spectrum analyser project, which converts almost any standard 'scope into a VHF/UHF spectrum analyser of quite surprisingly high performance. As an added bonus it even doubles as a wideband FM receiver, allowing you to identify many of the 'blips' you find on the screen. In short, I believe it's turned out to be a particularly satisfying and useful instrument.

We also have the second part of Arthur Spring's description of his Audio Sweeper; a simple 'executive decision maker' project; and Peter Murtagh presents a simple LED level meter circuit in his Experimenting With Electronics series.

For those who want to update their theory, we also have the first of a short series of articles written by Marconi engineers on the design and use of modern RF signal generators. In response to many requests, I've also decided to begin updating and re-presenting my 'Fundamentals of Solid State' series, dealing with the operation and use of semiconductor devices — so we're now starting to run this too, interleaved with our existing Basic Electronics and Basics of Radio series. There's all this and more, inside, so I trust no one can claim they're not getting their money's worth!

Jim Rowe

[illegible]

What's New in VIDEO and AUDIO

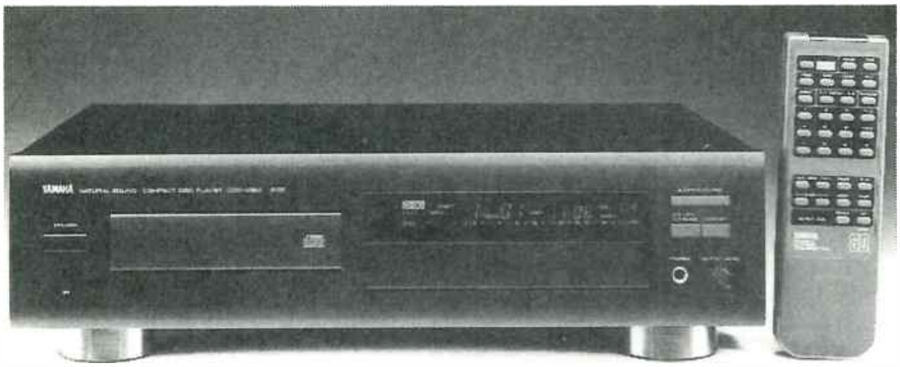
Sony camcorder has wobble correction

Sony has joined the ranks of camcorder manufacturers offering a model with automatic compensation for 'wobble' due to unsteadiness of the user's hand and arm. However not surprisingly, the firm has taken a different approach from the techniques used by Matsushita (Panasonic) and Mitsubishi, and one which is claimed to involve significantly less degradation of picture resolution.

The new CCD-TR900 Handycam is very similar to the existing CCD-TR105, but incorporates a special 'flexible prism' in the optical path. A pair of piezo-electric gyros are used to sense camera movement, and microcomputer-controlled circuitry drives a pair of actuators to vary the shape of the 'prism', to introduce an optical image shift of the same amplitude, but opposite in direction. This effectively cancels out the wobble, and provides a steady image without any resolution loss.

The prism consists of two optically-flat glass plates, separated by a bellows system filled with a special silicone-based oil having a refractive index very close to that of the glass.

The system is said to be capable of correcting wobble of up to +/-1.5° in both directions — equivalent to +/-45% of the image vertically and +/-33% horizontally, with the camera's lens at maximum zoom (x10). The complete wobble correction subsystem requires only 400mW of power, about 6% of total camcorder consumption.



CD player offers lower noise, distortion

Yamaha has introduced its 'second generation' S-bit Plus technology flagship CD player, which is claimed to provide more natural music reproduction. The new player, designated CDX-1060, also demonstrates better dynamic range and signal-to-noise figures never before available from single-bit models.

S-bit Plus is the name Yamaha has given to a group of enhancements to the company's single-bit digital-to-analog conversion system. The enhanced technology yields audible improvements, according to Yamaha engineers. Low level linearity and low level signal purity are both improved. High frequency response is cleaner which results in better defined harmonics, more ambient information, and a more defined sound stage.

The CDX-1060 employs second generation refinements to Yamaha's S-bit Plus which yield measurable and audible improvements and produce more natural sounding music reproduction. The signal-to-noise ratio has been increased to 120dB and the harmonic distortion reduced to 0.001%.

At the heart of S-bit Plus is a proprietary digital-to-analog converter, developed by the company's engineers. The I-PDM (Independent Pulse Density Modulation), DAC is said to reproduce pulse waveforms more precisely than previously available converters, by using multiple fixed-pulses to define amplitude rather than attempting to reproduce variable-width pulses.

S-bit Plus also incorporates second order noise shaping and an 8-times oversampling 20-bit digital filter. Second order noise shaping is used rather than 3rd or 4th, because it is said to provide optimum tonality in conjunction with the 17MHz master clock. The CDX-1060 employs massive 5th order passive low-pass filters which also operate together with the noise shaping to improve linearity and further refine realistic and natural sound quality.

Passive camcorder steadying system

The Flow-Motion Grip from SRB Film Services is a passive steadying system for camcorders, similar in its operation to the well-known professional products made in the USA. It was shown in prototype form at the recent Video Show in London, where it created considerable interest.

The Flow-Motion unit involves a ball and socket joint fixed to the camcorder's tripod socket, with a handgrip and a tripod balancing system using sliding counterweights. It is expected to be available in Australia shortly for under $500.

Further information is available from SRB representatives VideoCam Accessories, of PO Box 2000, Strawberry Hills 2012; phone (02) 698 1470.

PAL Laser Disc Association formed

Local Laserdisc hardware and software suppliers have formed The PAL Laser Disc Association of Australia, to promote the growth and development of this new area of home audio-visual entertainment.

Hardware members of the new association include Sony, Pioneer, Yamaha, Philips, Mitsubishi, Samsung and Sharp. Software members include Polygram, Sony Music, Warner Music Vision, Capital Media and Columbia Tristar Hoyts Home Video.

The PLDAA is planning to lift awareness of PAL hardware and software among retailers, and also boost customer awareness by means of a point-of-sale display. A 90-second promotional 'spot' will also be produced, and added to the front of videotapes released by Columbia Tristar Hoyts, First Release Home Entertainment and Video Box Office.

Amstrad predicts $399 satellite systems

Amstrad, which claims to be Europe's top-selling supplier of satellite television receivers and decoders, has announced that it expects to be able to sell Australian Pay TV subscribers complete satellite dish, satellite receiver and decoder packages for as little as $399(rrp).

This compares with estimates of $799 and $899 from other manufacturers.

Amstrad expects to market:

* Satellite dish, receiver and decoder packages, able to be used with any current (PAL) television receiver.
* 'Twin LNB' satellite antennae — unique to Amstrad — which will allow consumers to watch two satellite channels (from the same or even different satellite broadcasting companies) on different TVs using only one satellite dish.
* Combination videos and satellite receivers/decoders, costing much less than the two separate items.
* Combination television receivers and satellite receivers/decoders, offering the same benefit.

Amstrad's satellite receiving dishes will be manufactured in Australia. Arrangements are being discussed with two major Australian manufacturers, and Amstrad says it is developing a new type of satellite dish designed to extend resistance to Australia's harsh UV light.

Amstrad Australia's managing director, Mr Bordan Tkachuk, said that Amstrad was confident its satellite TV products would prove as popular in Australia as they had in Europe, where Amstrad dominates the markets with 80% of UK sales and 40% of other European sales.

In announcing Amstrad's plans, Mr Tkachuk also called for immediate resolution of 'the one really big unresolved technical issue for Australian Pay TV': whether the six satellite channels will all use the same 'encryption' system, and whether the standard will be the conventional PAL system already used for Australian broadcast television, the newer D2-MAC system used for satellite TV in parts of Europe, or the digital compression system — which is not yet technically viable, but which would give many more satellite TV channels.

Mr Tkachuk commented, "It would be utterly crazy for different standards to be used by the different satellite TV licensees. A clear decision is needed immediately, to eliminate the current confusion".

"If we don't make the decision quickly, and we keep waiting for the promises of new technologies just over the horizon, Pay TV in Australia will never actually happen. We are already the last western nation to get Pay TV. It's time for the backroom people to stop the frantic lobbying and politicking and bite the bullet. Digital compression is at least two or three years away from being a practical option. At present, it's just a gleam in the scientists' eyes. So the choice really comes down to PAL or D2-MAC."

"Although Amstrad is ready to go tomorrow with either PAL or D2-MAC, as we already have both types of products, we strongly believe the Australian consumer would be best served by adopting the PAL system as a uniform encryption standard."

"The guiding principle should be to give consumers what they want, not what the manufacturers decide is best for themselves."

"Some manufacturers want D2-MAC because this would give them a chance to 'on-sell' expensive new 'high-definition' (HD) and 'wide screen' televisions, which currently cost around $7000, to replace current PAL television sets. This is putting the manufacturers ahead of the consumer."

"Not only would D2-MAC cost consumers much more, and bring no benefits to the vast majority of the population, it would greatly reduce the commercial viability of the satellite TV licensees, who will need very large numbers of subscribers." ❖

New models for B&W 800 speakers

B&W's Matrix 800 series has grown to include three new models. Although less costly than their well-respected forebears, most of the ingredients responsible for establishing B&W's reputation remain intact.

All three models feature a matrix enclosure, with a criss-cross network of internal cabinet bracing which ensures that the unwanted cabinet resonances found in conventional speaker cabinets are successfully suppressed. The woven Kevlar midrange/bass driver unit successfully pioneered by B&W for many years is also used, to provide the finest, most transparent midrange response possible.

In the model 805 it also carries the full spectrum of bass frequencies, whilst in the larger two models it is complimented by a dedicated bass driver. The latest version of the aluminium dome tweeter still features the nickel-cobalt magnet assembly and now includes magnetic-fluid cooling for improved transient response and power handling.

Common to all models is the individual tweeter housing on top of the main cabinet; this very distinctive practice ensures the best possible stereo imaging and improves phase characteristics compared to more conventional front baffle tweeter mounting. Also common to the new models is a new close-tolerance high performance crossover network, which uses the bare minimum of components to reduce crossover network losses. Spiked feet and gold plated bi-wireable inputs are also standard.

The 805 is the smallest of B&W's 800 series and comprises the 165mm Kevlar/mid bass drive and aluminium dome tweeter in a ported matrix enclosure. Designed for smaller domestic listening environments or for near-field monitoring in a variety of professional and studio applications, it is priced around $2800/pair.

Model 804 is a column-type floor standing loudspeaker with three individual drive units. In addition to the mid/bass and tweeter found in the 805 there is also a 165mm Cobex bass driver operating in a ported enclosured. Price around $4500/pair.

The larger and more imposing cabinet of the Model 803 houses two drive units in the same configuration as model 804 however, with greater cone size and motor assemblies to enhance power handling and bass extension. Price around $6000/pair.

B&W Loudspeaker products are distributed by Convoy International, of 400 Botany Road, Alexandria 2015.

Video & Audio: The computer revolution continues

MOVIES ON THE MAC, WITH APPLE'S 'QUICKTIME'

A revolution is taking place, in the processing of moving images and their related sound tracks. Conventional film and videotape are slowly but surely being replaced by digital storage and processing systems, and even personal computers like the Apple Macintosh are fast developing 'multimedia' capabilities.

by BARRIE SMITH

In recent years, computer magazines have devoted much space to the rise of 'desktop video' or 'multimedia'. It's an interesting development for many of us who have grown up with 35mm film, Cinemascope, then Panavision and then lived, or worked, through the audio-visual (AV) revolution — viewing presentations produced with batteries of 35mm and 6 x 6cm projectors, synchronised with high quality multi-track sound.

In many ways we can fairly say we've witnessed the 'gold standard' in terms of picture and sound quality, so we are surely in a good position to judge the new technology.

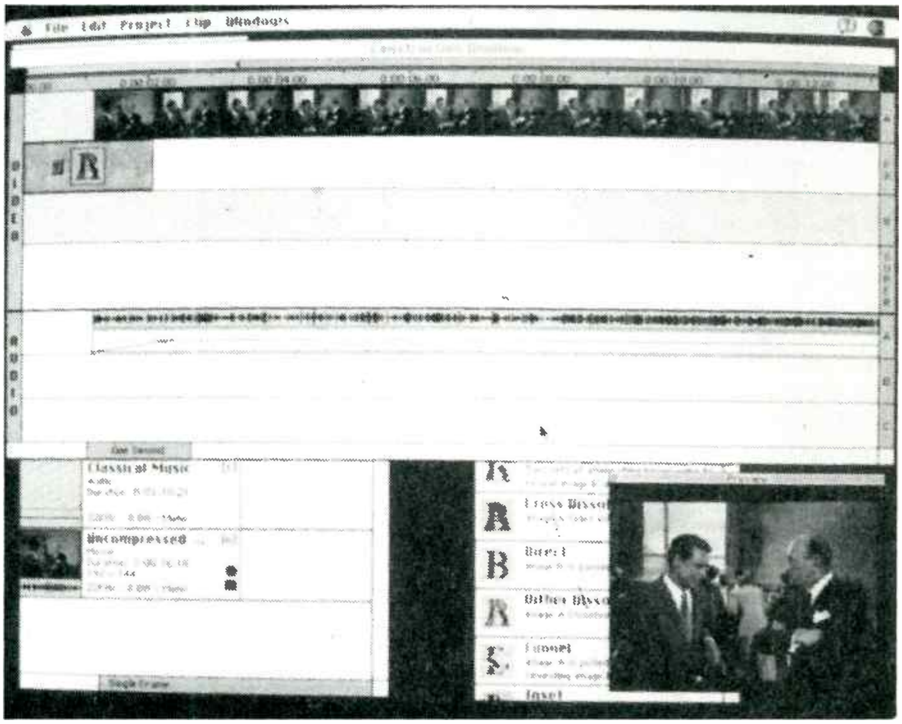
Currently, most business AV's are produced and exhibited via computer hardware and software. Unfortunately, the quality of image and sound of these presentations are still 'desktop' in quality and far being from 'multi' in terms of scope, they are still at a level that can best be described as 'minimal'.

However, it was much the same when the Macintosh appeared in late 1984, and turned the arena of conventional publishing on its ear.

Sure, the quality and style of early desktop publishing was, in many cases, woeful — due mainly to a shortage of software and limitations in the power of hardware to handle it.

But things soon improved, and now desktop publishing is a major industry, which is radically changing conventional publishing.

Moving right along, Apple Inc has now delivered to the computer community an operating system extension called *QuickTime*, which will undoubtedly cause the same kind of revolution in the processing of moving images and their related sound tracks.



Work window in Adobe Premiere — a QuickTime application. Assembly of scenes is shown in top 'Video' section. 'Out' or final frame of scene 1 is shown at bottom left; incoming or first frame of scene 2 is shown at bottom right. Note that the sound track display (shown in 'Audio') is synchronised with video sequence. The short diagonal line shown beneath start of audio display indicates fade in.

At this stage you can access the brilliance of this software only via a Macintosh — any Mac from an LC upwards (with 68020, -30 and -40 chips), and 4MB of RAM plus a hard drive of at least 80MB capacity. It is understood that *QuickTime* will be ported over to the IBM world sometime this year. But don't hold your breath!

The first Australian public showing of *QuickTime* was in November, 1991. In its most basic deployment a demonstrator typed a few words on the Mac II, using *WordPerfect* word processing software. He then picked up a video camcorder — plus a member of the audience — and moved outside to shoot a short video clip of the latter.

Returning to the auditorium, he dumped the freshly shot clip into an on-

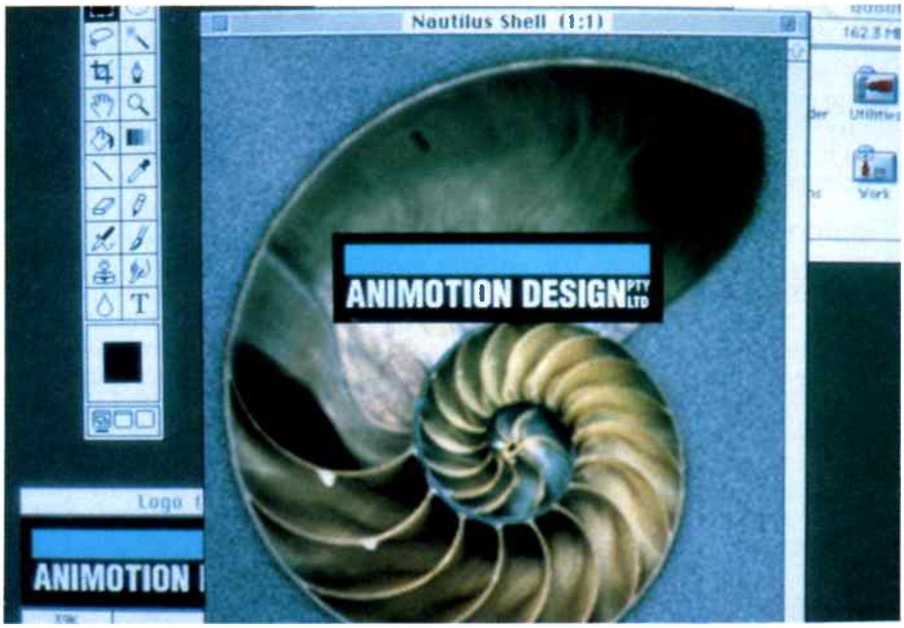


Image retouching software — such as Macintosh Adobe Photo Shop — can be used to retouch individual frames of video sequences.

screen letter; what the screen showed was the page or two of text, tailed by a still frame of the audience member. A quick double click on the image — and up came our friend in colour, talking and moving...

Video editing

One of the most interesting Sydney demonstrations was by Bruce Peak, engineering team leader on Apple's *QuickTime* project in Cupertino, California. Bruce used a CD-V disc of the movie *Terminator 2*, and showed how he could select short scenes from the movie, plus snatches of sound and rearrange them for replay on a Macintosh screen. Video editing on the Macintosh!

It must be understood that *QuickTime* is not a software application in itself. Rather it is an extension to the operating system, which allows the manipulation of a series of images or frames and their timing and relationship to a sound track.

It can link in with existing image and sound processing applications like *HyperCard*, *Adobe PhotoShop*, word processors such as *WordPerfect* and MS *Word* 5.0, and even presentation tools such as *Aldus Persuasion*.

One of the first *QuickTime* applications to arrive on the scene was Adobe *Premiere* — from those wonderful people who gave us PostScript! Adobe *Premiere* is to movies what page-making software, such as *PageMaker*, *Quark Xpress* and *Ventura Publisher* are to the printed page.

Premiere has a flexible and intuitive interface, typical of the Mac domain. It is not a creator of still or moving images, but an assembler: it allows the combination of digitised video footage, audio tracks, still images and graphics into one unified presentation.

Clips can be arranged linearly, with cuts or transitions such as dissolves and page turns. You may superimpose a scene or graphic over another.

You may mix two selections of sound together. You can fix the sync point of the image to a specific frame or cue point of the sound track. Having done so, you can alter this sync at any time, simply by moving or stretching indicator bars across the screen.

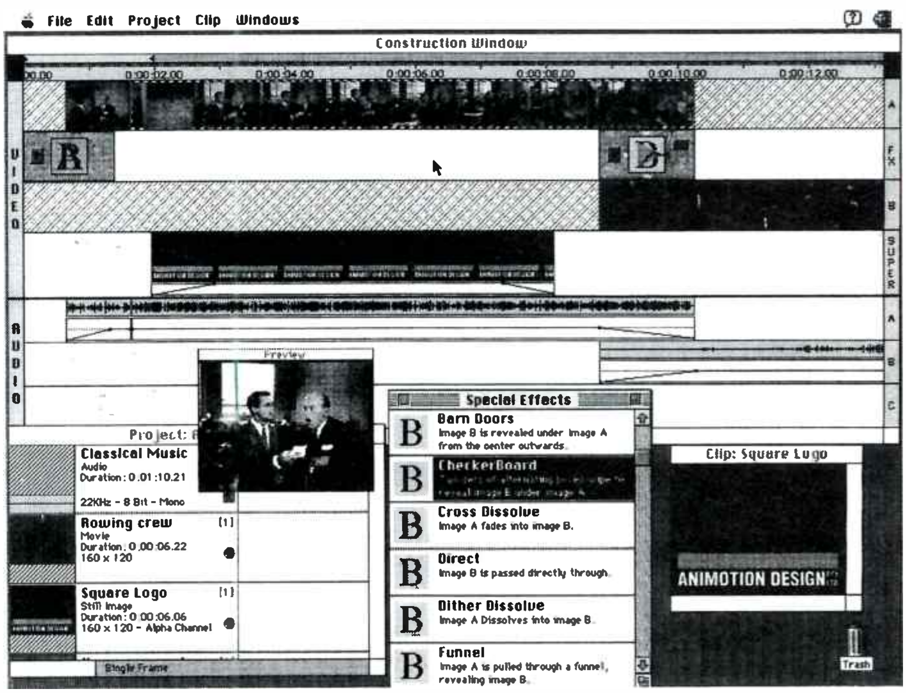
Want to duplicate a scene? No problem. Just select, copy and paste — just like working with word processing or page making software. The 'clips' are arranged in windows on the screen, supported by a display of time references, frame counts and audio cues. Sync can be achieved using SMPTE time code.

The output of the completed video footage can be made at any frame speed up to 25fps in PAL (or 30fps in NTSC) — with the only limitation being the processing speed of the computer platform itself.

Speed vs size

If all sounds glorious about *QuickTime* up to this point, the bad news is that at present, to run full 24-bit colour vision and sound at 25fps out to a video display device such as a monitor you have to endure a picture no larger than a quarter the whole display area. Enlarge the image to full screen and you'll view motion only at about 12 - 15fps.

To give you some idea of the size of the data involved, *Terminator 2* was transferred to a CD-V disc of 650MB capacity — about 75 minutes. A file of only 15 seconds of video and sound will occupy a 1.4MB floppy. The files are huge, and even with major compression techniques involved the tradeoffs are data size, versus image quality.



A screen dump made with Adobe Premier software, showing windows.

Movies on the Mac with 'QuickTime'

In *QuickTime*, Apple have incorporated a set of compression/decompression schemes that operate on still images, animation (or movement) and video.

The JPEG (Joint Photographic Experts Group) standard of compression has also been implemented, and is designed to compress colour images by factors of 10:1 to 25:1 with no visible picture degradation. Ratios up to 100:1 are possible, with acceptable but 'lossy' results. With the eternal and persistent limitations of hard drive storage capacity, the ability to compress a 25MB down to a very presentable 40KB is an attractive feature of the scheme.

To complement the JPEG operation, an animation compressor also operates on a series of motion frames, dropping data that may recur in successive images — say a portion of the scene that remains static.

The animation compressor can work in both 'lossy' or 'lossless' modes; the former loses some quality, but is fast enough for real-time playback.

QuickTime's compression algorithms look set to be the de-facto standard in image processing right across the industry. It is understood that Kodak is working closely with Apple in the development of its Photo-CD system.

Rapid growth

When *QuickTime* was first announced in the US in 1991, software developers very quickly saw the possibilities. By the beginning of this year, there were already over 100 applications on the market. As of May this year the figure had reached 220 — and it's still rising.

One impressive package is MacroMind's *ACTION!* This application allows relatively easy assembly of motion, sound, text and graphics, and permits synchronous interactivity with outboard hardware as well.

Another arrival is a collection of public domain video images to jazz up your productions: the variety ranges from space shots (ex NASA), animals, plants, people and weather. These can be used freely, and simply inserted by cutting, copying and pasting into your presentation.

Vision of the future

For this writer, having lived through a lifetime of working with silver images on 35mm EastmanColor, a *QuickTime* demonstration has to be viewed with some patience — and a sense of what the future holds. The vision is still tacky, the colours less than vivid, the motion often jerky. But there's no doubt that it's going to get there!

QuickTime will not in itself create a *Terminator 3*. Nor will it flash that exciting company presentation unaided onto the silver screen. But it will surely free up universal access to the assembly of full colour, full motion videos with multi-track sound — on the desktop, with no need for fancy AV editing equipment with costs approaching hundreds of thousands of dollars. Just a Mac — or an IBM/clone. Once that happens, as the technique becomes as widespread as desktop publishing, and the hardware catches up — then we may see computer-assembled movies of respectable quality, made on the desktop. But don't expect Panavision, at least for a while yet!

(Illustrations assembled and supplied by Animotion Design). ❖

READER INFO NO. 2

AUDIO DESIGN/MICROMEGA 'SOLO R' CD RECORDER

This month, Louis Challis had the unexpected opportunity to test (briefly) one of the new compact disc recorders. As we know there's a lot of interest in these devices, he postponed the product we'd previously lined up for review — so that we could provide you with this report as soon as possible.

Now that CD's have replaced the much loved (and oft hated) microgroove LP recordings, and the new DCC (Digital Compact Cassette) format tape cassettes are about to replace the conventional compact cassette, most of us have a short time in which to survey the topsy-turvy hifi market — which seems incapable of resting on its laurels.

Most of my readers will know by now that Sony is about to release its 'Mini Disc' format to compete with DCC, and that DAT (digital audio tape recording) has almost deliberately become a medium for professionals and super-serious amateurs, primarily because of the recording industry's reluctance (or should I suggest fear) of releasing pre-recorded DAT software.

From the moment that they were first released, CD's were viewed by both the public and the recording companies as a software medium that would not offer you (the public) the option of making your own recordings or copies (to the same or a similar format). But while that was true up to 1989, it was no longer so after that date — when the Taiyo Yuden Company of Japan announced their development of a *recordable* CD disc. This has created the means through which anybody with the right hardware and cash can produce or copy their own new individual or unique CD.

Of course the 'me too' syndrome is very compelling and consequently others soon followed, including TDK — which has released a similar product.

A recordable CD has an active side with a strange green hue, and is immediately identifiable from a conventional CD — which is normally shiny silver and is produced by a precision plastic moulding operation. This indents millions of tiny 'pits' into a polycarbonate substrate,

Measured Performance of the Audio Design/Micromega Solo R Compact Disc Recorder Serial No. RB 00427

1. Frequency Response 5Hz to 22.05kHz +/-.05dB

2. Linearity

Nominal Level	Original Disc	CDR	Copied Disc Data on Separate CD Player
0dB	0.0	0.0	0.0
-1.0	-1.0	-1.0	-1.0
-3.0	-3.0	-3.0	-3.0
-6.0	-6.0	-6.0	-6.0
-10.0	-10.0	-10.0	-10.0
-20.0	-20.0	-20.0	-20.0
-30.0	-30.0	-30.0	-30.0
-40.0	-40.0	-40.0	-40.0
-50.0	-49.9	-49.9	-49.8
-60.0	-59.9	-49.9	-59.8
-70.0	-69.8	-69.9	-69.8
-80.0	-80.2	-80.1	-80.3
-85.0	-85.1	-85.6	-85.2
-90.0	-89.6	-90.2	-90.1

3. Channel Separation

Frequency	Right into Left dB	Left into Right dB
100Hz	98	98
1kHz	94	96
10kHz	83	83
20kHz	79	79

4. Distortion (@ 1kHz)

Level	2nd Actual	3rd Actual	4th Actual	5th Actual	THD%
0	-	-112.0	-113.0	-111.5	.0007
-1.0	-105.0	-107.0	-108.0	-108.0	.0018
-3.0	-104.9	-104.2	-110.9	-100.8	.0024
-6.0	-105.0	-104.0	-107.0	-105.0	.0022
-10	-93.0	-101.0	-98.0	-100.1	.0054
-20	-84.0	-87.2	-88.1	-90.2	.018
-30	-75.1	-74.3	-78.0	-78.0	.063
-40	-67.0	-68.0	-70.0	-69.0	.15
-50	-60.1	-59.5	-64.0	-64.0	.33
-60	-50.0	-35.7	-50.6	-36.8	3.7
-70	-43.0	-32.0	-42.0	-40.0	5.0
-80	-34.9	-29.2	-35.5	-29.3	10.4
-90	-23.3	-26.7	-25.8	-30.9	19.0

5. Frequency Accuracy 19.9990kHz for 19.999kHz test signal.

coated with a thin layer of aluminium. Those minuscule pits, whose widths are approximately 0.5um and whose lengths range between 0.8 and 3um, have a height of only 0.13um.

After moulding and aluminisation the standard CD is protected by a further transparent layer of polycarbonate, and although better protected than your old vinyl LP discs, these discs are nonetheless still vulnerable to abuse. As many of you have by now discovered, they can also be disturbed by dirty finger mark contamination.

In order to achieve technical compatibility with the optical standards specified by Philips/Sony in the 'Red Book' of CD Performance Standards, the aluminium layer and overlying protective cover of polycarbonate must offer a 70% light reflectance for light with a wavelength of 7800 angstroms (780nm).

Taiyo Yuden's recordable disc achieves that reflectance figure by using a polycarbonate substitute on which a gold reflective layer was deposited — as the blue layer of solid dye required a little extra help to conform, notwithstanding the addition of a final outer protective layer of polycarbonate.

Of course all the subsequent manufacturers, the most notable being TDK, followed suit, and this of course makes it easier for both you and me to identify the recordable CD.

The recording technique that Taiyo Yuden developed was quite ingenious. They discovered that by using a much more powerful 'writing' laser beam, whose peak output power is between four and eight milliwatts (approximately 10 times greater than that which is normally used for a CD player), and by using a feedback system to carefully predetermine the appropriate power levels, then that beam could be focused directly on the dye layer.

This powerful and focused beam creates localised 'hot spots' in the dye, whose temperature would then rise to a controlled level — just above 250°C. The localised pressure then pushes the special dye outwards against the adjacent polycarbonate layer, distorting both it and the metallisation to create a 'pit'. Each of these localised distortions can then be detected by a normal CD player's low powered laser, working at a more conventional 0.3 - 0.5mW power output level, to read the encoded digital data.

Whilst all this sounds relatively easy, there is much more to it than meets the eye. Firstly, the high powered laser needs a little guidance to be able to form the correct spiral pattern on the disc. This is achieved by means of a pre-cut (or moulded) spiral groove, which is impressed on the reflective gold substrate even before the dye layer is added to the composite construction.

This groove is extremely important as it solves what would otherwise be a nasty problem. The groove ensures precise rotational speeds, as well as the correct spacing between the individual tracks, to ensure that the myriads of pits and lands which finally form the encoded data on the recorded CD may be read faultlessly.

The second set of complex problems to be solved involved conforming to the 'Red Book' standards which specify the basic data documentation to be recorded on any CD. Those standards have been subsequently added to and amended by the 'Yellow book', the first issue of the 'Orange Book', and more recently the second issue of the 'Orange Book', which has particular relevance in this situation.

Those requirements stipulate that all CD's have to include a *Table of Contents* (abbreviated to TOC) — as without a TOC, your conventional CD player won't even begin to play your disc.

This problem is readily resolved by leaving a dedicated blank section at the start of the recordable CD, on which the TOC can be subsequently recorded — either immediately after such recording, or if desired at some later stage.

With a recordable CD this TOC area is supplemented by another special desig-

[illegible]

nated band called the *Program Calibration Area* (PCAA), on which the CD recorder carries out controlled tests on each new blank recordable CD to determine the appropriate power level required to achieve optimum recording.

Over the last two years, a number of big names including Gotham of the USA, Yamaha and Kenwood from Japan, and Studer and Marantz (the Philips subsidiary) in Europe, have released CD recorders for professional use.

Currently there are at least five CD recorders in Sydney, with Studio 301 using a Sony system, Giant Productions with a Yamaha and Radio 2UW evaluating a Marantz. Other units are being reviewed by Turramurra Music (a Yamaha and other systems) and by Hutchison Keyboards. So it seems that the professional users are keen to adopt the new technology, provided it meets their needs and accepting the cost of the blank discs which are currently being supplied in ever-increasing quantities by both Taiyo Yuden and TDK Australia.

This particular aspect of the product is even more interesting. Taiyo Yuden is marketing conventional 12cm discs suitable for 74 minutes and 63 minutes, together with smaller 8cm discs suitable for 18 minutes of recording.

TDK Australia currently markets discs suitable for 63 minutes and 18 minutes of recording and seem to have about half the Australian market of 200 to 250 discs per month.

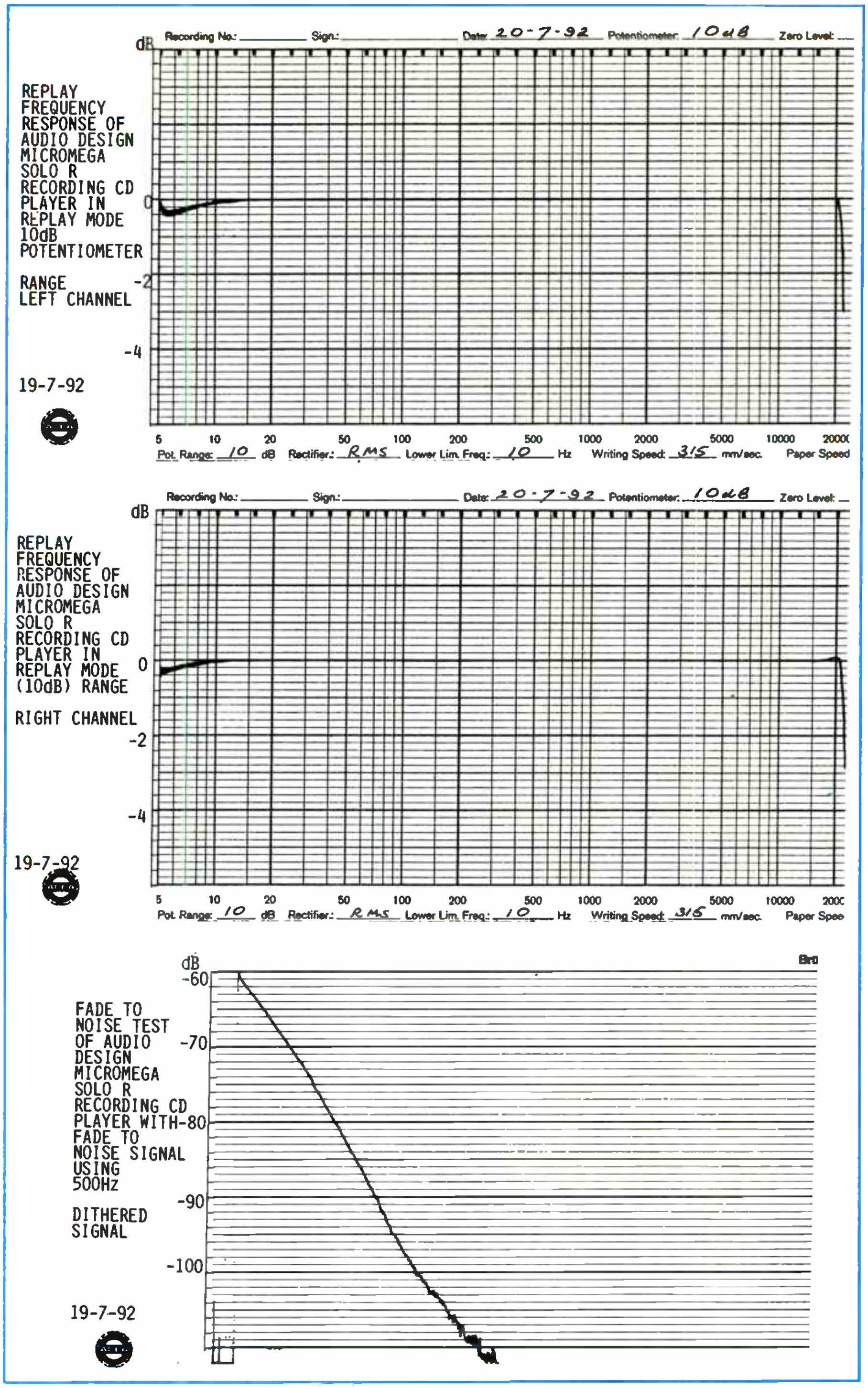
The larger discs sell for about $65 — so this is obviously not the way to illicitly copy that exciting CD you didn't want to buy! But even so, the recording companies are still worried about the threat.

Micromega's Solo R

The foregoing was about the extent of my knowledge of the subject and the market, when I was approached last week by David Wickert, the Australian Agent for Audio Design's Micromega Professional 'Solo R' CD recorder.

David realised that *Electronics Australia* wanted to evaluate a CD recorder, and promptly offered to 'drop one on my desk'. Naturally we accepted his offer, as it was an excellent opportunity to assess the performance of an exciting new machine — virtually all of whose critical technology has been developed by Philips, even though Philips as yet hasn't seen fit to market such equipment itself.

The Audio Design/Micromega Solo R Recorder is only slightly larger than the

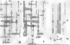


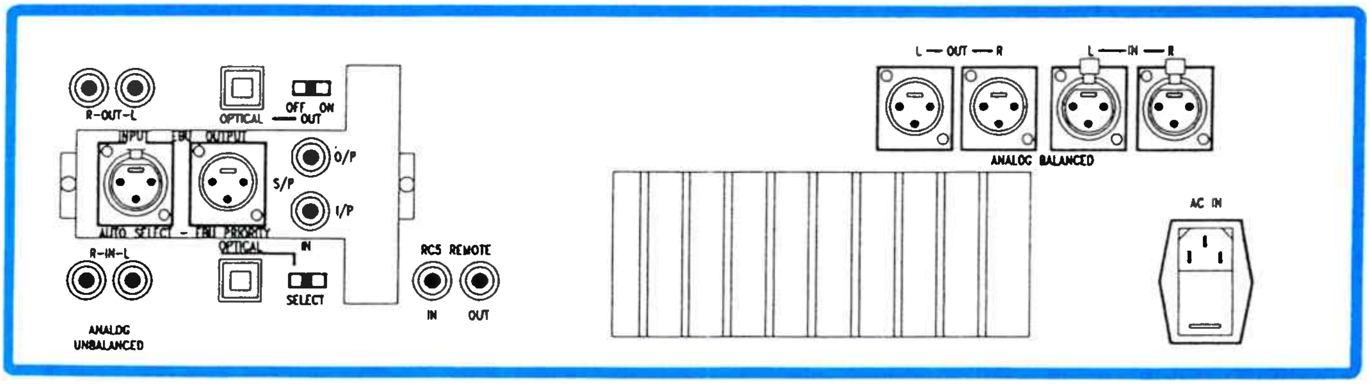
In the limited time available, these were the three main plots that Louis Challis could produce. The two upper plots show the replay frequency response for the left and right channels respectively. At bottom is the 'fade to noise' characteristic.

CD player I use at home; and yet, in spite of that, it's only 70% of the weight. But quite frankly, that is where the comparison begins and ends. The versatility of the Audio Design/Micromega Recorder is almost astounding.

The recorder has a front panel and superficial appearance which is just like many expensive CD players. The only obvious difference is a 'record' button and a few additional controls, whose functions are not immediately familiar.

The back panel is, if anything, more interesting than the front panel. It offers both balanced and unbalanced XLR sockets for analog inputs and outputs. These are supplemented by two 'tip-and-sleeve' microphone sockets. The inputs are connected to two separate 'bit stream' A/D converters, which offer the ability to per-





There wasn't time to take a photo of the CD recorder's rear panel, but this diagram from the manual shows the impressive array of input and output connectors. These include balanced analog inputs and outputs, and both electrical and optical digital inputs and outputs — plus conventional unbalanced analog output connectors.

form direct jitter-free recordings at line input level from switch selected microphones.

In addition to the analog inputs, there are both 75-ohm unbalanced digital inputs and outputs, and also balanced AES XLR digital inputs and outputs, which fulfil the critical connection functions free from earth loop problems. These are supplemented by an optical connection, and of course a mundane set of coaxial audio connections for the CD player's 'right' and 'left' channel outputs.

The recorder's functional controls may be further expanded by an optional 'Smart Box', which is a digital interface marketed by Audio Design and through which digital audio tape sub-code information is converted to a compatible format to conform to the differing requirements of the CD sub-code.

For those of you unfamiliar with DAT recording formats, each DAT tape at the time of original recording, or during subsequent mastering is provided with 'Start ID' and related ID's through which the track information and other fast spooling signals are identified by the DAT player. Similar (but inevitably different) data needs to be transferred to the CD recorder (CDR); but without the appropriate interface, this is not readily achieved. Thus the need for a 'Smart Box'.

Testing begins

David Wickert provided the CD recorder, and fortunately TDK made available sufficient numbers of blank CDs for us to record test signals as well as music, for a comprehensive evaluation of the Audio Design/Micromega CDR's capabilities.

The approach that I adopted was to record a range of digitally based test signals, selectively derived from the large number of CD test discs which I have purchased over the last 10 years. The vast bulk of that data relates to test signals on which precise reference levels have been encoded, to assess the linearity and total harmonic distortion of a CD player.

The earliest form of such data was selected on a simple numerical basis, which ignored the ability of a CD player to introduce quantisation problems through which false signals and unstable data could result. Some of the more recent test discs and their associated test data offers selective options in terms of 'dithered' signals, which at low levels ensure the appropriate detection of the appropriate signal level. It was interesting to note what differences such dithering provided in the assessment of both the record and replay characteristics of the Audio Design/ Micromega CDR.

As it happens, we didn't waste any time in starting our evaluation, and spent one whole day producing a test disc with both digital data and some equally important analog-derived data through which to evaluate the recorder's characteristics. The task was greatly simplified by the simple ergonomic control functions with which this recorder has been equipped; apart from a few inadvertently pushed buttons, everything went without a hitch.

The data written on the test disc was then examined differentially, by the simple strategy of measuring the signal on the original test discs on a separate Sony CDP 555ESD compact disc player, and then repeating the exercise with the test disc recorded on the CDR. For good measure, we also measured the characteristics of the test data on the original test disc on the CDR, to assess its digital to analog conversion characteristics.

What we found

The first thing that we discovered was that the digital to analog conversion linearity of the CDR is extremely *smooth* and *flat*, all the way down to -90dB — with a maximum deviation of only 0.6dB at -90dB. To my surprise, even changing to a dithered signal did not improve the conversion linearity.

Although the Sony CDP 555ESD CD player that I used for the comparison is of a slightly older generation, it achieved comparable results and comparable linearity of results over the primary 90dB assessment range.

I progressed to a 'fade to noise' test, with a dithered 500Hz signal which covers the -60dB to -110dB range — to provide a graphed signal through which the low level conversion linearity of the CD player section of the CDR may be rapidly and readily visually assessed. Not so surprisingly, the linearity down to 80dB is particularly smooth, while the linearity between -80dB and -100dB displays the same type of non-linearity characteristics that I had already detected in my measurements at -80dB , -85dB and -90dB, with even more marked non-linearity over the range -90dB to -100dB — at which point dithered or random noise tends to dominate the signal on the curve.

Viewed objectively, the replay linearity characteristics of the Audio Design/ Micromega CDR, although not perfect, are extremely impressive.

By the same token, the digital *encoding* characteristics of the CDR for the same test signals indicate that the maximum non-linearity that it introduces are immeasurable down to -70dB, with only 0.1dB error at -80dB and -85dB, and a 0.2dB error at -90dB.

It should be noted that there has been considerable commentary in the overseas press, suggesting that a well designed CDR should have the capabilities to reduce errors and non-uniformity of signal, compared with the original data encoded on a commercially recorded and manufactured CD.

This issue is of particular relevance to

those people who are considering purchasing such a device, as it augers well for their ability to provide recorded content which is at least comparable in terms of quality — and if the pundits in America and Europe are right, marginally superior quality.

The next series of measurements that I performed were to assess the *distortion* characteristics of the CDR when used in the conventional replay mode, i.e., as an ordinary CD player. Here I was gratified to note that the distortion levels at the top of the range (0dB to -10dB) are amongst the best that I have seen, whilst lower down the dynamic range the distortion characteristics generally either conform to, or are slightly better than the norm. Thus at -70dB the distortion is 5%; at -80dB, 10.4%; whilst at -90dB it's a salutary 19%. Considering that neither you nor I can readily hear the fundamental of a signal at -80db, -85dB, or -90dB, the harmonics of such a signal are of course either virtually or totally inaudible.

I progressed with my objective testing to review the analog to digital conversion accuracy of the CDR, and was not surprised to find that its A to D converters are not quite as linear as the D to A converters. Thus by way of example, once the signal reaches -45dB, I was able to measure at least -1dB of conversion nonlinearity, which would ultimately be detected by a sharp-eared listener by way of increased harmonic or intermodulation distortion.

Using the two tone IEC total difference frequency distortion measurement signals, I was able to both measure the conversion non-linearity and also the intermodulation products for decreasing signal inputs. The intermodulation distortion products are most certainly measurable, and in this respect I am sure, not greatly different to any other analog to digital conversion system.

The channel separation of the CDR in the replay mode is exceptionally good, with separations from left into right, and right into left channels, which are an exceptional 98dB at 100Hz, and still 70dB or better at all frequencies up to 20kHz.

The frequency accuracy of the CDR is particularly good, with a speed accuracy of .045% maximum error, which is quite acceptable.

Subjective testing

Whilst there were obviously other parameters which I could evaluate, time and luck were against me, and I progressed with a subjective evaluation of the CDR using some pre-recorded material which Sony Classical were kind enough to provide in DAT format for that purpose.

The first and foremost software that I used was a pre-recorded DAT tape which Sony Classical provided out of the USA, featuring Midori playing Paganini's *24 Caprices for Solo Violin Op.1* (SDJ44944). This was played through a Panasonic SV-3700 Professional DAT player, into the CDR via the Audio Design 'Smart Box' digital interface. This generated the appropriate CD 'Start ID' and 'Track ID' signal encoding, so that the disc that I produced would behave in precisely the same way as any pre- recorded CD would on my CD player.

Of course after we produced that disc, (and the previous test disc), we used the CDR's 'fix up' circuitry and controls to write the correct TOC information, according to Red Book standards. And *viola!* — I had produced a conventional CD, which apart from its visual appearance is in no way different or identifiable from any other normal CD.

The more pressing tests and evaluations followed thereafter. The first of these involved a comparison of the subjective differences between the DAT tape featuring Midori playing Paganini's *24 Caprices* (played through a Sony DTC1000ES DAT recorder) and the same material played from our recorded CD. I hate to admit it, but in A-B testing, we could not tell the difference (and we tried *very hard* to identify that difference).

I then followed with some conventional music, using the CDR as a conventional CD player. The first disc that I used in this evaluation was the Australian Chamber Orchestra playing selected *Sonatas and Adagios for Strings* by Jancek, Barber and Walton (Sony Masterworks SKJ48252). I had the good fortune to hear the Australian Chamber Orchestra live a little more than a week ago, and firmly believe that they are one of the most masterful and accomplished group of young musicians that I have had the pleasure to hear. Their performance on this particular disc is almost exemplary, and the CDR behaved in what I could best describe as an absolutely 'neutral conduit' for that music.

The last disc that I used for my evaluation was a somewhat unusual one featuring Yo-Yo Ma the famed cellist, with Bobby McFerrin who is renowned for his impersonations of instruments as well as other singers, and whose efforts on this particular disc (Sony Masterworks SK 48177) are if anything more exciting and novel than the other discs and pieces in which I have heard him previously perform. Again the CDR performed exceptionally well as a straight CD player, and its performance was in no way inferior to the comparison playing of a more conventional and somewhat less expensive CD player.

The bottom line

In summary, while I imagine that very few of my readers will rush out and purchase an Audio Design/Micromega Solo R CD Recorder, I have no doubt that those who do so will be amply rewarded for their expenditure — whether they be a professional audio engineer or a well-heeled amateur. As an audio recording device it will fulfil many of their wildest dreams, with an ease and a degree of operational panache that they would never have dreamt possible.

The Solo R measures 420 x 400 x 135mm, and weighs 10 kilograms. It carries a recommended retail price of $13,500.

Further information on both the Solo R CD recorder and the matching Smart Box is available from the Australian distributor for Audio Design, David Wickert of DW Productions, 6 Lombard Street, Balgowlah 2093; phone (02) 949 7781. ❖

[illegible]

ASIA EMBRACES SATELLITE TV

While satellite TV in Australia currently serves only remote locales and specialised outlets like pubs and the TAB, and the fate of our proposed pay TV system still seems to be on a wheel of fortune, Asians in increasing numbers are tuning in to 'TV signals from the sky'. Here's a report on much of the activity that is taking place in neighbouring countries to our north and north-west.

by THOMAS E. KING

From Bali to Bombay, Kyoto to Karachi and the Persian Gulf to the Gobi Desert, Asians are turning their attention to the cosmos. The reason is not some exotic astronomical event, but rather the arrival of a glistening state-of-the-art electronic 'star' — radiating a galaxy of entertainment and information.

Launched in April 1990, AsiaSat 1 is Asia's first privately financed regional satellite. It has made possible the progressive introduction of international standard, quality programming throughout 1991 by the pioneering Hong Kong-based STAR-TV, launching a new era in consumer entertainment. This man-made 'star' has not only changed how Asians watch television, but more importantly what they can watch.

No longer do the programme-hungry viewers of these countries have to be satisfied with limited hours of transmissions from a lack-lustre government controlled station, or be content with a single viewpoint on a controversial issue. They now have a real choice.

STAR TV (AsiaSat is at 105.5°E — roughly over Singapore) is beaming down that choice, with a selection of five diverse C-band channels, all on a 24-hour a day basis.

Available is an Asianised version of America's MTV music video channel, Music TV; Prime Sports, which relies heavily on the Denver-based Prime Network International for a world of sports; Star Plus, an entertainment channel featuring primarily British programming, from comedy to documentaries; and the BBC's World Service Television. In addition is a Mandarin channel, with appeal to expatriate Chinese living under the STAR's extended 'electronic blanket'.

While the various satellite signals from STAR TV spread across some 38 countries, from Egypt to Japan and Turkey to Indonesia, an area where there

Six satellite TV channels originate from the high-tech STAR TV headquarters in Hong Kong.

is a potential audience of nearly 2.8 billion viewers, the official reaction to this new era in direct broadcast satellite television is varied.

Anyone can install receiving equipment in Japan, Hong Kong, the Philippines and even India, a country where there is even a choice of equipment from local manufacturers.

India, Japan

In a short time, satellite TV has made a big impact in India. With an estimated 500,000 satellite-ready households and an approximate viewing audience of over two million individuals throughout the massive country, STAR TV is set to launch a multi-lingual channel in August. Programmes in Hindi, the national language of India will be broadcast in prime time in competition with the country's two existing land based channels.

Programming will also be in Japanese, Arabic, Bengali (a major language of eastern India) and Urdu. The language in which programmes will be telecast from Hong Kong will vary according to the time in the targeted country.

While the new multi-lingual STAR TV channel will beam Japanese language programming to the Land of the Rising Sun, it will be competing against three existing encrypted Pay TV satellite channels. Two carry programming originating from Japan's national broadcaster, NHK, while the third is owned by Japan Satellite Broadcasting. JSB's WOWOW channel transmits a mix of predominately US movies and sports to an ever-growing audience, turning on to Direct Broadcast Satellite TV (DBS). (See separate box.)

Japan already has the lion's share of world satellite receivers (85% of the estimated five million sets), but it's just the beginning. One prediction puts the number of satellite TV customers in the archipelago at 10 million by 1995. By then, it is forecast, Japan would have eight satellite TV channels. Some of these would carry HDTV (High Definition Television) signals.

In Japan, a potential satellite TV customer can choose from a number of dedicated receivers and dishes manufactured by many different companies. Equipment choice is somewhat more limited in Taiwan, Indonesia, Pakistan and Thailand, although a simple licensing procedure is only required for installing satellite TV receiving equipment.

And then there's Singapore, Malaysia and Brunei Darussalam, which are more guarded in their approach to allowing the free flow of satellite news, views and entertainment. Singapore, for example, prohibits the private use of satellite receiving equipment — although last year permission was given to some financial houses and certain businesses for satellite TV receiving setups.

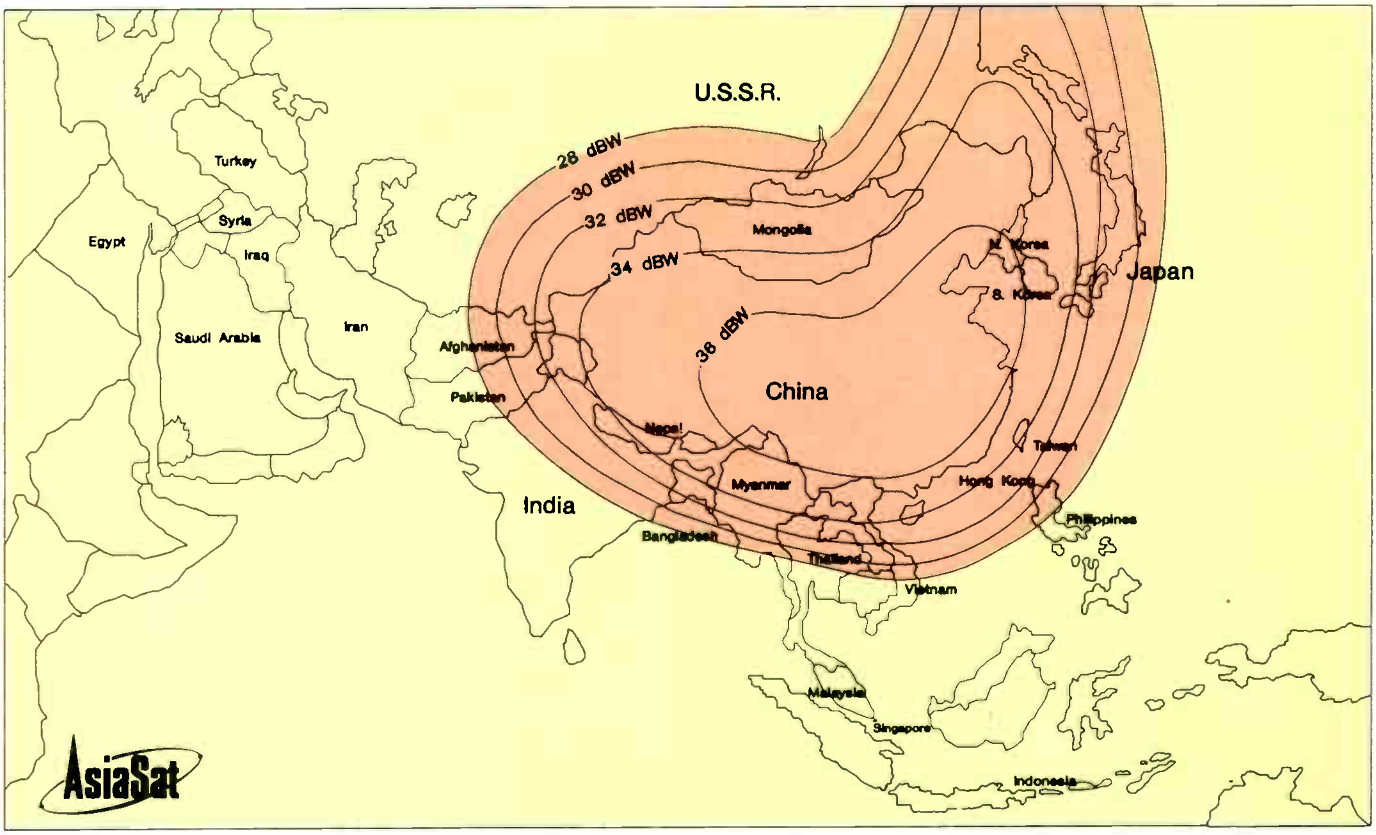
Of course, the recent introduction of a subscription-based TV service has put Singapore virtually on par with many countries in Asia. Malaysia and Brunei Darussalam have yet to catch up, as private satellite receiving equipment is prohibited except for royalty, the government and foreign diplomatic missions.

It's not surprising that the one-billion-plus mainland Chinese aren't permitted access to satellite TV services from foreign lands. Ironically, though, programmes in Mandarin — beamed by

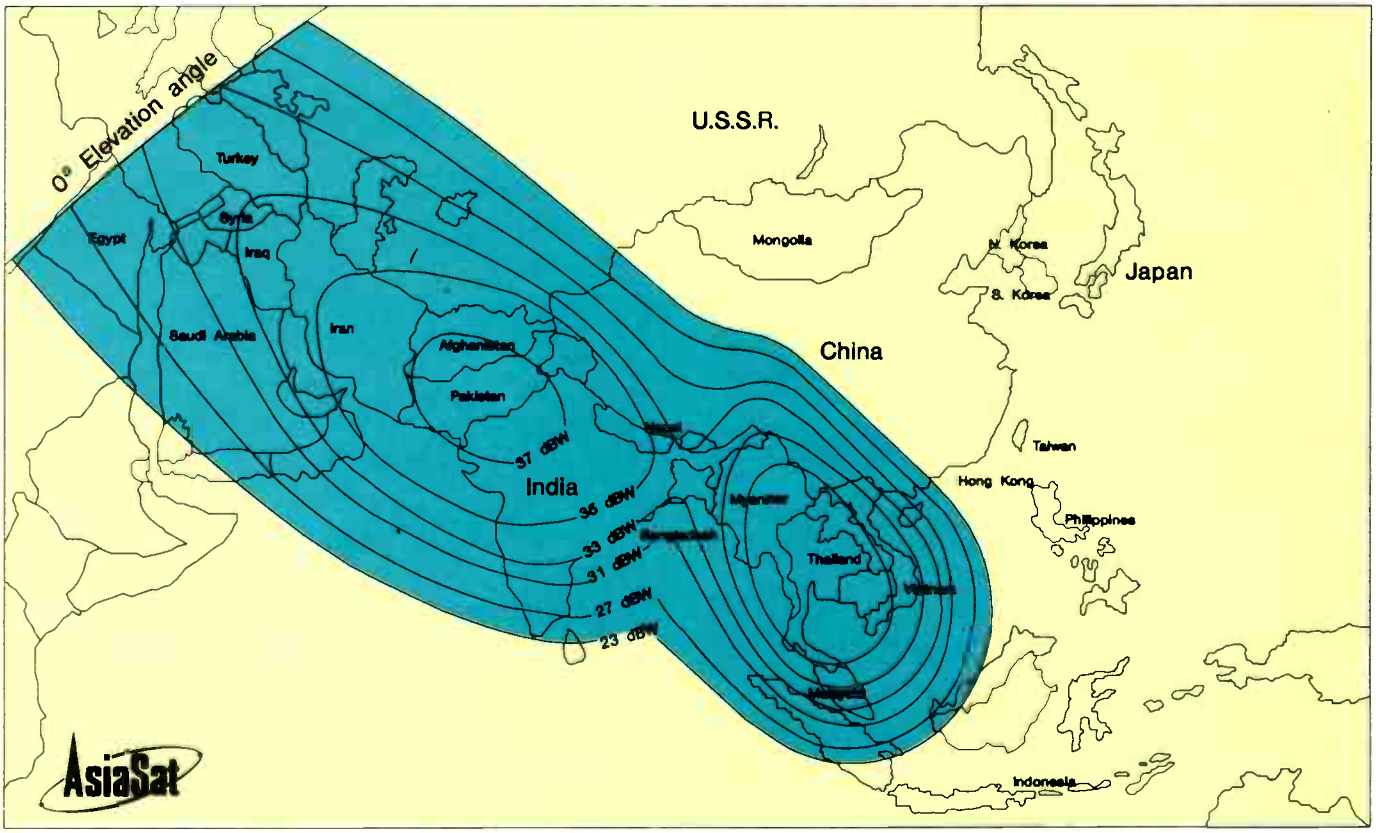
A recent addition to the Bombay skyline is the STAR TV satellite dish on top of the five star Oberoi Towers Hotel.

In most Japanese cities a wide range of Ku-band DBS equipment is available.

ASIASAT 1 Northern Footprint, EIRP (dBW)



ASIASAT 1 Southern Footprint, EIRP (dBW)



domestic Chinese satellites to various parts of the massive country for local consumption — can also be received as far afield as Indonesia and India.

Clarke's vision

The solar-powered AsiaSat may be the biggest catalyst in revolutionising entertainment and popular culture since the progressive commencement of television transmissions across Asia, but the concept of sending signals from the sky is nothing new.

Satellite communications were first prophesied in 1945, by the fair-sighted Arthur C. Clarke, author of *2001: A Space Odyssey*. Clarke's vision of satellite communications foretold of electronics-filled, solar panelled cylindrical tubes positioned in a geosynchronous orbit (an orbit in which the satellite appears to be stationary relative to the earth) 22,300 miles (35,680 km) above the equator, which could relay television signals back to earth.

Today, there are well over 100 communications satellites orbiting the earth, in the appropriately named but intangible 'Clarke Belt'. More than 30 of these are above the continental USA, and in total they provide 250 million Americans with the capability of some 250 channels!

In England and particularly the continent, Europeans have had access to satellite TV for over a decade. (See separate box.)

Communications satellites, frequently called 'birds', are merely orbiting solar powered relay stations. They receive *uplinked* signals from special satellite earth stations, equipped with suitable transmitters and 10-metre or larger parabolic antennas (commonly called 'dishes'), and faithfully retransmit the signals earthwards at the speed of light.

As the signal is being *downlinked* it spreads (unless specifically focused) over a huge area, known as a 'footprint'. The strength of a signal is greatest in the centre of the footprint and decreases as it spreads out.

The most obvious part of any home satellite TV system is a stainless steel, painted steel or aluminium parabolic antenna whose size depends upon the strength of the signals in that area, and can range from less than a metre to six or eight metres.)

This concentrates the very weak signals at a focal point, where a low noise block converter (LNB) collects, amplifies and sends them via a coaxial cable to an indoor satellite receiver. This unit — not to be confused with a conventional TV receiver, and in a cabinet

Despite their isolation in the arid lands near Marrakesh, this wealthy French family can watch satellite programmes from Europe during visits to their winter home in Morocco.

Direct Broadcasting By Satellite (DBS)

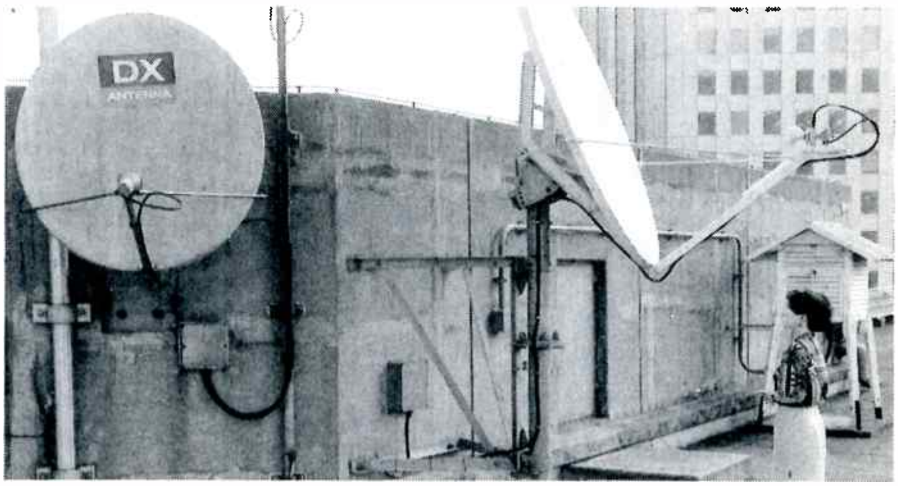
While orbiting satellites have been beaming their relayed earth-originated programming to eager audiences around the globe for over a decade and a half, it's only been in the past few years that true direct-broadcast satellite TV has come of age. (With their low power outputs and the need for large dish antennas, the transmissions from C-band satellites using 3.7 - 4.2GHz were actually intended solely for cable TV operators and international broadcasting links.)

State-of-the-art DBS is proving to be a real 'knockout', for a number of reasons. The technological advancements of recent years have led to the launch of a new breed of Ku-band (11 - 13GHz) satellites. Because this portion of the radio frequency spectrum has been allocated exclusively for satellite communications, much higher transmitting power can be used, to beam signals into smaller dishes without causing interference to other communications users. In addition, Ku-band signals are relatively free from terrestrial interference.

There's little doubt that C-band will continue to be the major mode of delivering programming to cable companies and home dish owners in the USA, for the next decade or so. But already there are many Ku-band or hybrid C/Ku-band satellites serving both North and South America.

In Japan and Europe the trend toward Ku-band operations is far more advanced, with this band predominating for the delivery of satellite TV signals. (The Japanese were the first, in fact, to test DBS transmissions, in 1981!)

DBS dish sizes keep getting smaller and smaller, and this has some less liberal, one-party governments worried. With 24cm satellite antennas (called 'horns' because of their revolutionary shape) now being used to receive strong DBS signals, huge pieces of aluminium or mesh are no longer needed — so no one need know when free-to-air TV is being received. The DBS TV system in some countries may well be Pandora's box!



Several satellite dishes positioned high atop the luxurious Century Hyatt Tokyo allow guests to keep in tune with the world.

about the size of a small video cassette recorder — provides for TV and audio channel selection.

There is an alternative to individual satellite dishes in some Asian countries, namely Thailand, India, Japan, Taiwan and South Korea.

This is the local cable operator, who owns a dish or two and channels signals via coaxial cable to individual homes. Subscribers pay an installation fee and a monthly service fee.

In addition to the multitude of television signals, not to mention telephone calls, fax messages and data information relayed through satellites, there are an overwhelming variety of special interest and mass-appeal radio signals, not receivable on any conventional radio.

These 'hitch a ride' on the back of the satellite TV signals, are collected by the earth-sited dish, 'flow' through the LNB and the satellite receiver and can usually be piped through the home stereo system.

More than able to offer a continent-spanning collection of mass market radio and TV programming, the US built, Hong Kong-owned and China-launched AsiaSat is also being used by some Asian TV stations to distribute their own programmes.

A good example of this is in Nepal, where the mountain kingdom's varied topography makes use of a satellite ideal for the expansion of Nepalese Television and the distribution of television on a nationwide basis.

Using AsiaSat, the main studio in the capital of Kathmandu is now able to uplink TV programmes to the orbiting satellite. These are, in turn, relayed back to Television Receive Only (TVRO) terminals, connected to local terrestrial retransmission stations that Nepal Television is progressively installing over the next seven years.

AsiaSat is also being used in other more remote and less populated areas, where major retransmit stations are not planned. Here low power transmitters are being used in conjunction with TVRO terminals.

These are providing isolated villages with access to television programming in the Nepali language, for the first time. And the scheme of low power transmitters relaying TVRO-originated material is being recognised as a cost-effective way to distribute educational programmes through this developing country.

AsiaSat has another advantage for Nepal, in that its coverage through its northern and southern beams covers much of Asia.

Increasingly Nepalese communities and embassies in neighbouring countries will be able to keep up to date with events in their homeland, by installing TVRO systems to receive Nepal Television by satellite.

Such applications of sky-high technology for home consumption is light years ahead of *Sputnik*, the earth's first artificial satellite which was launched by the then Soviet Union in October 1957. This heralded the start of the space age.

Satellite TV in the UK

The United Kingdom is supposed to be in the grip of a deep recession, but you wouldn't know it from the sales of satellite TV receiving equipment. Of the approximately 2.9 million UK television households equipped to receive Sky Television programming at the end of January 1992, about 440,000 received it through cable services and 350,000 watched it through SMATV (Satellite Master Antenna TV) systems. The vast majority of 2.1 million households, however, used their own satellite dishes — bought in the last few years.

Individual dish ownership is growing rapidly. For example in December 1991 alone, 116,000 satellite dishes were sold — with 36,000 of these going to homes solely during the week before Christmas.

Even at that late date, viewers were still able to watch holiday programmes. It doesn't take long for Astra dish installation, because the medium power Astra 1A and 1B Ku-band satellites used by Sky Television (the major player in the UK satellite TV game) deliver signals throughout the UK (and Europe) to dishes ranging from 60 to 75cm in diameter. These can just be clamped onto existing suitable supports.

The availability of affordable equipment, coupled with the ease of installation, has made satellite TV a winner in the UK. And Rupert Murdoch's Sky Television, which started in its own right in November 1990 after merging with former competitor British Sky Broadcasting (once owned by Alan Bond, and which used the non-compatible D-MAC system) has made it a runaway success.

In fact, at the end of Sky TV's first year in late 1991, a report said that 'the demand for Astra dishes far exceeded that for colour televisions, video recorders or compact disc players in their respective launch years'.

Astra satellite-equipped viewers in the UK have access to six Sky Television channels. Sky One, the entertainment flagship, is targeted at the younger middle-market family, while Sky News is a 24-hours-a-day news and current affairs channel.

Viewers have free access to these two advertising-supported channels, while Sky Sports is scrambled. A Sky decoder (integrated into many new satellite receivers) is needed to unlock this non-Pay TV channel, with its emphasis on British Sporting competitions and key matches from German and Italian leagues. There are two 24-hour Pay TV film channels: Sky Movies Plus and the Movie Channel, which between them broadcast 24 different films a day!

On October 1, 1991, Sky Television extended its five channel lineup by adding The Comedy Channel. A mix of British and American programmes, broadcast seven hours a day, are provided at no additional charge to all film channel subscribers on the Astra satellites.

In addition to these offerings intended for UK viewers, a number of other companies are also broadcasting English-language TV channels using the two Astras: MTV, Europe's own version of the rock-and pop-around-the-clock favourite; The Adult Channel; the Children's Channel featuring cartoons and short drama programmes daily from 0600 to 1900; Lifestyle, which screens suitable material for women viewers; and Screensport.

For ethnic audiences in the UK there are a variety of satellite channels broadcasting in German, French, Spanish and Italian. These have a dual role, as their programming is also being used as foreign language teaching aids in UK schools.

While the 11 English-language channels on Astra are highly popular with British viewers, they represent only a fraction of satellite channels currently available to curious viewers.

There are in fact some 16 Ku-band satellites which can be received in the UK with PAL, Secam and D-MAC compatible satellite TV equipment. As some birds beam more than two dozen different television signals to positioned dishes below, the choice of programming is second only to that found in the USA.

In the UK, if you aim your dish above the eastern horizon you can eavesdrop on TRTU's TV1, 2, 3 and 4 on EutelSAT and Intelsat VB, and watch a variety of light entertainment programmes from the Television Service of the Voice of Turkey. Or change channels on the same satellite to view the USA's Armed Forces Radio and Television Service's general broadcasts to its troops stationed in Turkey.

Position the dish above the western horizon, and Mexico's PanamaSat comes into view with its sports, games and variety shows from Mexico in Spanish. In between is everything from Japanese broadcasts for expatriates living in London, and 'spice' from Scandinavia, to studio interviews and music from Belgrade and the French 'Canal Jimmy' with its rather specialised 1960's and 1970's nostalgia programming.

And yet more is on the way. Astra 1C, with its launch and co-positioning to 19.2°E (to join 1A and 1B) next year, will enable viewers to pick up 48 channels on the same receiving equipment. Meanwhile work is well under way on Astra 1D, which after its launch in 1994 will be used for distributing the European HD-MAC standard of high definition television to eager viewers throughout the UK and Europe.

A keen satellite TV viewer to say the least, this over-the-top enthusiast can watch favourite programmes while motoring around Tokyo.

Just a few months later the USA launched its first satellite, *Explorer 1*. Later in 1958 it broadcast a Christmas message recorded by President Dwight D. Eisenhower.

Although the first satellite with receive and transmit (transponder) capabilities was launched in October 1960, (primarily for overseas telephone traffic) the first 'television-friendly' equator-hugging satellite in geo-synchronous orbit was Intelsat's *Early Bird* of 1965.

Founder President Eisenhower, President Johnson and other world leaders were interviewed for an international television audience in June, and in November sport enthusiasts enjoyed the live coverage of a Soviet track meet.

In the 1960's and early 70's, live-by-satellite broadcasts brought the Vietnam War into the living rooms of the world. That war ended, but another began — this one to win viewers. By 1975 several domestic communications satellites had been launched in the USA. Cable TV operators saw them as the logical way to provide greatly improved programming, at considerably lower costs. Home Box Office, a name now well known in the USA, was the first service provider to 'take to the skies'. A then little-known entrepreneur from Atlanta was next.

Ted Turner, whose Southern Satellite Systems Cable TV Service was a money maker from its first year, is the man behind the mega-successful Cable News Network (CNN).

A reliable information source, CNN ironically became a household name during the Gulf War — because the network changed the concept of news from 'an event that has happened' to *something that is happening*.

CNN and EPSN, a major satellite sports network in the USA, both plan to be the next entrants in the Asian satellite scene. Both networks have announced plans to serve selected regions of Asia, using existing transponders on Indonesia's *Palapa* satellite. The Palapa footprint covers all of Southeast Asia, and extends northwards to Hong Kong and eastern India.

In addition to these two programme providers, later this year Palapa is expected to transmit the financial and commercial services of the Hong Kong-based Business News Network. These could well be carried on Palapa's new venture company, Pasifik Satelit Nusantara.

By the time PSN is well established, however, it and the other satellite providers will have still more competition. Planning and basic design of Asia-Sat 2 has already started, with a launch date scheduled in 1993.

Further ahead, Japan's NHK is looking at still more competition with its Global News Network. While no government decision has yet been taken about Japan's first entry into the all-Asia satellite communications scenario, the concept behind GNN is revolutionary, if not daunting.

GNN's core idea is that news gathering organisations from around the world would constantly send news video via satellite to Tokyo, where it would be co-ordinated and relayed to world-wide news hungry audience.

The project, which knocks at the boundaries of existing technology, may seem like an impossible dream — but then so did a viable Asia-wide satellite TV network, just a few short years ago. ❖

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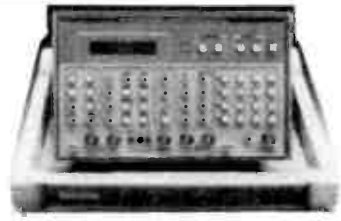

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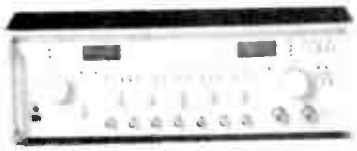

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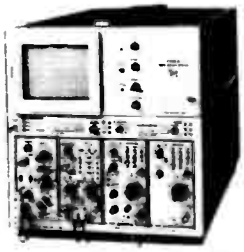

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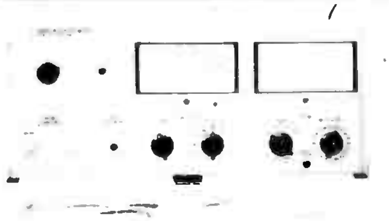

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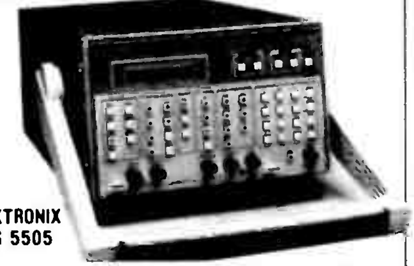

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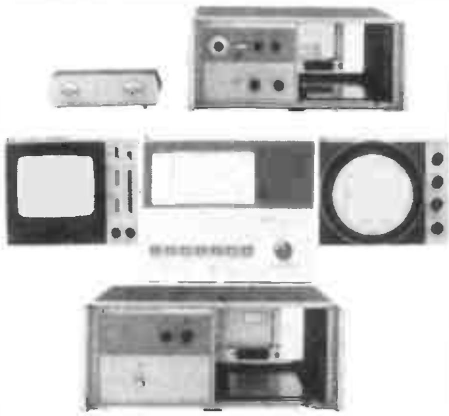

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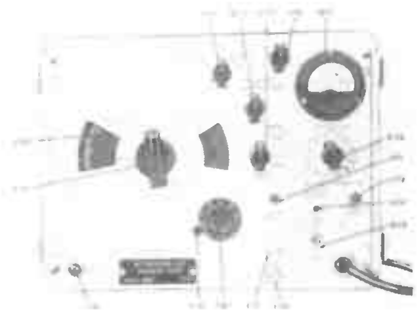

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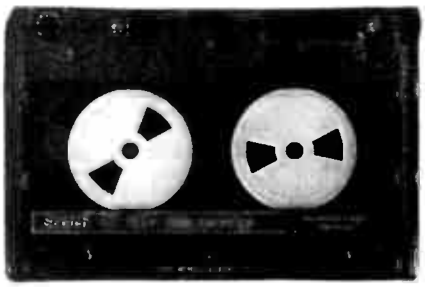

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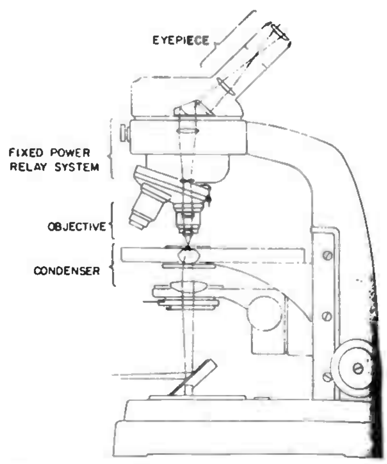

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When I Think Back...

by Neville Williams

Fred Thom and Tasma - 1: Once a prominent manufacturer - now almost forgotten!

As long-time readers of this magazine will know, a considerable number of Australian radio manufacturers — large and small — emerged in the 1920's, prospered in the 30's, 40's and 50's, lost their way in the 60's and finally disappeared in the 70's. How it happened to the manufacturer of the once popular 'Tasma' brand receivers has been recalled by co-founder of the company, Fred Thom.

First a word of acknowledgment to Harry Gordon of Murrurundi, NSW, who alerted me to the existence of key source material. He says that, when chatting with a friend from the same town, Harold Burraston, Harry mentioned that he had once worked as a telegram boy for AWA Beam Wireless, transferring thereafter to the firm Thom & Smith. In later life, he had joined University Graham as Sales Manager, subsequently becoming Managing Director of that company.

Responding to this, Harold Burraston recalled that, amongst his papers, *he* had a document produced by the Telecommunication Society of Australia (TSA) which carried a virtual autobiography of Fred ('Freddie') Thom, a co-founder of Thom & Smith, who owned the 'Tasma' brandname.

While outlining his own life story, he added, Fred Thom had mentioned a number of his contemporaries who are prominent figures in their own right in our electronic history. Published at least 10 years ago, the document was identified as 'F.W.P. Thom, Biographical Notes, Monograph No.9, Telecom Historical Society'. As it turned out, I managed to obtain a copy through TSA.

The monogram was/is essentially a transcript of a taped interview conducted by Robert Langevad, at the time immediate past-president of the TSA, NSW Division. What follows is a complete rewrite, presenting the original and supplementary information in chronological order.

In a recent personal interview, Fred Thom himself told me that he was born in 1904. He'd had an unsettled childhood, he said, as his father — a civil engineer employed by the NSW Government Railways — moved from job to job all over the state, often into makeshift accommodation.

Fig.1: Fred Thom, in 1992. He's won some battles in his day, and lost quite a few others. But, chatting with him, one can only concede that, at age 88, he's won his own private war.

Now living in retirement on Sydney's North shore (Fig.1), he still has vivid memories of a colourful career, embracing wireless technology from the period immediately following the Great War (1914-18).

School 'drop-out'

Fred Thom's story, as told to Robert Langevad, has a familiar ring for that time frame: I quote:

My mother was widowed early and I had two infant sisters and an older one. There was no money, no pension, and things were pretty grim. I decided to drop out of high school and go to work.

So I looked up the (Sydney Morning) Herald, and the highest paying job I could see was: 'WANTED; boy, City Hatters — thirty shillings a week'. To a teenager in 1919, that sounded like a fortune.

Fred tells how he joined a queue of 10 other 'blokes', being interviewed by a stout, balding gentleman, who kept on saying no, no, no! Fred was next in line.

Watching them, Fred says he had enough ego at age 15 to feel that he was smarter than the 'pugs' who had missed out, and felt confident that he would get the job. He continues:

Then along came a lady with a small boy wearing thick glasses and a straw hat. She sailed past me to the manager's table and, using some sort of influence, prevailed on him to give the straw-hat kid the job.

So I learned my first lesson in the workplace: It isn't what you know; it's who you know!

Since it was still just after nine o'clock, Fred took another look at the *Herald* and came upon a small advert: 'WANTED: office boy, Amalgamated Wireless, 97 Clarence St, Sydney'. He duly made his way there and asked about the job, which was offering only 15 shillings a week — but even that was better than nothing. In his own words:

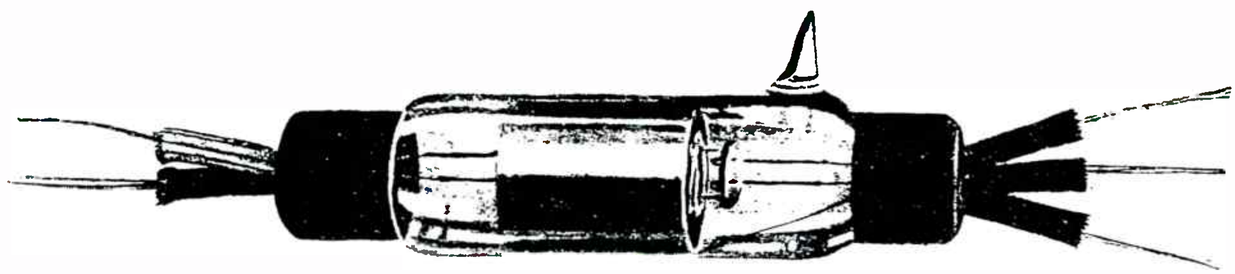

Fig.2: As pictured in 1923, this Australian made 'Expanse-B' valve differs from the original version described by Fred Thom, in having a spiral grid and a cylindrical anode.

There were two of us there and the selection was left to two female secretaries, one deputising for the AWA Company Secretary J.F. Wilson and the other for 'Tiny' Larkins, the Company Accountant. Their names were Dulcie Clarke and Vera Evans.

They looked at us and one said to the other: "Which one do you like?" Vera said: "I like this one." Dulcie replied: "All right, we'll have him." So I was hired on the spot, at 15 shillings a week'.

Fred said he had only been there a couple of hours when they put him on the switchboard during the lunch break. It was a three-line board with about 15 extensions, and his stint as operator was preceded by a five-minute lesson.

At the end of three months, he asked for a rise and was granted 30 shillings a week — a 'magnificent sum' for an office boy in 1919.

AWA's first factory

More to the point, Fred had realised that AWA had an upstairs 'factory' at 97 Clarence St, called Australectric. Here they manufactured telecommunications equipment, as distinct from telephone components. They were also involved in marine radio, which had been fundamental to AWA for some time. I quote:

Over the years, Australectric had made all kinds of things from conduit fittings (of malleable cast iron) to Marconi-designed marine transmitters and receivers. In those days, remember, they were still using magnetic detectors, coherers and crystal detectors; also emergency transmitters with a straight induction coil and a spark gap tuned with a variometer.

A lot of the radio sets were just like a loose coupler and the transmitters used to have spark gaps and God knows what. Originally it was all spark and Morse, and no telephony.

Fred says that when telephony had appeared on the scene, Australectric were quick to take advantage of it by manufacturing a marine receiver which was known as the P1. It was their first application of the Armstrong regenerative principle, and was concentrated around a single valve, with or without an audio stage.

Either way, he said, it was far simpler than earlier valve receivers — which had a great row of valves, so bright that one could get away without extra light in the radio room. Described as an 'aperiodic' circuit, it amplified all incoming frequencies without discrimination.

According to Fred Thom, the P1 receiver had proved very successful and, at times, it had exhibited 'astronomical' range. It was in this period that AWA had achieved the first direct wireless reception from London, on a wavelength of 25,000 metres (12kHz) — well inside the present day audio band. The 'bloke' that actually made the contact was the late David G. Wyles, but as boss of the company, E.T. Fisk 'got all the kudos'.

Despite the fact that AWA did not manufacture telephone or cable equipment, they gained special support from the Federal Government because of their involvement in wireless technology. This put AWA at odds with the British Post Office which, according to Fred Thom, "was sold on undersea cable". He added that "AWA fought the BPO to a standstill", and ultimately obliged them to evaluate beam wireless.

The Importance of Being Ernest (Fisk)

"As a 15-year-old office boy", says Fred Thom, "it was my job to post or deliver AWA's mail. One day I had to deliver an urgent document up-town and, as the envelope was unsealed, I opened it and was reading the contents when I came face to face with the big boss, Ernest Fisk.

That afternoon I was summoned to his office. Said he, in a quiet voice:

"Son, your job is to post or deliver mail?"

"Yes, sir!"

"You were reading a company document in the street, this morning?"

"Yes, sir!"

"You mustn't do that. In future, if you want to read company correspondence, you must come up and do it in my office!"

Said Fred: "He didn't even raise his voice, but I got the message, loud and clear."

A previously unpublished anecdote, as related to the writer by Fred Thom during the preparation of the present articles.

The 'bug' bites...

At the time, according to Fred, many bureaucrats doubted that wireless would ever amount to much; but he didn't go along with them. Intrigued by all the gadgetry AWA were making and selling upstairs, he decided that the smart thing would be to become an apprentice, even if it meant some hardship in the process.

As office boy, he was at least on the spot and had sufficient qualifications for further training. Australectric already had three or four apprentices but, in due course, Fred joined their number, signing on for twopence an hour — a meagre eight shillings a week. He continues:

In those days, if you wanted to be an apprentice, your parents had to find the premium — a payment of 50 pounds to the teacher or employer, which would be returned at the conclusion of the training.

I didn't have to pay the premium, but I did have to work for twopence an hour. And after I'd paid train fares and twopence each way on the ferry to Circular Quay, there wasn't much left over.

If the ferry ran late, I would race up three flights of stairs to make up time. But, if I was even one minute late, I would have to wait at a sort of stable door for 15 minutes, before being permitted to start.

You see, our pay was docked for being late, and as a halfpenny was the smallest coin, I had to be docked for 15 minutes. Silly as it seems now, I had to wait for that many minutes to pass before being allowed to start'.

Fred recalled that life was not easy for apprentices in the 1920's for other reasons. As now, if you wanted to improve your status, you went to tech — but you paid your own way, and you did it in

[illegible]

your own time after work, usually for three nights a week. On such days, he said, he would catch the train at 6.45am and not arrive back until 10.20pm. In the evening he would dine royally on Sargent's pies.

"Nowadays, apprentices get full wages and the boss covers time off for tech."

His next observation also has a familiar ring:

And so I progressed, but only by making myself heard. I remember once going to the union and saying: "They're supposed to teach me a trade, but I've been on the turret lathe making screws for over six months, and I know how to make all the screws in the world — I want to try something else!"

So the ETU advised me to seek a transfer, and I was moved to the coil winding section — where I learned to wind 'all the coils in the world'! It was time for another shift so, when they started to make radio valves in Australia, I got a transfer to that section.

Locally made valves

That first AWA valve was designated the 'Expanse-B', a derivative of the deForest Audion. In conversation, Fred mentioned that a Miss Devaux, experienced in valve production in Britain, was despatched to Australia to help Australec get the project under way. (From other references, this would have occurred in 1920 or thereabouts.)

He recalls that the Expanse-B had a twin V-shaped filament, which was handy if one of them burned out — you could carry on with the other one. The grid was flat and shaped like the 'demisting' heater element on the rear window of a car, while a flat plate served as the anode. He remembers bringing out the filament wires through one end of the envelope, where they provided a ready means by which the valve could be 'hung' in the P1 receiver.

(There appear to have been other, later versions of the valve. Some pictures showing terminal connections rather then flying leads, others the use of a spiral grid and cylindrical anode — Fig.2).

The Expanse-B was classified as 'soft' valve, meaning that the internal vacuum was not very high. This was fortuitous for AWA, Fred says, because their vacuum pumps weren't all that good anyway!

He recalls that, while assembling some valves, one day, he somehow managed to get some mercury mixed up with the components, which others tried to remove without much success. So, for good or evil, at least one batch of AWA Expanse-B's would have made their debut as mercury vapour triodes!

Shortly after this, he was transferred to the AWA Patents Department. At that time, he says, the company had a strong affiliation with RCA, involving 'oodles of patents' which they used later 'to extract royalties from other local manufacturers'.

Fred enjoyed being in the Patents Dept, where he was paid to sit down and read all the main journals on behalf of the departmental head, Alan Longstaff. He particularly remembers *The Electrician* and *Wireless World*. His job was to select important articles and write a precis for staff reference.

From Patents, Fred made it into the lab — for what he rates as one of the most interesting periods of his life, rendered the more so because, at the time, AWA was doing its best to promote radio against an entrenched official dependence on cables.

The role of amateurs

To make things even more interesting, he recalls, amateurs like Charles Maclurcan were constantly stirring the pot. Son of the late Mrs Maclurcan who owned Sydney's famous Wentworth Hotel, Charles was a 'real radio boffin' and 'very good at it'.

As the amateurs were nudged off the medium frequencies, they moved ever higher, towards the then-VHF band — progressively demonstrating the potential of this portion of the spectrum. Maclurcan even succeeded in making Morse contact with England at a power level of 0.2 watt, by bouncing signals off the Heaviside layer.

"Mind you", says Fred Thom, "there was comparatively little electrical interference in those days (at the average amateur station site), with fewer cars and few high tension lines to cause buzz and fuzz".

At this point in his monogram, obviously prompted by thoughts of Maclurcan and the role of the amateur fraternity, Fred launched into a spontaneous word picture of the old AWA/Australectric lab, when he worked there in the early 1920's. What follows is a paraphrase of Fred's own sentiments, as captured on the tape by Robert Langevad:

Fisk came across a lab digest of a QST article which described a parabolic reflector and said: "I've got to make up one of those". So we built up QST's parabolic reflector, along with a one-valve transmitter using a Marconi valve known as an LST. God, would that be a museum piece now!

The transmitter was contrived by Longstaff and a young physics graduate

Stromberg-Carlson

No. 2a

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Fig.3: An advertisement for LPR Bean & Co, published in 'Australasian Wireless Review' for February 1923. It shows their trading address and features American Stromberg-Carlson headphones.

called A.W. Young, along with Charles Tapp — who wasn't a graduate — and E.A. (Eric) Burbury, all of whom worked in the Australec lab at the time.

Most such people had been one-time radio operators. The way things were, you graduated from spark coils and this and that to other research. We had radio direction finders and all this kind of thing but, in outside electrical circles, even our most impressive gadgets tended to be dismissed as toys. REAL electrical engineering had to do with power generation, electric motors, traction and so on — not the kind of stuff we were on about!

Anyhow, we made up this parabolic reflector and, so help me, Fisk got to using it in directional radio demonstrations — to ring bells, switch on lamps, open proceedings and so on. What we had done was provide a graphic way of demonstrating what could be achieved with directional radio waves; in other words, 'beams'. It enabled more to be done with less power — in those days a revolutionary idea.

In a way, it was an extension of the work of Meisner — the bloke who is credited with inventing tuning. In the old days of the open spark gap, tuning (of sorts) was accomplished by varying the length of the aerial, but few if any understood the real principles involved. Meisner sorted it out and showed how deliberately tuning the transmitter and receiver (to the same frequency) would ensure vastly improved communication with much less interference.

Fred says that, at the time, Marconi had a yacht called 'Elettra', which spent much of its time in the Mediterranean. It had been fitted out with a short-wave transmitter and Marconi had a prearranged schedule with Fisk, who would listen for his signals at his home in Vaucluse, Sydney, using any available shortwave receiver.

Fred recalls him trying out the first superheterodyne receiver to come to hand. It used a valve oscillator, a 'Q' (untuned?) amplifier for the IF section, followed by two audio stages.

"It proved to have negative gain, and didn't damn well work!"

So they replaced it with an Armstrong regenerative version of the old P1, modifying this to work on the 90-metre wavelength being used at the time.

Shortwave experiments

At this point, I revert to Fred's verbal account of what followed, which differs markedly from the formalities of the published accounts:

A.W. Young did the calculations for a loop aerial, which we stuck on crossed broom handles. To turn the aerial, we used a couple of loops of rope around it, like the steering mechanism of a steam roller.

We tuned the aerial using three little coils on an ebonite rod and moved them to get the coupling right with a 20" ebonite rod sharpened like a pencil. And so help me, we got Marconi coming through from the Elettra, on that one-valve regenerative set-up — and that was one helluva thing! As well, it was telephony for the first time, from 'Elettra' to Vaucluse direct.

This trumped the British Post Office, and that's the way it was done. But the set-up was hardly one to display to the press. Instead, Fisk posed for pictures in the main room, with headphones, seated in front of that bloody great 'Q amplifier' — while we're out the back (capturing the signals) with a one-valve set and a broomstick aerial!

Fig.4: Fred Thom as pictured in the 'Who's Who in Radio' section of the 1935 edition of Mingay's 'Radio Trade Annual of Australia'. By then, Thom & Smith had been operating for about six years, and was located in Dowling Street, East Sydney.

What's more, we changed the size and tuning of the loop and the Elettra romped in on 30 metres. Fisk was delighted. This was the proof he needed that telephony was possible direct from Europe to Australia, by beam wireless. In due course, Billy Hughes made the Federal Government a majority partner in AWA, with responsibility for the whole marine set-up, and culminating in the Beam Wireless organisation, as an adjunct to the Post Office.

While Fred's recollections of events and situations remain quite graphic, he is unsure of the exact dates. My guess is that much of the above would have occurred in 1922, a year in which the Federal Government was addressing itself to the problems of wireless communication, broadcasting and administration, for enactment during 1923.

A new career

As it turned out, Fred Thom left AWA in 1923 and joined L.P.R. Bean & Co — which, as he remembers, had premises at 86 Crown St, Sydney and in Newstead House in Castlereagh Street. (See Fig.3.)

Apart from being Australian agents for Stromberg-Carlson (USA), L.P.R. Bean was engaged in the manufacture of switchboard indicators for the manual telephone exchanges of the day — plus ring and listening keys — and they had just started to make telephone lightning protectors to satisfy an order for 30,000 units — which was a breathtaking order for the period.

L.P.R. Bean & Co was said to be the first local company to manufacture telecommunications equipment, although some of the raw materials had to be imported. All processing, such as turning the cores, winding the coils, assembly and testing was done locally.

Fred Thom says that Leslie Percival Bean himself had been the youngest-ever trainee engineer in the Australian Post Office (APO), and to his discomfort was sometimes referred to as 'the boy engineer'. But, to give him his due, he was good at it and had an ambition to see more equipment manufactured in this country. Bean was fortunate in having as a partner another APO engineer named Norman S. Gilmour, who later founded Lekmek Radio and served as IRE President during 1938. Gilmour was well respected in the APO, having served in the Newcastle area and pioneered the installation of underground cables beyond the central business district of Sydney.

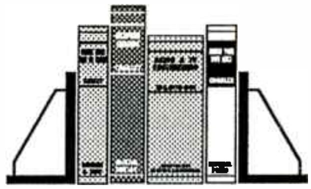
In the process, he had ensured that the manholes and conduits were made large enough to cater for future expansion — a consideration that might otherwise have been overlooked by the then APO management.

As importers, as well as manufacturers, L.P.R. Bean had access to handsets, bell boxes and a variety of other telephone hardware made in the US by Stromberg-Carlson. From this vantage point, both Bean and Gilmour — says Fred Thom — 'badgered' the Post Office to invite tenders for locally-made components.

In the second part of Fred Thom's story, we'll see how he and John E. Smith left L.P.R. Bean (by then Stromberg-Carlson Australia), to form their own company and manufacture the 'Tasma' range of receivers and other equipment.

(To be continued) ❖

NEW BOOKS



Satellite TV

THE WORLD OF SATELLITE TV, by Mark Long and Jeffrey Keating. Published by MLE Inc, 1992. Soft covers, 248 x 189mm, 222 pages. ISBN 0-929548-08-6. Retail price $29.90, plus $5 packing and postage.

This is a new Asian/Pacific Rim edition of a book that has been available in the USA since 1983, and has established quite a reputation there as a comprehensive and authoritative guide to domestic satellite TV reception. The same authors have also produced the well-known *World Satellite Almanac* and *The Big Dummy's Guide to CB Radio*, as well as producing the ongoing *World Satellite Transponder Report* (quarterly) and *World Satellite Update* (monthly). So they're in a very good position to produce this kind of book...

The idea of the new volume is to provide an up-to-date combined reference book and introduction to this rapidly-expanding field, with particular regard to the Asian and Pacific Rim area. There's plenty of introductory material for the reader new to the field, plus a lot of timely and detailed technical reference data for the more experienced reader. And it's all presented in a friendly, concise and easy to read manner.

I particularly liked the data appendices, which give a great deal of useful technical information about the satellites, transponders, footprints, TV standards, encoding systems and programmes carried in this part of the world. There's also a handy glossary of satellite terminology — and all for a very reasonable price.

In Australia the book is only available from Peter C. Lacey Services, PO Box 678 (74 Fulton Road), Mount Eliza 3930. (J.R.)

Control technology

SENSORS AND TRANSDUCERS, by Ian R. Sinclair. Second Edition, published by Newnes (Butterworth/Heineman), 1992. Hard cover, 240 x 160mm, 214 pages. ISBN 0-7506-0415-8. Recommended retail price $69.95.

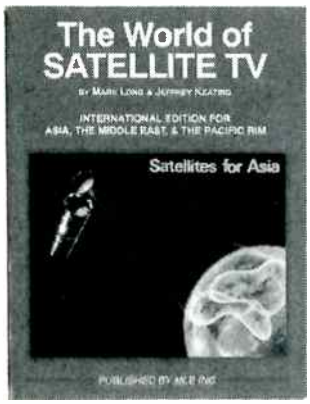
The purpose of this book is to explain and illustrate the use of sensors and transducers associated with electronic circuits. Most texts concerned with the interfaces between electronic circuits and other devices tend to deal only with a few types of sensors for specific purposes. But this one describes a very wide range of devices, grouping them according to sensed quantity and explaining in detail the physical principles involved.

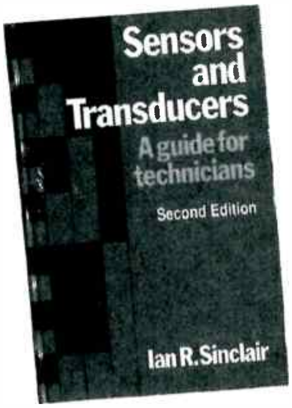
So the first seven chapters deal, in order, with: strain and pressure; position, direction, distance and motion; light and associated radiation; temperature sensors and thermal transducers; sound, infrasound and ultrasound; solids, liquids and gases; and environmental sensors.

The final two chapters cover other sensing techniques, e.g. permittivity and nuclear magnetic resonance, and instrumentation techniques (especially A-D and D-A conversion).

There is a vast amount of information contained in the book, very well presented and explained, and with many diagrams and tables to help your understanding. It more than adequately meets its specified goal of 'proving useful to anyone who encounters sensors and transducers, whether from the point of view of specification, design, servicing, or education'.

The review copy came from Butterworth Australia, 271-273 Lane Cove Road, North Ryde 2113. It is available from technical bookshops. (P.M.)





Micro interfacing

MICROPROCESSOR INTERFACE DESIGN, by J.D. Nicoud. Published by Chapman & Hall, 1991. Soft cover, 240 x 160mm, 292 pages. ISBN 0-412-45140-9. Price in the UK £24.95.

This book is aimed at showing young students, as well as experienced engineers and technicians, the main aspects of integrated system design. It deals both with digital circuits and the interfaces between a microprocessor, its support circuits and the outside world.

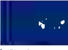
The first three chapters include basic knowledge about the technology, as well as about combinatorial and sequential logic circuits. The next three chapters discuss memories, programmable logic devices (PLDs) and input-output interfaces. And the final chapter gives some specific solutions (design examples) — passing on some of the author's experience, learned from years of practice.

There is also a very large appendix (70 pages) which includes a list of most of the circuits currently used by digital interface designers. These are illustrated with clear functional symbols, as well as their part numbers. So many ICs are listed that the appendix begins with its own contents page. A table of IC manufacturers is also included.

The publication provides a very useful reference for microprocessor interface design. As well as listing the large number of ICs available, it also indicates which ones are now considered obsolete and which ones are in common usage — a big help to keep you up-to-date with new developments.

The review copy came from Chapman and Hall, London. The local agent is Thomas Nelson Australia, 102 Dodds Street, South Melbourne 3205. It should be available from technical and larger bookshops. (P.M.) ❖





Construction Project:

HIGH QUALITY STEREO AMPLIFIER USING VALVES - 1

Here's your chance to build a genuine, newly designed high quality stereo audio amplifier based on thermionic valves — the Stereo Eighty. It's not a rehash of an old project, nor a quirky and 'over the top' design that aims for perfection at any cost. The author has even organised the supply of all components that are nowadays hard to get, and is offering complete kits for less than $1000. What better opportunity could there be to find out for yourself whether the claims made for valve amplifiers are true?

by TEAN Y. TAN, B.E.(Hons.)

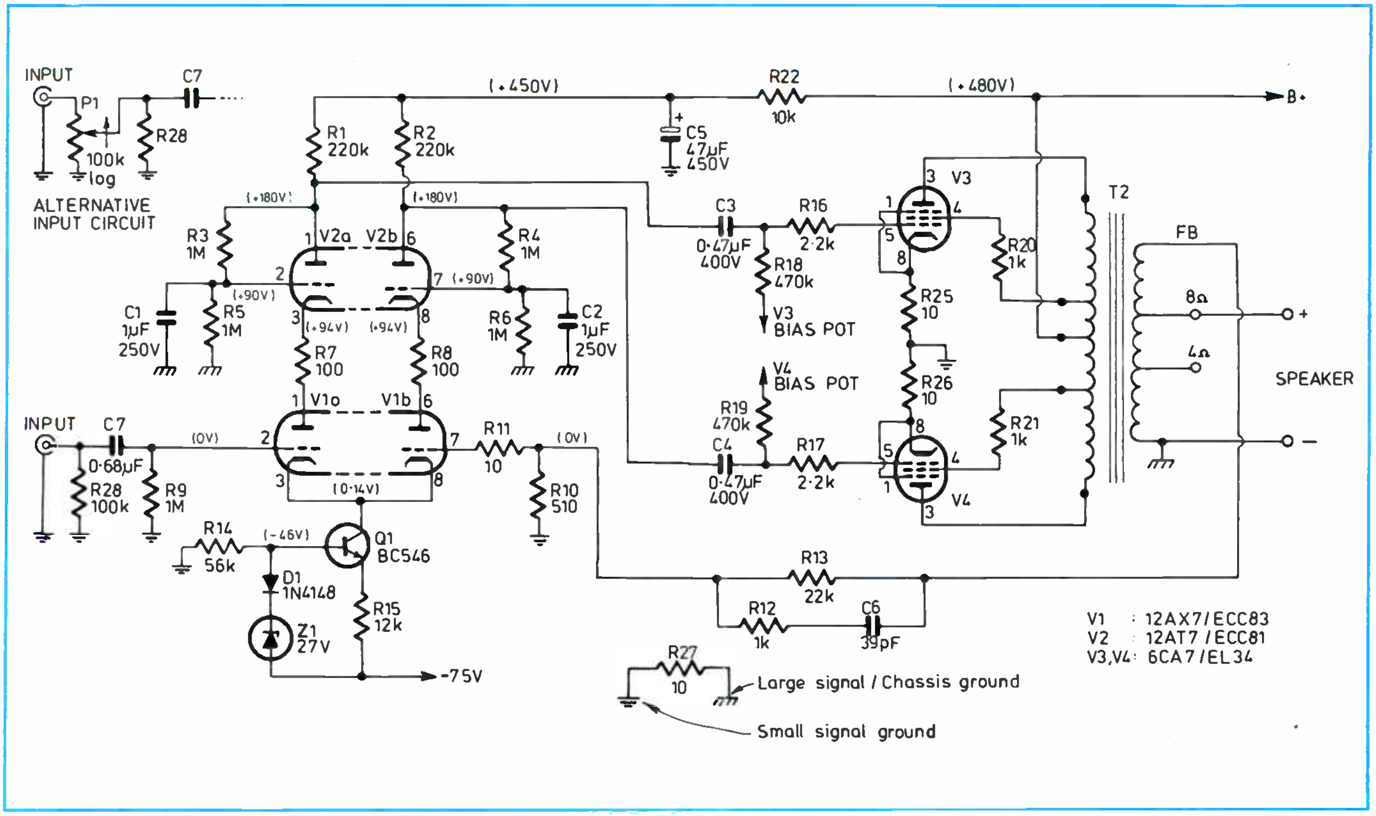
Recently, there has been a resurgence in the use of vacuum tube amplifiers (more commonly referred to as 'valve' amplifiers) for domestic and studio environments. Their re-emergence is largely due to the fact that many people believe valve amplifiers are capable of producing music more accurately than their solid state counterparts.

Musical characteristics such as a larger soundstage, better imaging, better dynamics and greater ambience are among terms used by reviewers in describing valve amplifiers. Only the most expensive solid state amplifiers are capable of attaining these characteristics.

As an indication of the sonic quality of valve amplifiers, a large number of them are now sold in both Japan and Hong Kong each year. These amplifiers are also gaining acceptance in the US and United Kingdom. Many brands with different output tubes and power outputs are available in the market. Listen to one in a better hi-fi retail outlet and you're likely to be convinced. Of course valve amplifiers also tend to be expensive, nowadays, due to the cost of the power and output transformers which are sourced from overseas.

But in the project described here, all of the transformers are designed and

Here's the author's prototype for the amplifier, built on a standard rack-type case as a chassis. The kits which will be available from the author will use a slightly different chassis, custom designed for the project.



Each channel of the stereo amp uses four valves, connected as shown in this schematic. V1 and V2 are connected in a cascode long-tailed pair configuration, using transistor Q1 as the common cathode load.

manufactured right here in Australia. In addition to keeping the cost down and providing greater reliability of supply, this has other benefits — it helps Australia's balance of payments, and also assists in keeping Australians employed.

One of the aims of this project has been to provide a high quality and an affordable stereo valve amplifier for audio enthusiasts and music lovers. Imported valve amplifiers are very expensive — over $2500 — largely due to the import duty and high mark-ups imposed by retail stores. This goal has been achieved, and now there is an affordable amplifier which is less than $1000 in kit form, for those who enjoy building their own units. A fully assembled and tested unit is also available.

The amplifier is housed in a rigid case which is made of mild steel and has a powder- coated black satin finish. The paint is sufficiently thick for it to be effectively scratch proof.

The transformers, valves and large filter capacitors are mounted on top of the case. The smaller components such as resistors and capacitors are mounted inside the case on a printed circuit board (PCB). All components are within easy assess to the builder. This should enable anyone with reasonable experience in assembling electronic projects to build the project easily, with a minimum of mistakes and convenience in terms of any future maintenance. Minimum hard- wiring is required between the various components.

The layout of the major components and PCB assembly are such that they are very close to each other, with only short lengths of signal cable used throughout. This improves the overall sonic quality.

The amplifier comes with an optional volume control, so that a CD or DAT player can be connected to it directly if desired. The output speaker terminals can be configured as either four ohms or eight ohms to suit the speaker type. The normal position is eight ohms, to suit most standard voice-coil type speakers, but four ohms would be more suitable for many electrostatic and ribbon speakers.

There is an on-off switch on the front panel, with a red LED to indicate the 'power on' condition. For those who wish to ground their auxiliary equipment, there is also a ground terminal at the rear of the case.

The construction and adjustment details of the project will be explained in the next article.

Design background

The factors which contribute to the sonic quality of a valve amplifier are circuit design, component quality and the use of appropriate construction techniques. All these factors have been taken into consideration when designing this amplifier, and will now be briefly discussed.

The valve amplifier has been around for a long time. Its application in the audio field received more prominence after the publication in 1947 of the technical paper 'Design for High Quality Amplifier' by D.T.N. Williamson, published in the UK magazine *Wireless World*.

Williamson's paper highlighted the fact that he was able to improve linearity, frequency response, phase shift and output resistance through prudent use of negative feedback.

Since then, many more design variations on the 'Williamson Amplifier' have been published. One of the more notable works published is that by Hafler and Keroes on the *ultralinear* amplifier. In essence, an amplifier operating in ultralinear mode is able to achieve high power output at low distortion. Another publication by B. Hedge on the 'long-tailed cascode pair' talks about improving the linearity and high frequency response of the input and driver valves.

The topology of this present design's circuit embodies the principles established by Williamson, Hafler and Hedge, but couples these with contemporary design techniques.

Valve amplifier

Circuit description

The final circuit is one which provides the following advantages:

1. A push-pull cascode configuration is used for the input and driver stages, which improves the linearity and symmetry.
2. A highly stable constant-current source is used to regulate the bias for the input and driver valves.
3. The output valves are individually provided with adjustable bias, to allow crossover distortion to be minimised.
4. Negative feedback is derived from the same winding on each output transformer that is used to drive the speaker, to reduce overall distortion.
5. The amplifier uses the ultralinear configuration and class AB mode of operation, to maximize power output and minimise distortion.
6. The power supply provides a high value of reservoir capacitance, to improve the dynamic response.

Refer to Figs.1 and 2 for subsequent explanation of the circuit.

The two halves of V1, a 12AX7/ECC83 'medium-mu' low noise twin triode, form the input and feedback mixing stage. These are directly coupled to the two halves of V2, a 12AT7/ECC81 twin triode, which forms the push-pull driver stage. As can be seen the two stages are connected in series, using the 'cascode' configuration.

The total bias current I through both stages is determined by the constant-current source formed by transistor Q1, zener diode Z1 and diode D1, and resistor R15. This gives a total current of 2.2mA. Because the transistor acts as a current source, it therefore appears as a common AC cathode impedance of almost infinite value, for the two sections of V1.

This means that they are tightly coupled in the so-called 'long tailed pair' configuration, giving greatly enhanced common-mode rejection ratio. As a result the common-mode component at the output of the driver stage is greatly reduced.

The bias currents in both halves of V1 and V2 will not be exactly equal, because the two halves of both valves are generally not identical. As a result the voltage at pins 1 and 6 of V2 can vary by between 5V and 20V; however this is not a matter of much significance as these points are biased at about 180V. In any case, capacitive coupling is used to transfer signals between the plates of the driver stage and the output valve grids.

The push-pull output stage of each channel uses two high-power EL34/6CA7 pentodes (V3 and V4). These are individually fed with adjustable fixed bias, using four preset potentiometers (two per channel). This allows the quiescent current for each pair to be balanced, for optimum performance.

The quiescent current in each output valve is typically set for between 25 and 30 milliamps, depending on the desired compromise between performance and valve life. With each valve's bias set for a quiescent current of 30mA, class AB operation results and a power output of 40W can be achieved from each channel.

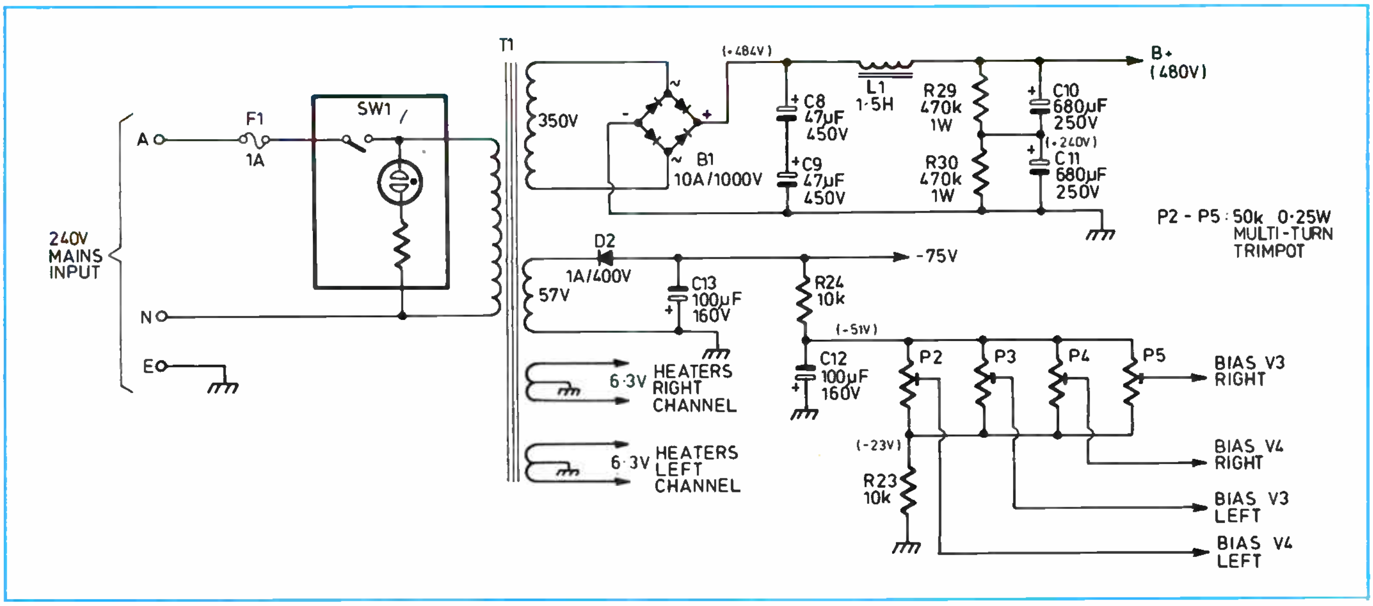
Output valves V3 and V4 have their screen grids connected to taps on the output transformer primary windings, in the correct ultralinear configuration. Each tap is at approximately 43% of its valve's half of the primary winding, which is the point shown by Hafler and Keroes to produce minimum distortion and highest output power, because of the 'pseudo pentode' operation.

Although I recommend the ultralinear configuration shown, together with biasing for class AB operation, some audiophiles may wish to experiment with other configurations and bias levels, in order to determine for themselves the effect on sound quality.

One possibility is setting the biasing so that the output valves operate in class A mode. The effect will be lower distortion, but also lower power output: a maximum of 25W total per channel. The operating life of the output valves will also be considerably shortened.

Another possibility is to change the output stage configuration, so that the valves operate in triode mode. This is done by simply connecting the screen grids (pin 4) to the plates (pin 3), instead of connecting them to the transformer taps. Again, the power output will be considerably reduced, in either class A or class AB mode, compared with the ultralinear connection.

The triode configuration is strongly favoured by many valve amplifier manufacturers, including Audio Re-



Here is the power supply circuitry for the complete amplifier. Rectifier bridge B1 is used to produce the high tension voltage, while diode D2 is used to generate the negative bias for the various valves. Preset pots P2-P5 are used to set the bias on each of the output valves, and ensure that each output stage is balanced.

[illegible]

search Corporation. With this design, the builder is free to experiment with the different output configurations and bias conditions, in order to achieve the best compromise in terms of desired sound quality and valve life.

Despite this flexibility, the circuit is quite straightforward. Under no- signal conditions, the grids of both halves of V1 are very near ground potential. The input signal is fed to the grid of V1a, while the negative feedback signal from the output transformer secondary is fed back to the grid of V1b via the divider R13/R10, with components R12 and C6 used to shape the phase response and ensure loop stability at high frequencies. More about these shortly.

The 12AX7/ECC83 has a medium transconductance and low noise, making it ideal as an input valve. Its transconductance variation from unit to unit is not as widespread as with 6DJ8/ECC88, which has higher transconductance. This enables the circuit to have a consistent open loop gain. The transconductance of each half of V1 is about 1.6mA/V.

Each plate of V1 is directly coupled to the cathodes of the two halves of driver stage V2, which has its grids grounded for audio frequencies via C1 and C2. In this configuration, the effective AC load for each half of V1 is close to the physical driver load resistor (R1 or R2), in parallel with the top resistor of each driver's grid divider (R3 or R4), and also the bias series resistor for the associated output valve (R18 or R19). As a result the voltage in of each input stage/driver stage pair is about 100, measured at points A and B. To improve linearity in the circuit, the gain at points A and B should be equal.

Low feedback

The benefits of negative feedback are widely known and will not be elaborated here. The circuit configuration used employs a low feedback design of less than 8dB (return difference). The feedback is taken from the secondary winding of the output transformer, and results in an overall gain for the amplifier of about 25 - 28dB.

It is the author's belief, based on experience, that a low feedback amplifier has a more 'open' sound.

Since this is a low feedback design, circuit stability is not a real problem. Capacitor C6 and resistor R12 are used for 'lead' compensation, to improve stability at high frequencies. However for those builders who prefer an extended high frequency response these components can be removed without affecting the overall stability.

Components R7, R8, R11, R16 and R17 are 'stoppers', used to ensure stability and reduce the amplifier's sensitivity to RF interference. Similarly resistors R20 and R21, in series with the output valve screen grids, are included to improve stability and minimise distortion. The latter have a nominal value of 1k, but those who require greater power output can reduce their value to 470 ohms if desired.

MEASURED PERFORMANCE

Frequency response
(1W into 8 ohms):
3Hz - 40kHz, +/-3dB

Power bandwidth
(30W into 8 ohms):
10Hz - 35kHz (- 3dB)

Signal to noise ratio
(relative to 30W):
93dB

Maximum power output
(both channels driven, into 8 ohms):
38W RMS/channel

Input sensitivity:
700mV input for 35W output
into 8 ohms (gain approx. 25)

Damping factor
(1kHz, 8 ohm load):
2.57 (Output valve Iq = 30mA)
3.76 (Output valve Iq = 60mA)

Total harmonic distortion:

Power level Frequency	Output valve Iq = 30mA	Output valve Iq = 60mA
1W at 1kHz	0.12%	0.03%
3W at 1kHz	0.20%	0.05%
10W at 1kHz	0.70%	0.18%
30W at 1kHz	2.30%	0.70%
35W at 1kHz	2.70%	0.95%
30W at 40Hz	3.5%	1.5%
30W at 10kHz	3.1%	1.8%

Intermodulation distortion
(two tones, 4:1 ratio):

Power level	Output valve Iq = 30mA	Output valve Iq = 60mA
10W	2.4%	0.3%
30W	6.0%	1.3%

Although the grid of V1a is nominally at ground potential, coupling capacitor C7 is used to prevent any possibility of noisy volume control operation due to grid current.

Resistors R25 and R26 in series with the output valve cathodes are basically to allow convenient monitoring of each valve's quiescent current, using a DMM.

Since the resistors have a value of 10 ohms, they will have a voltage drop of 100mV for each 10mA of quiescent current. With this low value the resistors do not make any significant contribution to valve performance, although in theory they will introduce a small amount of negative current feedback and protective self-biasing.

The power supply (Fig.2) uses a single untapped HT secondary winding on the transformer T2, with a voltage of 350V. This feeds high-voltage silicon bridge rectifier B1. Series-connected capacitors C8 and C9 are used for the capacitor-input L-C filter, which uses inductor L1 (1.5H) to provide excellent hum filtering. Output reservoir capacitors C10 and C11 provide a total of around 340uF of capacitance, to cope with peak current requirements and achieve good dynamic response.

Resistors R29 and R30 are used to ensure that the capacitors share the applied DC voltage equally, despite differences in leakage current.

Negative bias for the valves is produced from a separate 57V transformer winding, with a half- wave rectifier using diode D1 and capacitor C13. R-C filtering can be used here, due to the very low current requirements. Using readily available 100uF capacitors for C13 and C12, together with a 10k resistor for R24, we are able to maintain the hum on the bias supply to a very low level.

Resistor R23 is used to limit the range of the output valve bias adjustment pots P2-P5, to make adjustment easier and also prevent the risk of damaging the valves due to accidental removal of bias.

The input valve current sources, based around Q1, are supplied directly from the negative rail available across C13.

The valve heaters for each channel of the amplifier are powered from separate windings on the power transformer, to minimise any possible crosstalk. Each winding has a centre tap, which is earthed to ensure low hum coupling into the valve cathodes.

Finally, a few words about grounding. Some care must be taken in grounding any valve or transistor amplifier. Here a 'star' grounding technique is used throughout. The PCB ground, power supply ground, chassis ground and mains earth are all connected at a single point on the tagstrip supplied, which has one leg screwed to the case/chassis.

Using this method, ground loop hum is extremely low at the speaker output terminals, and virtually inaudible. Note that the input stage grounding is decoupled from that for the rest of the circuit via R27, to minimise earth loop currents.

The grounding technique used will be discussed again in the next article.

Component quality

As mentioned earlier, components play an important role in the sound quality of any amplifier. Here good quality components are used throughout, without

going 'overboard'. If the very best components were used, then the amplifier would not be within reach of most music lovers. But by making a sensible choice of components, we are able to achieve good sonic quality without allowing the cost to escalate unduly.

Metal film resistors are readily available nowadays, at a very reasonable price. While there are even debates among audiophiles on the type of metal film resistors which gives the best sonic quality, in this project we use the normal type — i.e., no special brand. These resistors give a cleaner sound over their carbon counterparts.

The capacitors are the most critical components which affect the sound quality. It is not advisable to use polyester capacitors for signal coupling, because of their high distortion. The normal choice is polystyrene for low values and polypropylene at higher values. The latter have been chosen for this project as coupling capacitors, while polycarbonate capacitors are used for bypassing.

The 12AX7, 12AT7 and EL34 valves have been chosen for their sonic quality, while at the same time being readily available off-the-shelf.

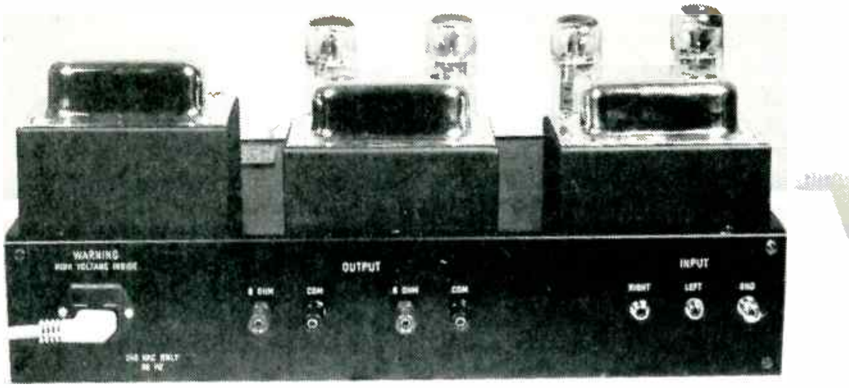
The prices of these valves are reasonable (by today's standards), with the 12AX7/12AT7 costing about $10.00 each and the EL34 around $18.00 each. The circuit is designed such that the output valves should last for a long time, if the bias is set for low quiescent current class AB operation.

The critical component in any standard transformer-coupled valve amplifier is of course the output transformer. The output transformers used in this project are designed and manufactured in Victoria, Australia.

They have a very impressive specification, with a frequency response of 13Hz — 60kHz +/-1.0dB. A grain-orientated iron core is used to give this frequency response. Under testing, each transformer can deliver full rated power (35W) from 23Hz to 20kHz, without excessive distortion.

The power transformer comes from the same local source, and is a husky unit designed to provide more than enough power for both channels. The total power rating for the transformer is 250VA, which gives a capacity for at least 100VA per channel, plus the power for the heaters which is another 50VA.

For those who require a volume control, a high quality dual-ganged



A rear view of the amplifier, showing the input connectors at far right, the speaker terminals in the centre and the mains input connector at the left. The power and output transformers are locally manufactured and of high quality.

logarithmic potentiometer is available. This pot is especially matched to enable the same output to be achieved from both channels. Also included is a volume control knob.

Sound quality

Now, the question that by now, everyone will be asking: how does it sound? The attractive feature of this valve amplifier is the 'warm' sound, with emphasis on the midrange.

While it may lack the deep bass response of some transistor amplifiers, the latter cannot give the same degree of rich warm sound. Mid-priced transistor amplifiers can also tend to sound 'flat', by comparison.

Without being at all biased about this amplifier (after all, I am its designer!), the following claims are made:

It offers a 'clean' sound, without being too clinical through the use of quality resistors and capacitors.

The midrange is warm and rich, terms synonymous with traditional valve technology.

The bass response is much fuller than many traditional valve amplifiers. Although not as powerful as some transistor amplifiers, it blends in well with the lower midrange.

The treble response is well behaved and can sound a bit bright on some speakers. But after a sufficient warming up period, the brightness tends to disappear.

The overall sound brings out the vocal qualities in many recordings. It is not embarrassed by recordings with wide dynamic range.

In an A-B comparison with a commercial valve amplifier which cost over $4000, it gave very comparable performance. In fact in some areas, it was even judged to sound better. A comment from one reviewer was that it has 'the romantic sound of a Leak, but with better bass response'.

No doubt there is still room for improvements in the circuitry, so as to improve the sonic quality. This could well become a subject for further discussions in future issues of *Electronics Australia*, if there is sufficient reader interest.

(Editor's Note: Mr Tan loaned us a prototype of his amplifier for a couple of weeks, and we were able to both test it with our lab instruments, and conduct listening tests in our homes with suitable speakers and signal sources. The loan unit was also used to take the photographs.

The results of our measurements are shown in the table. As may be seen, it gave a good account of itself even by modern standards, with wide frequency and power response, a good signal to noise ratio and genuine 38W RMS output per channel into 8-ohm loads with both channels driven.

Understandably, for this kind of amplifier, the total harmonic distortion and intermodulation figures were both quite dependent on the quiescent current level chosen for the output valves. Increasing the quiescent current levels to 60mA for class A operation reduced the distortion by a factor of four times, for example.

However this will undoubtedly shorten the life of the valves, as the author points out — even though the dissipation of each valve (30W) is still within the official ratings.

The design therefore seems a good one, in that constructors can decide for themselves how much they are prepared to

'pay' for lower distortion, in terms of reduced valve life.

In our listening tests, the Stereo Eighty provides some very pleasant and relaxed listening. It can drive reasonably sensitive loudspeaker systems with ease, and provides very smooth and well-balanced sound. With most kinds of programme material there is very little, if any, 'edginess' due to distortion — even with the output valves running at only 30mA quiescent current. No doubt this is due to the relatively 'soft' nautre of the distortion produced by a valve amplifier, with predominantly low-order harmonics being generated.

Only with more complex programme material like that produced by a full orchestra and/or a choir, could we really detect the effects of THD and IMD, at the lower current setting. However our impression is that even this becomes virtually inaudible when the quiescent currents are increased.

In short, we're very happy with Mr Tan's design, and delighted to present it to our readers. We believe he has provided today's audiophiles with an excellent way to build a flexible, high quality stereo valve amplifier, at a reasonable cost and with minimum hassle.)

Obtaining the kit

A complete kit for the Stereo Eighty amplifier can be obtained from Contan Audio, of 37 Wadham Parade, Mt Waverley 3149; telephone (03) 807 1263.

The price for the kit, complete except for the special volume control potentiometer and knob, is $999 plus postage/freight if applicable. If the volume control is required as well, the price is $1035 plus postage. These prices include sales tax.

If required, the amplifier can also be supplied in fully assembled and tested form. In this case it is priced at $1249 without volume control, or $1284 with volume control. These prices again include sales tax, but postage/freight must be added if applicable.

Contan Audio can also supply individual components such as output transformers, power transformers, chassis, valves and so on. Prices for these items are available on request. All parts are guaranteed for one year, except the valves which are only covered for six months and against manufacturing defects only.

In the second of these articles, the assembly and adjustment of the amplifier will be described.

(To be continued) ❖

FORUM

Conducted by Jim Rowe

Tying up a few loose ends, about toroidal transformers and magic power cables

Not surprisingly, quite a few people have written in to comment on the item in the June column, about a power cable that is claimed to make your hifi system produce distinctly better sound. One reader even accuses ME of pontificating! There have also been a couple of further responses to the May discussion of toroidal power transformer safety, so I've decided to devote this month's column to 'tying up the loose ends' for these two topics.

Let's deal with the toroidal transformer safety business first, since the letters concerned have been waiting a little longer. The letter I'd like you to consider first comes from Steve Calder of Hycal Electronics — who started the discussion in the first place, you may recall. Steve has responded to the points raised in the May column, as follows:

I would like to respond to the May Forum concerning the toroidal transformer controversy, since my name was mentioned several times.

Firstly, you have correctly grasped the central issue I was talking about, in my letter published in February. That is, that toroidal transformers supplied with kit projects are not 'inherently fail safe'. Which means that unless external devices (NOT specified by the transformer manufacturers or suppliers) are fitted, they are inherently unsafe when overloaded.

Your correspondents, the transformer manufacturers and suppliers, all skimmed over this point as one might expect, and concentrated on irrelevancies like how many plastic wraps were used, etc. Anyone can check that copper melts at around 1082°C, so a plastic wrap that melts at 250°C is no safety barrier at all. Even a hot soldering iron will go straight through it!

Secondly, I would like to comment that in most commercial amplifiers I have seen, using toroidals, the power supply centre tap is grounded to mains earth and hence the secondary of the transformer is grounded. If this is the case in a kit project, then there is usually no safety hazard to the user even if the transformer insulation melts down.

However where this is not the case, as in several bench power supply projects published in the last few years, there is a distinct possibility of the output becoming live if the transformer overheats. I would strongly recommend owners of these units to connect the common or negative output terminal to mains ground immediately.

Finally, would the manufacturers or other transformer experts who promote their toroidals as complying with AS3108 kindly publish information covering the full range of their transformers, as to the types and ratings of thermal breakers, thermal cutouts or fusing they would recommend, so that the home constructor and kit designers can make their installation comply with AS3108. Also can they suggest where to obtain these devices?

Failing this information being supplied, possibly the use of an ELCB or Residual Current Device (safety switch) would be advisable, with projects employing toroidal transformers.

In conclusion, let me thank you for the unbiased way in which you have conducted the debate on this matter.

Thanks for those further comments, Steve, and especially for that final compliment. I always try to tackle our Forum subjects as objectively as I can. It's good to know that I was successful in spotting the main point you were originally making, too — about whether or not toroidal transformers were 'inherently fail safe' or not.

I'm not sure which bench power supply project designs Steve is referring to, though. To the best of my knowledge we haven't published such a design using a toroidal transformer, in the five years or so that I've been back at *EA*, so if he's referring to one of our published projects, it must be before then and during the time I was away. All of the supply designs we've published in the last five years have used standard E-I type transformers. And the couple of projects we've published which *have* used a toroidal transformer (like Rob Evans' Playmaster Pro Series 1 amplifier and Pro Series 2 Preamp) have also used a secondary circuit that is either permanently connected to mains earth, or effectively so in operation.

Although Steve Calder's suggestion about immediately connecting a bench power supply's common or negative output to mains earth sounds OK from a safety viewpoint, I imagine it could well create problems when the supply is being used. The output of bench supplies is normally left floating deliberately, so that multiple supplies can be connected to test circuits in any desired combination without complications.

For any readers with such a supply, my own suggestion would be that rather than connecting either side of the output *permanently* to mains earth, you may want to fit an additional 'Earth' terminal to the front panel, connected to mains earth. This will allow you to link one of the output terminals to this most of the time, but also to remove the link (or perhaps earth the other side of the supply's output) when this is necessary.

If the toroidal transformer doesn't already have a suitably rated fuse in series with the primary, I'd fit one as a matter of course. And to be really safe, I'd suggest fitting a thermal cutout device as well, mounted so that it will respond to any dramatic temperature rise in the toroid's windings.

Mind you, as Steve Calder suggests, getting hold of such a device may not be easy. Many of the suppliers do seem to have been rather coy about them, both in terms of their being desirable, and in terms of 'where you get them'.

FORUM

I notice that Jaycar Electronics has five types of 'thermal fuse' listed in its latest catalog, however. These have cutout temperatures ranging from 72°C to 240°C, and I imagine that the units rated at either 152°C or 228°C would be suitable for the job. They're quite cheap ($2.75 each), but you'd have to make sure that their leads are well insulated — because the cutout has to be wired in series with the transformer primary, and will be at mains potential.

As Steve Calder suggests, using an ELCB/RCD device would also offer a degree of protection, in the event of a 'melt down'.

Toroid maker

Moving on, the second letter concerning toroidal transformer safety comes from Michael Larkin, who also contributed to the May discussion. Michael is a director of Tortech, you may recall, a manufacturer of toroidal transformers based in Sydney's North Strathfield. Here are his follow-up comments:

As a further extension to the May article and your comments, I would like to explain that transformers can be designed and manufactured to limit the overload situation.

The device to do this is called a thermal cutout, and is normally wound in the transformer primary winding. It is not external, but is incorporated into the transformer. This means that the transformer is deemed to be 'non-inherently overload protected', as defined in AS3108-1990. The device will turn off the power to the input winding of the transformer immediately, when its rated cutoff temperature is reached.

Once the transformer cools down, the device will attempt to regenerate the primary circuit, but if the overload situation is still present the transformer will heat up again, and the device will again turn the power off.

These devices are readily available and can be supplied. Transformers with this thermal cutout device have been tested and approved by a NATA testing laboratory on Tortech's behalf.

Summarising, it is not possible to overheat the transformer with this kind of device wound into the primary winding, and this type of transformer will therefore not fail by overheating due to an overload situation.

From our point of view, when dealing with customers we discuss the merits of such a device and incorporate it if required. On large transformers (300VA and over) the cost is relatively small.

Thanks also for your further comments, Michael. They do clarify some of the points raised by your letter reproduced in the May column — especially the fact that a thermal cutout can be built *inside* the transformer, to provide a level of protection that must indeed be very close to that of an E-I transformer with a divided bobbin, in practice.

Incidentally Mr Larkin also invited me out to visit the Tortech factory, both to see how their toroidal transformers are made and also to see a demonstration of the overload protection achieved using a thermal cutout. Happily I was able to accept his invitation, and found the visit very informative.

The demonstration involved a toroidal transformer rated at about 150VA, provided with an internal thermal cutout and wired to a load which amounted to a very severe overload — around 200%. When I arrived the transformer had been on for a couple of hours, and its temperature had risen to the point where the thermal cutout had opened up, removing power. When the transformer had cooled down by about 30°, the cutout re-applied the power — but as the overload was still present, it took only 15 minutes or so for the temperature to rise again and the cutout to 'pull the plug' again.

[illegible]

While I was there, this cycling took place a number of times. Clearly the cutout was reliably preventing the transformer from overheating and being damaged, demonstrating Michael's point that such a transformer is quite safe.

But how many of the toroidal transformers sold by electronics suppliers, either separately or in kits, are fitted with this type of thermal cutout? This was the question I asked Michael Larkin, and he had to admit that in many cases, suppliers have chosen *not* to order their transformers fitted with the cutouts. Presumably this is done in order to save costs, with the idea that the end users would rather do this than pay for the additional safety feature.

As Michael Larkin points out, firms like Tortech can't *force* customers to pay the higher price, to have the thermal cutout built in. All they can do is point out the advantages. If the customer (which in Tortech's case is generally the components or kit retailer) chooses *not* to order them with the cutout fitted, that's *their* business.

Which means, I guess, that it is the end users themselves — you and I — who have to decide if they want the additional safety provided by the thermal cutout, and are prepared to pay the extra cost. Then we'll need to apply pressure to the parts and kit stockists, to carry them.

The ball's in our own court, then, as consumers. As Michael Larkin has shown, toroidal transformers can be made effectively just as safe as the conventional type. The question is, how many of us are prepared to pay the additional cost? What's your life worth — or that of one of your loved ones?

Pope Jim IV?

And with that observation, let's move on again and return to the subject of special 'purer power' mains cables. There have been quite a few responses to the discussion of these in the June issue; most of them were skeptical, like myself, but there was one which took me to task for my critical approach.

Let's look at this one first, in case anyone thinks I'm trying to avoid or delay criticism. The writer concerned is Mr Dan Dempsey, of Oatley in NSW, and here's what he has to say:

My annoyance with your writings on hi-fi must be cumulative. I can't let your latest missive on cable effects go by without comment.

You pontificate on hi-fi matters just as I imagine the clergy did when Galileo was making his 'discoveries'. They refused to believe their eyes, just as you refuse to believe your ears. Or is it that you have impaired hearing (in which case I offer my sympathy) or perhaps you have yet to hear a high definition system.

I agree that some hi-fi advertisements read like gobbledegook and I wonder how much of it is 'copywriter's licence' (which is not exactly confined to the hi-fi arena).

I've heard plausible explanations on reasons for the differences in sound of cables, but for most people the explanation is secondary. The over-riding consideration is: do cables sound different?

People listening to music through a typical rack system with (maybe) one speaker behind the lounge and the other on a shelf are never going to hear the differences between cables of any sort (and probably not a lot of difference in most music). The others who have bought a reasonable high fidelity system and have taken the trouble to set it up won't need convincing on the effect of cables on the sound.

Sometimes the effects are unexpected. For example, some of the most obvious sonic differences can be heard in coaxial/RCA digital interconnects, between CD transports and outboard D/A converters. Digital data is supposed to be least affected by cable properties, yet different interconnects modify the sound as much as amplifiers do.

The effect of the 240V power chord is more subtle and is probably system and locality dependent (dirty mains/roads?). The most convincing demonstration that I've heard involved changing the power chord on a pair of electrostatic speakers. This chord powers the electronics charging the high voltage plates in the speakers and does not carry any signal; yet the effects were unmistakable.

Needless to say, I don't expect this letter will change your views on cable effects. But perhaps I could arrange a demonstration that might dent your confidence. Then you could search for the explanation for cable sound!

Thanks for your comments, Mr Dempsey — or should I perhaps offer you some kind of blessing? We pontiffs need to be fairly magnanimous, I suppose.

Actually I'm not quite sure exactly *why* I'm being accused of pontification; Mr Dempsey gives no specific examples, just a general claim that I do it. Since I generally go to some trouble to discuss facts and analyse claims in detail, rather than simply delivering some kind of *ex cathedra* pronouncement such as 'it can't possibly work', it doesn't sound a particularly valid criticism. But then I suppose I *would* be expected to claim that, wouldn't I?

Frankly, Mr Dempsey's criticisms sound very much like yet further variations on the familiar theme 'if you can't hear the dramatic difference of these cables, you either have cloth ears or a hopelessly low definition system'. Presumably we should now add two further options: 'or you haven't set up your system correctly, or you're so fixed in your ideas that you refuse to believe your own ears'.

I can't help but suspect that Mr Dempsey's definition of impaired hearing applies to anyone who cannot hear the alleged sound improvement provided by fancy cables. Similarly, I imagine his definition of a hifi system with 'poor definition' is one where you can't hear the same improvement.

Presumably if I can show evidence that (a) my hearing is reasonably normal, according to the usual audiometric tests, and (b) I've tried listening to various cables on a system that at least a reasonable number of 'hifi experts' agree is capable of 'high definition', but I still remain unconvinced, then Mr Dempsey will still want to fall back on his trump card: I supposedly won't believe my own ears!

There's really no answer to this kind of proposition, because it's actually closer to the position taken by the medieval clergy, than to Galileo. The only valid comments are those which support the belief system of the 'convinced' cable enthusiast, it seems.

How about Mr Dempsey's offer to set up a demonstration, to convince me that cables *do* make an audible difference? Well, I've had a number of offers along

the same lines, but none of them seems to have come to anything.

Perhaps that's because I've made it clear to all concerned that in order to convince *me*, the demonstration/test would have to be of the 'double blind' A-B comparison type — where neither the listeners nor the experimenter knows which cables are in use, during the actual listening tests. Only then, if statistical analysis of the results shows that there is a significant probability in favour of consensus discrimination, will I believe that there's anything to the claims.

Why am I insisting on this kind of test? Simply because I know that we humans — ALL of us, ME included — have an almost limitless ability to fool ourselves. It's just *so easy* for us all to convince ourselves that we're hearing, or seeing what we expect (or want) to hear or see. So unless we force ourselves to be objective, using this kind of approach, the results of any demonstration or test are highly dubious.

Dangerous braid?

Moving along again, another letter referring specifically to the 'super clean power cord' came from Mr M. Madden, of Trott Park in South Australia. Mr Madden writes as follows:

I have only a couple of comments, i.e.,

1. One redeeming factor that I can see is that the cable appears to be covered with a braid. I am assuming the braid to be connected to the earth pins of the terminating plugs, a well-known practice for the reduction of RFI in the amateur radio and electrical circles.

2. The other point, of which I personally am a bit wary of (whether real or imagined) is if the earth potential is increased substantially by the advent of EMS (electromagnetic storms) or EMP (God help us if this should occur). Catastrophic equipment failure could be possible, and/or shocks obtained from the equipment in use, if contact is made with same.

The other thing I thought of, while in the shower, was that the braid should have been insulated with a cover, to offset the problem of inadvertent contact. In other words it is an extremely bad design practice, in my opinion.

Thanks for your comments also, Mr Madden. I must confess that I had assumed from the picture (and in the absence of any claims about shielding) that the cable concerned to be covered in woven cotton or similar fabric, rather like the traditional jug or iron cords, rather than metallic braid. But you may be right — perhaps it does have a shielding braid, in which case I agree that it should really be covered with further insulation.

By the way, if you're wondering about that acronym 'EMP' — it stands for 'electromagnetic pulse', and is believed to be radiated from a thermonuclear explosion (i.e., a hydrogen bomb).

Battery operation!

Another response to the June column came in the form of a fax, from Mr Alan Jeffrey of Blackmans Bay, in Tasmania. Mr Jeffrey comments:

Regarding 'The Power Cord' mentioned in June's Forum, you may be interested in the accompanying pages. I received this sometime in 1989. The product looks similar except for the American plug.

These people have to be joking — can they really be serious?

I have an idea they may like, for power supplies. Forget about mains power; use batteries. I suggest that for good bass, lead-acid batteries should be used, while the mid range would probably benefit from nickel-cadmium. For the treble, the choice would have to be lithium.

I am only joking, but if some of the 'Golden Eared' types hear of it, they will probably try it. Maybe I should patent the idea. Replacing the power supply with batteries would enable the designer to eliminate the electrolytics in the power supply, thus opening up the possibility of a true 'output capacitorless amplifier'.

I have just heard of another one: a green plastic ring, to slip onto the circumference of CD's. No more messy pens!

Keep up the good work.

Thanks for your comments too, Mr Jeffrey. By the way, the 'accompanying pages' to which Mr Jeffrey refers are pages from a sales flyer sent out from a Melbourne hifi dealer, with reference to a similar 'sonically superior power cord' — identified as the 'MAS Powermaster'. The brief blurb describing this product's claim to fame offers the comment that 'there is an absolute plethora of arguments for why such a device should — in fact does — work. But who cares? All you have to do is listen to it!' I imagine Mr Dempsey would be gratified...

But not our next writer, who is none other than our frequent correspondent Mr Norm Bush, of Canterbury in NSW. Mr Bush's letter is pretty long, so I've taken the liberty of extracting the main points he makes:

I read with great interest your June Forum — it looks as if another 'magic' cable has floated to the surface! I read the advert that accompanied the article, and have come to the conclusion that, to use your own terms, it is a lot of 'dah dum'.

The 72-hour waiting period before you 'hear' the difference sounds (no pun intended) suspicious to me. More dah dum, I think! At $199, you'd think the bloody cable would at least be run-in and ready to go.

There are a few other things about the cable which further arouse my suspicions. The three-pin plug appears to be an ordinary type, available at most hardware stores — unless the pins are of 'pure grain-orientated brass' — while the socket is a standard IEC type. The lead itself appears similar to the type once fitted to valve radios and electrical radiators. Not only that, but each end of the outer sheath looks as though it has a piece of insulation tape around it. I am inclined to think this 'wonder' cable is an April fool's joke. If it isn't, then the price sure is!

I would like to see these so-called 'better' products get the acid test by one of our consumer groups, where an A-B comparison could be made by ordinary people with ordinary hearing.

Still, I await with great anticipation for a special lead-sheathed cable to appear — just in case there are any stray X-rays or cosmic radiation lurking out there, just waiting for the chance to degrade the performance of my equipment!

Thanks for your comments too, Norm — I liked that bit about expecting the cable to be at least 'run in', if you were paying that kind of money.

It's a bit unfair of us to criticise the Electrocompaniet cable on the basis of assumptions made from the picture, though. Perhaps the plug and socket are specially re-worked, with contacts plated with precious metals, or other fancy 'enhancements'. Not that this would necessarily make much difference to the performance, of course, but it's easy to fall into the trap of criticising on the basis of our own assumptions. I'd need to see a sample of the cable, before deciding some of these aspects.

As for lead shielded cable, why stop there? Presumably it would be even better to shield everything — amplifier, speakers, CD player and all.

And that's about all we have space for, this month. I have just received one more letter on the subject of cables, from a reader who has carried out a lot of careful measurements comparing three different 'grades' of speaker cable. The results are very interesting, so I'll try to present it next month.

I hope you'll join me, brethren. Until then, peace be with you. ❖

Digitor handheld DMMs

Dick Smith Electronics now has available several new members in its Digitor DMM range. The meters are particularly well protected from all types of hazards — shock, dust and liquids, and electrical overloads. They even emit an audible beep when contact is made with a dangerous voltage.

The three handheld digital multimeters sent to us for review include a basic 11-range pencil-style meter, model Q-1580, obviously designed for field measurement; a 27-range model (Q-1582) which allows you to manually override the autoranging on DC and AC voltage and resistance measurements; and a very similar 29-range model Q-1584, which also includes six capacitance ranges.

Also sent for review was a 300A current clamp, which slides onto the top of the slim Q-1580 meter, but which can also be attached by special leads to any other meter. Such meters need a 2V AC range to obtain a direct reading.

All three meters feature a 3.5 digit display, auto power-off, a low-battery voltage indicator, and an audible beep when contact is made with a potentially dangerous voltage greater than 28V. Their measuring rate is 2.5 times per second, with a typical input impedance for voltage and resistance measurements of 9M ohms.

Very good physical protection is provided by a high-impact case, (which is claimed to be drop tested to 3m!) and the two sections of the housing are sealed with an 'O' ring to keep out dust and liquids.

Input protection is provided by the use of both a fuse and a MOV (for transient voltage surges). Even the 20A current range, on models Q-1582 and 1584, is protected with a separate 20A fuse.

Models Q-1580 and 1582 also have a very convenient 'HOLD' button, to freeze any reading on any range. As well, both have a logic high (voltage reading>2.8V) and logic low (<0.8V) indicator. All three meters include a continuity/diode tester.

Model Q-1580

A 12-position rotary switch gives you access to the various ranges on this meter: DC and AC volts, ohms, one capacitance range (200uF), and the logic and diode testers.

There are three ranges for DC voltage: 2V, 200V and 1000V, with an accuracy of (+/-)0.5%+1 count. Similarly, there are three AC voltage ranges: 2V, 200V and 750V, with an accuracy of 1.2%+3.

Resistance is measured on two ranges only: 200 and 2k ohms, with 0.8%+1 accuracy.

Test leads plug into sockets at the very top of the meter casing. However, only one test lead is provided with this meter, plus a short, plug-in tip. The lead is used for negative or neutral connections, while the protruding tip makes the positive or active connection. This makes for convenient one-hand operation.

These top sockets also have another use. The current clamp, model Q-1590, is designed to slide over the top end of the meter and plug directly into them. This clamp accessory contains a 1000:1 current-to-voltage converter, which allows AC (only) current readings up to 300A to be read directly on the 2V AC voltage range of the meter. A lever allows you to make a temporary break in the circular metal former of the clamp to insert one current-carrying conductor. The sensor now encircles the conductor, and allows you to measure the current without having to break into the circuit.

Model Q-1582

Far more ranges are provided by the 17-position rotary switch on the Q-1582 meter. DC and AC volts and ohms are autoranging, but the use of the 'RANGE' button allows you to restrict readings to any selected range. Holding the button down for two seconds easily returns you to 'autoranging'. A very useful addition to the display is the indication of the range selected by either you, or the meter. This range value appears, very small but quite readable, immediately below the actual reading.

There are five DC voltage ranges: 200mV, 2V, 20V, 200V and 1500V, with 0.5%+1 accuracy. AC voltage has four

ranges: 2V, 20V, 200V and 1000V, with 1.2%+3 accuracy.

Resistance is measured on six ranges: 200, 2k, 20k, 200k, 2M and 20M. The accuracy for the 200 ohm range is 1%+3, for the 20M range 3%+4, with 0.8%+1 on all other ranges.

Both DC and AC current have five ranges: 2mA, 20mA, 200mA, 2A and 20A. The DC accuracy is 1%+1 for the first three ranges, 2%+1 for the next, and 1.5%+1 for the 20A range. The AC accuracy is 1.5%+3 for the first three ranges, 2.5%+3 for the next, and 2.0%+3 for the 20A range.

This meter is also fitted with a trimpot to allow re-calibration of the basic 200mV range, should it be needed — provided of course that a suitable DC voltage calibrator is available.

The manual says that this adjustment can be made by removing the back of the casing, held in position by four screws. In actual fact, you also have to unscrew and remove one of the PCB layers to gain access to the trimpot.

Model Q-1584

The rotary switch selector on this meter has a massive 30 positions to choose from. This is mainly because none of the quantities to be measured (e.g. voltage, resistance) has autoranging, and the meter also includes six ranges of capacitance.

The DC and AC volts and resistance ranges, together with their accuracies, are the same as with model Q-1582.

But there are three current ranges only: 200uA, 200mA and 20A, for both DC and AC. DC accuracy for the first two ranges is 0.75%+1, with 1.5%+1 for the 20A; the comparable AC figures are 1.5%+3 and 2.0%+3.

Capacitance is catered for with six ranges: 2nF, 20nF, 200nF, 2uF, 20uF and 200uF. The accuracy for all ranges is 2%+5.

Like the model Q-1582, this meter also has a trimpot for re-calibration. It is accessed in the same way.

Inside the case

Four self-tapping screws secure the front and back sections of the sturdy case of each meter. When removed, the two halves easily come apart, displaying the 'O' ring which provides their dust-proof and water-proof protection. Models Q-1580 and 1584 are powered by a 9V battery, while Q-1582 has two AAA batteries. As mentioned before, all models give an display indication when the battery voltage is low.

The rotary switch mechanism dominates the meter 'works', sandwiched between the two PCBs which contain the electronic components. When the bottom PCB is removed on models Q-1582 and 1584 to access the trimpot, the rotary switch is seen to be a four-pole one, with spring clips rubbing directly on printed circuit board tracks. In both these models, the large 20A, 600V fuse is plainly visible.

The probes for these two models are standard, with handles with finger guards, and sharply pointed metal tips, with grooves near the end to 'lock on' to component leads.

Summary

The accuracy of the three meters was tested, where appropriate, with four DC and two AC voltages, four DC currents, six resistances and eleven capacitances. All the standards which we used to make our tests were calibrated with a Fluke 8050A meter, except the capacitors which were calibrated with an HP-4263A LCR meter.

Most of the Digitor meter readings were well within their stated accuracy, though there were a few exceptions which were marginally outside. This occurred mainly with the model Q-1584.

No exceptions were recorded with the model Q-1580, and only one occurred with model Q-1582. This was the reading of a 200.2k resistor which measured only 198k — its true value is still slightly higher than 199.7, which is the upper limit of 198 at 0.8%+1 accuracy.

Six exceptions occurred with model Q-1584: two DC voltages (2.999V and 9.982V) and four resistors (10.002k, 33.33k, 1000.01k and 200.2k). A 1nF capacitor also measured slightly high, but this could very easily be due to the capacitance of the measuring leads. However, it should be stressed, all these 'errors' gave readings just outside the stated accuracies.

The current clamp was not tested against a standard supply, but a comparison was made with a current measurement made with the Q-1582 meter reading, when inserted in series with the circuit. A fan heater running full bore was used to draw a fairly constant current. With the Q-1582 meter in series, the reading was 9.55A; with the current clamp on the Q-1580 meter, the reading fluctuated between 10 and 11A. The current clamp then gives a reasonably approximate current reading, but with far greater safety and convenience than the conventional measuring method.

For some reason, the lowest AC voltage scale on the Q-1580 meter is labelled 2000mV (and not simply 2V). This gives rise to some confusion in the operating instructions, which state that the meter will read the current directly on the 2000mV scale (which it does), but needs to be 'multiplied by 1000 if using the 2V range' — which it doesn't, because the 2000mV is the 2V range!

General impressions of the three meters are that they are all extremely rugged, and well protected against all possible hazards. They sit comfortably in the hand, and both larger models are provided with a tilt stand and a field hanger which can be hooked over a wire or small pipe. The LCD screens give very clear and easy-to-read displays of all measurements.

My particular preference would be for the pencil style Q-1580 model for field measurements, and the Q-1582 for the lab. I prefer the fewer positions of the 1582's rotary selector (compared with the 1584), and the use of autoranging scales for voltage and resistance, with its optional override facility. But, of course, the Q-1582 can't measure capacitance! I believe all models give good value for money.

The prices for the Digitor models Q-1582 and Q-1580 are $149; for model Q-1584, $179; and for the current clamp Q-1590, $39.95. All models are available at Dick Smith Electronics stores. (P.M.) ❖

Moffat's Madhouse...

by TOM MOFFAT

Wayward robots

Some time ago the *Australian* newspaper carried a report that in the not too distant future, robots would be performing surgery. Not doing the thinking or making the decisions, mind you, but operating under the guidance of a skilled medical man. I can see it all now...

Doctor: 'OK, you can wheel in the robot now.'

Robot (mechanical voice): 'Good morning doctor, how can I assist you?'

Doctor: 'Appendectomy'.

Robot: 'Scalpel please, nurse.' (buzz, click, click)

'Swab!' (click, slurp)

'Retractor!' (clank, click, whine)

'Oops.' (clunk)

'Sorry. Programming error.'

You see, the robot got a little confused. It couldn't quite decide whether the doctor had said 'appendectomy' or 'amputation', and now there was a leg lying on the floor. The doctor would have an embarrassing explanation to make when the patient awoke and tried to stand up.

Will robot surgery come? Maybe when speech recognition techniques are a little better? The answer is most likely yes. If robots can operate on cars now, people won't be far behind. Robots come into their own in work where extreme accuracy is required, providing someone with a bit more smarts is available to give the orders.

A lot of robotics research is going on all over the world, although not as much now as before the recession started. Many of the forward-looking companies have now gone under, but pre-recession, I was working with a company that did some really far-out experimental stuff.

Our main products for keeping the wolves from the door were educational robots for schools, mostly in the form of the 'Tasman Turtle'. But one fellow there developed a turtle with a fully articulated arm that could move about, pick things up, and put them down somewhere else, all the time avoiding bumping into obstacles. Another guy was working on a replica of the human hand that had fully jointed fingers and knuckles.

One question that always comes to mind in this kind of work is, 'I wonder if we can make it do this...?' — 'this' meaning some weird thing that has never been thought of before. Since robots are generally computer controlled, a new application sometimes means little more than writing a few lines of software.

Our ultimate 'turtle' product unfortunately never made it to market. It contained pretty much the normal turtle mechanics, one wheel on each side of the housing and skids front and rear. You could rotate both wheels at once to make the device go forward or backward, or if one wheel went one way and the other the opposite way, the turtle would spin around in one place. Combinations of these movements could make the turtle do just about anything.

The housing of the turtle was made to look something like the animal version, with a long neck and a pair of LEDs for the eyes. But inside was a system that took me several months to develop. The turtle moved with stepper motors, gadgets that draw heaps of power whether they are moving or standing still. This was the first battery-powered turtle, so it was necessary to power it up to move, and then quickly power it down again, even between 'steps' of the motors.

Control was no longer via a trailing cable, but by infrared light. I designed a fairly powerful infrared transmitter that fired a flood beam at the ceiling of a room, and reflection from the beam made its way back to the turtle. If someone stood in the way, the beam would find another way to get to the receiver. It was ideal for a classroom situation.

The IR beam was pulsed on and off with serial data, which was converted to an 8-bit byte in the turtle's logic circuits. It wasn't hard to make the system control two turtles at once — both turtles received all data, but we used one bit to specify which turtle was to respond to the command. If bit 7 of the command byte was set to '0' the command was for turtle A; if the same bit was set high, the command was for turtle B. If you wanted both to respond you quickly sent the command twice, once for A and once for B.

We released this new 'wireless' robot system to the world at an IEEE convention in Melbourne. We had two infrared turtles, an A version and a B version, named Amanda and Bertie. They were run via the infrared link from an old Microbee computer, which also had two speech synthesizers connected to it. The Microbee was running Forth, the ideal language for this kind of work.

Amanda and Bertie were programmed to do a little dance. One speech synthesizer, Bertie's voice, would say 'Come on Amanda, let's dance' and the other would say 'Oh, Bertie, I'd love to!'

And off they'd go, first bowing to each other, then rolling back and forth in unison, and then spinning around in circles. It was like a turtle square dance, with Bertie doing the calling. This took much trickery in Forth, sending alternate commands to each turtle as quickly as possible while controlling the two speech synthesizers.

Conventions, as a rule, have more than their share of dirty old men, away from their wives and families for awhile, and prepared to whoop it up a little. Some of these people saw what Amanda and Bertie were up to and wanted to see more. They thought maybe they should try to make little turtles. The challenge was thrown down: If these robots are so flexible and versatile, you MUST be able to make them — well, you know!

As I said, Forth is ideal for this kind of work, and it wasn't long before the world's first robotic soft-porn peep show was up and running.

Bertie began with a spiel of synthesized sweet-talk which Amanda responded to with the immortal line, 'But will you still love me in the morning?' After that came some robotic ac-

tions which I don't intend to describe in a family magazine, but you get the idea.

I realize this sounds a bit vulgar, but considering who (what) the participants were, it was very funny stuff. Grown men (and women) would line up at the display several deep to see the show, and then they'd fall about in uncontrollable laughter. Soon the show organizers came to see what all the fuss was about, probably intending to put a stop to it. But they got roped in too.

Perhaps the only people who weren't amused were the school officials who were supposed to buy the new robots. What would happen if Amanda and Bertie lost control of themselves on the floor of the classroom?

Maybe that's why the infrared turtles never made it into full production. It's a bit like teaching someone's prize cockatoo to swear, isn't it? Not nice, but fun.

Now consider the case of Elami, a robot designed mostly as a toy for very rich kids. The prototype Elami (pronounced EL-uh-me) stood waist-high on an adult human, or about the same height as a child.

Elami was billed as 'your electronic friend' and that's where I suspect the name came from — 'el' for electronic, and 'ami' as in amigo. Elami looked so good he even made the cover of *Your Computer* magazine, but he had a personality problem: he was a disgusting wimp, a yes-man, a real crawler.

Elami was constructed on a bigger version of the above-mentioned turtle base. He had a Commodore 64 computer in his belly, arms that stuck out the sides, and a nine-inch TV monitor for a face. Being an electronic friend, Elami's TV screen face was in perpetual smiles, At the touch of a key his inbuilt speech synthesizer would say in a simpering voice: 'Hello, I am Elami. Please let me be your friend.'

Production model Elamis ended up about a quarter the size of the prototype. The Commodore computer gave way to an internal micro and a simple keypad, and the face became an array of LEDs instead of the TV monitor. But the wimp behavior remained, and I didn't see how any kid would ever enjoy a robot that did nothing but grovel. I was right; sales weren't exactly startling.

All that development had taken place before I arrived on the scene, and Elami's 'personality' had been pretty well dictated by the Japanese, who were seen as his prime market. When I arrived the prototype was still there, and people were making noises about hiring it out for conventions and shopping centre promotions. So my job was to 'ruggedize' Elami — strengthen his power supply and propulsion system, and strengthen his image. In short, make him into a MAN!

We souped up the wheel drivers, with bigger motors and a feedback system that would apply maximum current to get Elami moving, and then reduce the power once he was up to speed. The motors were controlled via a long cable by two handheld front-back switches, bulldozer style. Push them both forward and Elami would lurch into action, pull both back and he would reverse, and one switch at a time would make him turn.

We replaced the TV-monitor face with a pair of bicycle tail-lights for eyes, fitted with funny glasses, a big false nose, and a moustache. The mouth became a variable bar-LED display that worked from rectified speaker audio, so Elami's mouth opened and closed as he spoke. We installed a big speaker in his belly, driven by a 20-watt amplifier, so Elami didn't really speak — he bellowed. We installed a solenoid-operated gripper on his right arm so he could carry things, or pinch ladies' bottoms.

Elami's public debut was at a function to launch a new automotive paint, where he was required to make a speech. The original speech synthesizer had been replaced by an Apple computer at the end of the control cable, running a software package called SAM or 'Software Automatic Mouth'. This was programmed to deliver the entire spiel about the new paint, fully synthesized. The audience loved it, and we were in the hire-a-robot business.

Elami's next job was at a computer convention, in the presence of the Premier, industry leaders, top bureaucrats, and other bigwigs. By now his new 'manhood' had developed into a cross between W.C. Fields and the Barry Humphries character Sir Les Patterson. We had prepared a menu of appropriate comments on the speech synthesizer; press a number key and out it came. We could also plug in a microphone for more ad-lib comments.

Elami began his performance with 'Good morning Senator Grimes, and welcome to the show!'. He then backed away, to stand at polite attention as Senator Grimes delivered the opening speech. So far, so good.

But then the government officials came on, verbally slapping themselves on the backs for deeds supposedly well done for the local electronics industry, and promising more. Elami couldn't restrain himself, and he erupted at full synthesized volume with a sarcastic 'Ha, Ha, HA!!'

Mouths dropped. Eyes shot daggers at Elami, who stood there looking innocent. Elami's operators looked even more innocent. But Elami wasn't finished yet.

We had learned that the speech synthesizer could do pretty good sound effects as well as words, and Elami was prepared. Once the speeches were over, the captains of industry stood in little groups, drinking their drinks and cooking up business deals.

Elami decided to join them. We jammed the control switches forward and Elami charged out onto the floor at full tilt. When the group he was aimed at was about to scatter in terror, we threw the switches into full reverse. Elami lurched and skidded to a stop, rocked back and forth, flashed his tail-light eyes, and then emitted an ear-shattering belch. He then spun around toward another group to repeat the performance.

From then on we were known far and wide as 'those guys with that bloody robot'. But at least we were known, and Elami got quite a few more jobs making a public nuisance of himself. Eventually the novelty wore off — everyone had already seen Elami and learned to steer clear — and he spent several months in exile sitting in the corner on our workbench.

But then one day a knight in shining armour came along, in the form of an entrepreneur from Sydney. 'I'm going to take you away from all this', he said. 'I'm going to make you a big star'. And off Elami went, to find his fortune in the big smoke.

We never heard from him again. Did Elami break into the Sydney show-biz scene? With his new masters, did he continue his vile habits, or did he become civilized? Let's hope he's not too civilized, I'd hate to see him as a wimpy 'electronic friend' again. Elami might have been a bit rough, but he was lovable, too. ❖

[illegible]

THE SERVICEMAN

Puzzling faults that needed a certain amount of theory to track down

This month we have a couple of stories from my own bench — and stories with a difference. Each in its own way shows a kind of fault that requires more knowledge of theory than practical experience, if it is to be tracked down and eventually solved. Yet in both cases, the cause turned out to be a relatively simple 'low tech' one.

The first of the stories is about a colour TV receiver. When I began to write the report, the problem still existed and appeared so complicated that I was worried that I might never finish the job. Now that it is finished, I know that the fault was so simple and so silly that I am almost embarrassed to tell about it. Ah well, here goes...

It concerns a Sharp colour television set, a model DV4884. This is an elaborate stereo table model, with a 20" screen and detachable satellite speakers. It also features a dockable infra-red remote control.

When it first arrived, it would not do anything. Although the fuses were all intact and power was reaching the power transformer, there was no sign of life anywhere on the chassis.

In fact, this problem turned out to be quite easy to solve. It concerned a small, secondary power transformer mounted on one of the PCB's. The purpose of the transformer was to provide a 12V rail to the remote control receiver when the set was in 'standby' mode.

In this case, the transformer primary had gone open circuit and without the 12V rail, the remote control receiver had gone to sleep. This is another example of those products that cannot be operated without the remote control.

This time the circuitry had failed — but what if the RC handpiece had been lost? Or if the battery had gone flat? The entire TV would have been just useless junk, until suitable replacements could be obtained — providing they could be obtained.

I strongly recommend to my customers that they avoid like the plague any device that cannot be operated by front-panel push buttons alone. Remote controls are a great convenience, but they are a damnable nuisance if they can't be found or won't work.

The easiest way to check is to see that every button on the remote control has a corresponding button on the front panel. With some remote controls, that would mean a front panel covered with seldom- or never-used buttons. But at least all the main ones should be available.

(Come on, you've been on that soap box for long enough — Ed.)

Anyway, I was able to prove the point (about this Sharp remote control) by importing 12V AC from a small powerpack to the secondary side of the transformer. This allowed the set to be switched on, and indicated that there were no other obvious faults to be corrected.

I placed an order for a replacement transformer and put the set aside to await its arrival.

The new transformer went in without any hitches and the set was soon tidied up, ready to go back to its owner.

Display had gone

Unfortunately, the owner didn't have it for very long when he was on the phone again, asking as to where the ON SCREEN display had gone.

I had to admit to complete ignorance about the display. It just goes to show how complacent one can get.

When I had fired up the set, I had pressed button number 2 and up came channel 2. Keying in '28' had produced channel 28, and similarly for all the other channels. It simply didn't occur to me that there was no channel display anywhere on the set — neither on the cabinet nor on screen.

Now that the owner was complaining, I realised that I had not seen any on-screen display and that if there had been such before, then we still had a problem and the set would have to come back.

Which it soon did...

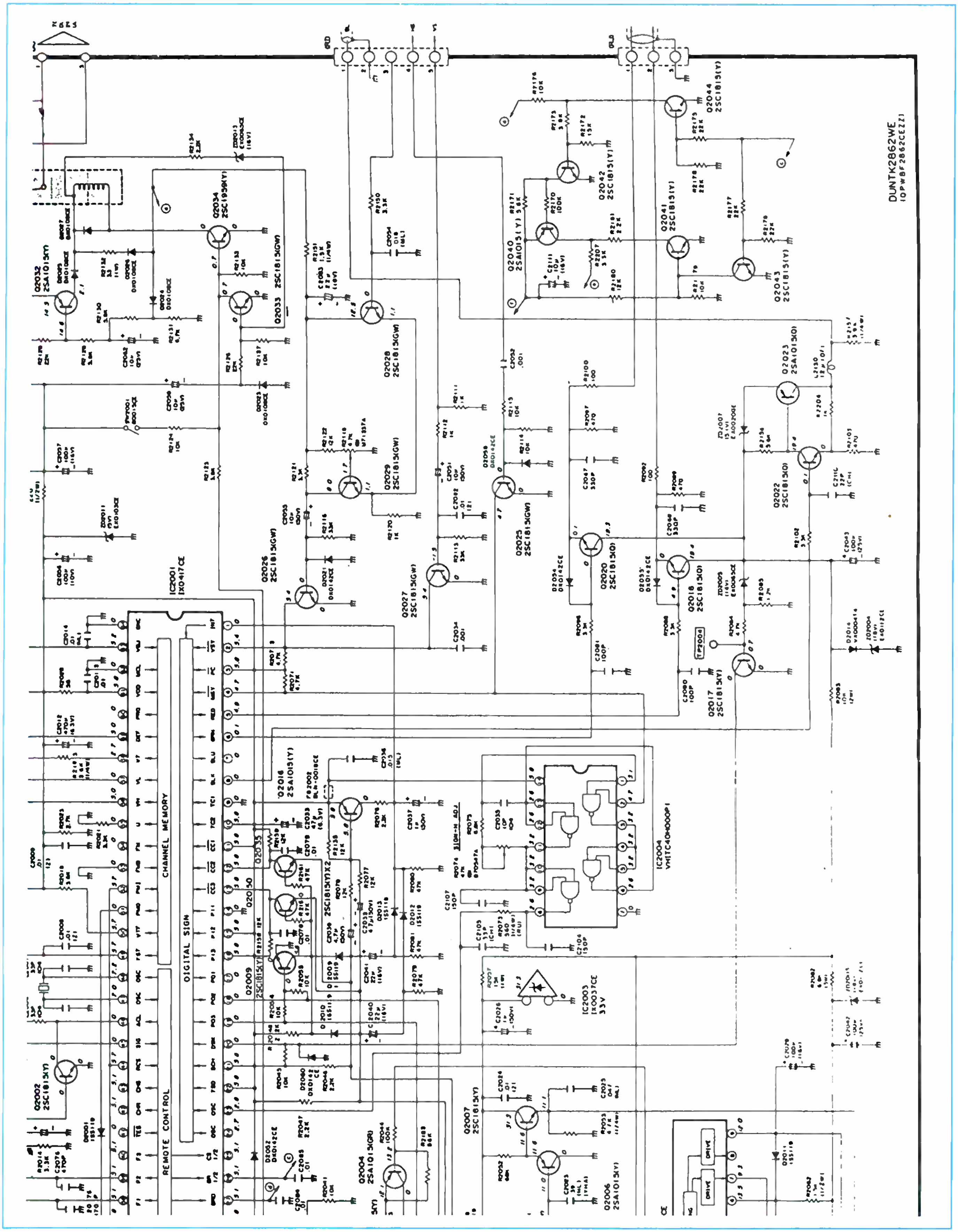
On the bench I began what I hoped would be a systematic search for the problem. The first hunt was for any loose or misplaced plugs or leads.

The works in this set comprise half a dozen or more separate boards, each connected with the others via numerous multiple leads. Any one of these loose or broken could account for the loss of the display. But I could find nothing of the kind. So I began a careful reading of the circuit diagram, to appraise myself of the way the display is generated and delivered to the picture tube. Unfortunately, the information on the diagram is little better than useless in explaining how the system works.

To begin with, I had to find out where the characters were generated, and this was in no way clear. Eventually, I found the source on the Remote Control board,

[illegible]

[illegible]



Our first story this month concerns a Sharp model DV4884 colour TV, in which there were two faults — or strictly one initial fault and another which the Serviceman inadvertently created. The first was easy to find and fix; the second turned out to be much harder. It was associated with the on-screen display circuitry, shown in this schematic.

in the middle of IC2001, a 64-pin LSI chip that also ran the remote control and the tuning functions.

Which didn't help things at all, because both the remote controls and the tuning were working perfectly. Although there is a possibility that part of a chip could fail, leaving the rest unaffected, it's not a very likely scenario. Like union stop-work activities, it's usually a matter of 'One out, All out!'

So for the time being, I decided to consider that the chip was OK, and that the cause of the trouble lay elsewhere. I was prepared to change my mind later, but for now I would search along the signal path towards the picture tube.

It was at this point that I realised that there were two distinct signal paths involved with the 'Digital Sign', as Sharp chooses to call it. It was a three-colour display and entailed separate red and green signals, to produce red, green and yellow 'signs'.

These passed through emitter followers Q2018 and Q2020, on their way to the tube, so anything that throttled the transistors would blank the signals. But voltage measurements around both transistors revealed nothing out of place. They should both be processing any signal presented to their bases.

My next test was to look for some kind of signal into or out of these two transistors. I stoked up the CRO and set everything up to look at the waveforms. Except that there were no waveforms to be looked at...

I had expected that there would be something coming out of the chip on the two signal lines. Either that, or something going into the chip on the line marked 'blanking'. But there was no sign of anything, anywhere.

With 64 pins to look at, I didn't relish doing a voltage check around the chip. But a further examination of the circuit diagram showed that only 24 of the 64 pins were associated with the on-screen display. So I began to think that a voltage check would not be so tedious after all.

And in fact it wasn't all that terrible. Most of the voltages were reasonably close to the figures given on the diagram. The exceptions were the two signal output lines. These should have been zero on the green line, and 4.9V on the red line. But they were both about 3V.

I didn't know what to make of these voltage readings. They could be the result of a faulty chip, or it could be that the chip could not develop the correct voltages because of an external malfunction.

For some time all I could think of was that I would have to unsolder 64 pins and change the chip, if only to prove that the original chip was not faulty. It wasn't a pleasant prospect.

There seemed to be just one more possibility. I hadn't checked the blanking transistors Q2022 and Q2023. If either of these were faulty, they could conceivably stop the chip from working, via Q2017 into pin 20 (marked DSK, whatever that means!)

In fact, that last comment was indicative of all the trouble I was having with this set. All of the pins on this chip had labels, but most were quite unintelligible: TCI, TCR, bar CC1, CC2 and CC3 etc. The only ones that made any sense were Red, Grn, Blk and OSC.

> **Fault of the Month**
>
> **National NV-370 VCR**
>
> **SYMPTOM:** No activity. There is no clock, no display and no functions. All rails from the power supply are present, although somewhat high, and the power indicator LED is on continuously.
>
> **CURE:** R1011, a 0.39 ohm 1/4W fusible resistor, was open circuit. This resistor feeds the main 5V regulator transistor and without it, there can be no activity in the main microprocessor.
>
> *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.*

That last label prompted another line of thought. OSC was obviously some kind of timing generator, so if that was not running, there may well be no display.

Thoughts along these lines were accelerated when I traced the OSC line to what appeared to be the oscillator chip, IC2004, and noticed alongside it a trimpot marked 'Sign-H adj'.

If this control really did adjust the height of the display, its failure may have reduced the height to zero, a symptom remarkably like the one I had in front of me. It took very little time to find that the oscillator was running, at approximately 4MHz, and was delivering about half a volt to the chip. So another useful lead had come to naught.

By this time I had wasted several hours on this set and I had to put it aside, to get on with some more profitable work. But I couldn't forget the problem, and over the next few days it gave me considerable angst.

And it came to pass that a week later I was talking to a colleague about this and that, and just happened to mention the Sharp with the 'off screen' on-screen display.

My story prompted him to recollect that he had once had a similar problem in that particular model. So he got out his copy of the manual, to see if it would refresh his memory enough for him to recall the full details.

In the event, his trouble was quite different and of no help to me. But while he had the manual out, he checked all that I had found and reluctantly agreed with me that it looked as though the chip would have to come out.

Sync inputs?

Then he had another thought. He asked me if I had checked the horizontal and vertical sync input to IC2001.

I had to admit that I hadn't realised there *was* a sync input to the chip. Yet a little cogitation showed that some way to lock the display to the set's picture was essential. And line and field sync pulses were the obvious way to do this.

Once having been alerted to the requirement for a synchronising signal, I soon found two pins marked respectively HSY and VSY on IC2001. These were fed with signals from another board via two transistors, Q2025 and Q2027.

The 'other' board turned out to be the line output board, and HSY came from a winding on the line output transformer. Similarly, VSY came off pin 2 on the vertical oscillator/output chip, IC501.

So, it was back to the CRO and on with the hunt!

We are very near the end of the story, now, because there was no sign of horizontal or vertical sync on the main chip — or on the sync amplifier transistors, or on the plug that should have brought the sync from the main board.

At the beginning of this story, I had checked all the leads coming to the remote control board, and found them all to be firmly fixed. So it looked as though I was going to find a fault on the main board, which could stop the sync reaching the lead to the remote control board.

I discounted a broken lead, since both horizontal and vertical syncs were missing. A broken wire would have stopped one, but not both. And two broken wires would have been somewhat more obvious.

I set about removing the main board from the cabinet — not a particularly easy job, since a large power transformer blocks direct access to the chassis.

With the transformer unscrewed and moved away from the chassis, I was

about to undo the clips which would have released the board when I noticed a small, unoccupied socket tucked away toward the back of the board.

These sockets are sometimes fitted to provide a row of test points, for easier access to parts of the circuit. But this socket looked too clean and white to have been exposed since the set was new. If it was a test point, it should have had a patina of dust like all the other components on the board. So it looked as though my search for a cause was over.

Except that I couldn't find a plug that would fit the socket. In fact, I couldn't find any loose plugs anywhere.

Every cable arriving on the main board was firmly attached, most of them to clearly visible plugs or sockets, others to firm but out-of-sight attachments of one kind or another. But in the case of the missing plug, it was an attachment of 'another' kind altogether.

I found the end of the sync lead on the remote control board and then traced it through to the main board. As I ran my fingers along the cable, it headed not for the empty socket, but straight for the heatsink carrying the line output transistor. This heatsink had been punched from aluminium sheet, leaving four short legs into which mounting screws had been inserted from underneath the board. This left the heatsink sitting some 5mm above the PCB, and it was in this 5mm gap that the missing plug had got itself caught.

No amount of pulling on the cable would release it. I had to poke at the plug with a screwdriver to push it clear of the heatsink.

Needless to say, the lost plug fitted the empty socket, and mating the two restored the missing on-screen display.

I still don't know how the plug and socket became separated. It must have happened when I was working on the set for the open circuit transformer. I had had to free the remote control board and turn it over, so perhaps I pulled a bit hard on that particular lead and so dislodged it, without ever noticing. Or it may have been somewhat loose all the time, and a gentle tug as I inverted the board was all that was required to free it.

Whatever the cause, the effect was aggravated by the trap under the heatsink. If you recall, my first exercise was to look for loose plugs and sockets. In fact, the plug was quite firm, but not in it's proper socket.

Oh well! You can't win them all, I suppose. But let it be a lesson to you, as well as me. Don't trust a plug and socket connection until you see them properly mated. A heatsink is not a satisfactory connection...

Strange VCR problem

My next story presents a strong case for another plug-and-socket mystery. As you will see, reseating a loose plug seems to have cured the problem, without in any way explaining why.

With modern video recorders it's very easy to get sidetracked into looking for a fault that isn't there. Or more correctly, into looking for one type of fault when the real cause is something quite different.

This one was an AWA AV12, quite a few years old now but still in good condition and working well, until the recent fault showed up. The complaint was that the sound failed periodically, accompanied by 'lines' on the picture.

On the bench, I found that the sound didn't really fail, but went very weak and dropped several octaves in pitch. It was as if the tape was slowing down intermittently — which indeed it was. Each time the tape slowed, the picture showed noise bars (the customer's 'lines') rolling up the screen.

So, it seemed as if we had an intermittent capstan servo loop. It might have been the motor, or the drive circuit, or the servo circuit. The question was, which?

To begin, I checked the drive voltage to the capstan motor at plug ME. This should be 3.8V on pin 1 and 0.2V on pin 2. In fact, I found these to be spot on when the motor was running at its correct speed, but it rose to 4.5V on pin 1 whenever the motor slowed down.

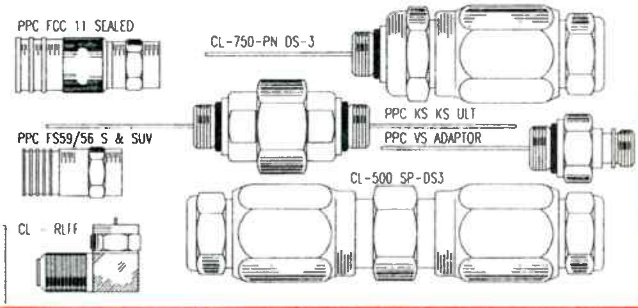
This introduced another problem to that already existing. In my experience, a motor slows when its supply voltage drops, not rises. In practice, a motor should speed up when the voltage increases. So what was going on?

I wound up the CRO and looked at the voltage, to see if waveforms had anything to do with the confusing symptoms. I didn't really expect to see anything, since the motor is of the DC persuasion and the servo control represents only a small change in the supply voltage.

What I found added confusion upon confusion, since the normal DC voltage appeared only while the speed was correct. As soon as the motor slowed down, the supply voltage became a 4.5V peak to peak interrupted DC, with a duty cycle of about 25-30%.

Well, at least it explained why the motor slowed when the voltage rose; but I never did find where the pulsed voltage was coming from.

Next, I replaced the tape with a test cassette — a clear plastic frame that can substitute for the normal cassette, yet still



allow access to the supply and takeup reels, tape guides, drum, etc.

With the test cassette in place and the machine in play mode, there was no sign of intermittent capstan speed. But of course, without a tape to provide control pulses, I had no way of knowing if the speed was correct or otherwise. Judging by the sound of the motor, I guessed that it was approximately right.

There was no sign of the pulsed DC on the supply to the motor, and the frequency generator pulses returned from the motor, on plug MS, were quite steady.

The frequency generator pulses at plug MS are shown on the circuit at FG+ and FG-. In other words, the FG pulses are floating above ground. So I tried to put my CRO across the two pins to get some idea of the peak to peak voltage of the FG signal.

However, I forgot to isolate the CRO input and as soon as I touched the probe ground lead to one of the pins, the capstan motor took off and headed for a low earth orbit. I've never heard a small motor scream so loudly.

And what's more, I couldn't stop it until I pulled the power plug. I had grabbed for the stop button, but with the machine opened up it was not easy to identify individual switches. And with the motor screaming its head off, the mains lead was an easier target.

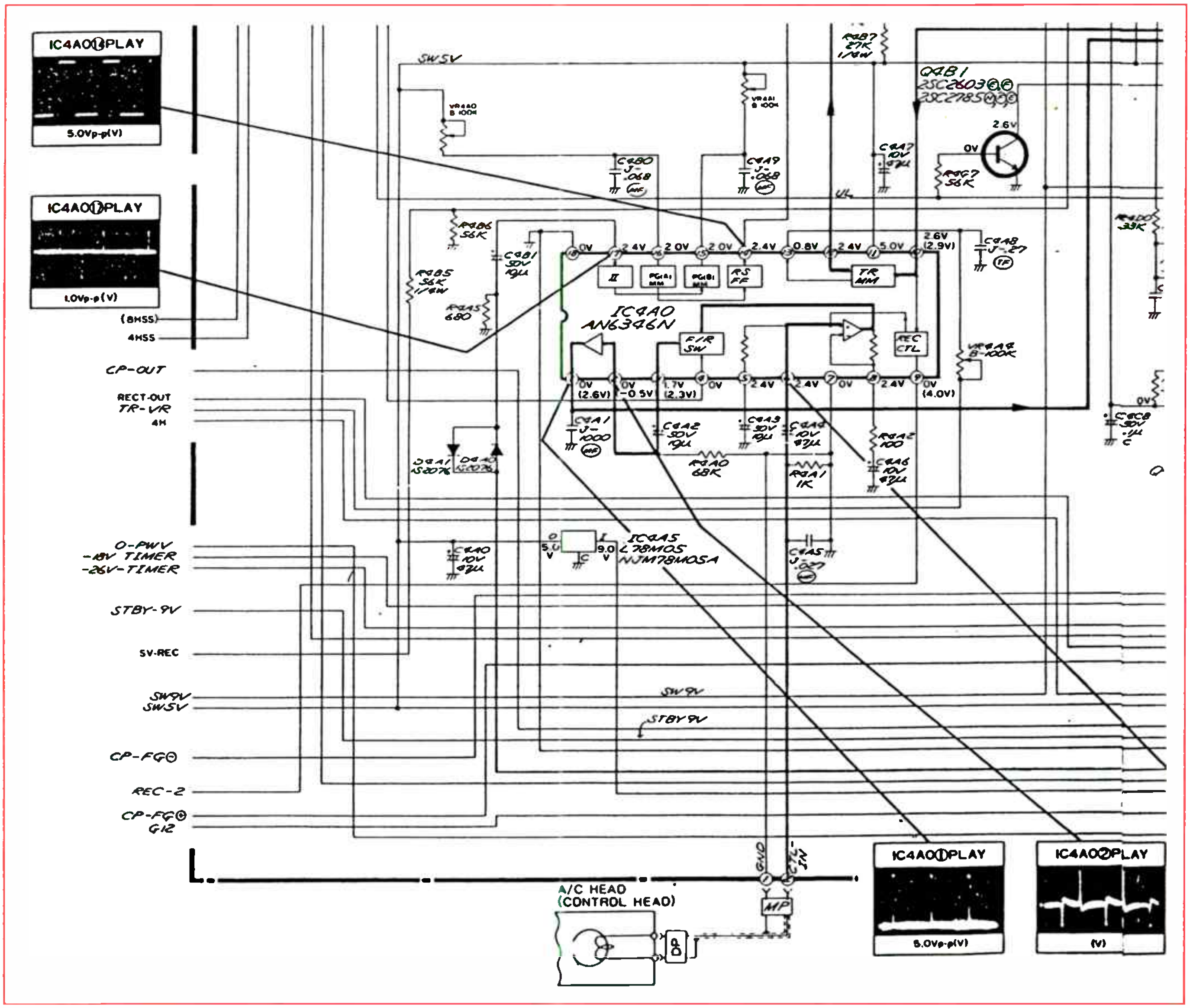
Different tape

It was at this time that luck took a hand in my deliberations. Until this point I had been testing the machine with the customer's own tape. It had been left in the machine when he delivered it to the workshop, and it had been convenient to do my tests using that tape.

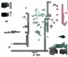
However, when I picked up a conventional cassette to check on the control pulses, I grabbed my own test tape and loaded it into the machine.

It played, and played, and played — without the slightest sign of speed variation. But when I restored the customer's tape, the intermittent speed was back again!

I tried the tape in a machine belonging to another customer and it, too, had developed the same intermittent capstan. Which implied that the fault was actually a *record* problem rather than a playback one, and the result was on the tape and



This month's second story involves a puzzling speed variation problem in an AWA AV12 video recorder. The problem turned out to be in the servo section, and specifically to do with the connections between IC4AO and the control head. The relevent section of the schematic is shown here, together with expected scope waveforms.



could be transferred from one machine to another, rather like a computer virus. Just to make sure, I took the faulty tape home and tried it in my own 'top-of-the-range' HiFi VCR. It too developed the intermittent capstan, but in addition it began flashing the SP/LP indicator, in time with the speed changes.

Working out what had actually happened took some mental agility. In the normal record mode, a VHS recorder will put down a control track comprising 25 pulses along each 23.39mm of tape. Thus, the pulses are 0.9356mm apart. In the LP mode, tape speed is slowed to half and the control pulses are laid down only 0.468mm apart.

In the case of the faulty machine, something had caused it to either increase its pulse rate to 50 per second, or the tape had slowed down for some reason and the normal 25 per second pulses had been recorded too close together.

I couldn't think of any way to determine which scenario was the right one, so all I could do was to put the machine into record mode and monitor the pulses being delivered to the AC head. I hoped that something might show up, and in the meantime went about my other jobs around the workshop.

It was while I was connecting my oscilloscope to the control head that I came across something that may have been responsible for all the trouble. At first, I couldn't find any pulses at the control head. The machine seemed to be running correctly, at the right speed, but there were no pulses that I could detect at the control head. When I shifted my attention to the Servo Board, I found plug MP to be in place, but quite loose. This plug feeds the control pulses to and from the control head, and the fact that it was loose could account for all the trouble.

I reseated the plug and the control pulses returned to the control head. The machine then ran in record mode for two days, without the slightest irregularity. Tapes recorded during that period could be played back on any machine with no sign of speed changes.

The customer collected his machine and when I checked a fortnight later, it was still performing perfectly. So whatever the fault was, it now seems to be cured.

Since then, I have puzzled over the reason for the machine's unusual behaviour. If the problem really was an intermittent control track, caused by the loose plug, I would have expected the capstan to speed up where the track was missing. (Remember the test with the CRO probe? Shorting the pulses on that occasion caused the motor to go into orbit...)

The only mechanism that I can think of that could slow the motor would be control pulses recorded on tape at less than normal intervals, either of time or distance. I didn't think to try running the machine with the control head plug disconnected. That might have revealed some anomaly with this particular machine that could explain the mystery. In the meantime, I can only tell the story as I found it, and hope that one of our readers can come up with a more detailed explanation.

As with so many problems related on these pages, both of these faults were tied in with 'mechanical' devices. Switches, potentiometers, plugs, sockets and any other bits of hardware are always a source of potential distress.

It's as well to go over these trouble makers before you pick up the soldering iron. You'll quite often cure the trouble without needing any of the tools normally associated with 'electronics' servicing.

That's all for this month. We have a selection of contributors' stories for next time. Care to join us? ❖


AUTOMOTIVE ELECTRONICS

with MAJOR AL YOUNGER (USAR, Ret.)

Engine basics - 3

So far, in our look at engine basics, we've covered the four-stroke cycle, engine efficiency, spark timing, compression and fuels. This month we look at the ignition system. Even in the latest vehicles this is still based on one of Dr Kettering's most valuable inventions, some 70 years ago.

In 1912, Mr Cadillac broke his arm whilst hand-cranking one of his firm's motor cars. Dr John Kettering took a DC electric motor, added a battery and — you guessed it, the electric starter was invented.

To keep the battery charged, Dr Kettering added a generator (actually another motor), driven by the engine when it was running. Later, one of Thomas Edison's inventions was added as well: head lamps. These were all sold as options, initially.

The ignition systems in those early days used either a magneto or an induction coil driven by a buzzer. But in the 1920's, Dr Kettering's improved ignition system was introduced for mass production. One of the first to use it was the 'Father of mass production', Henry Ford, who first introduced it in his Model A, flat-head, four cylinder automobile. Fig.1 shows the design; of course it was for a four-cylinder engine, not an eight. The V8 was not mass produced until 1931, again by Henry Ford.

Dr Kettering would probably be surprised to learn that his original ignition system is essentially still being used in 1992. The mechanical contact points have been replaced with solid state devices, and the turns ratio of the coil has been changed, but the basic principle remains.

Dr John Franklin Kettering was born in 1876. Apart from the inventions already noted above, during World War II he developed a V8 engine to power military tanks, with an unheard-of cylinder displacement. As I recall, they were around 750 cubic inches — that's about 12.3 litres! The engine greatly aided the Allies in tank development — it was very reliable, and could be mass produced. (Yes, Ford built most of them.) It became known as the 'Kettering Eight', and was later used in Cadillac and Lincoln automobiles.

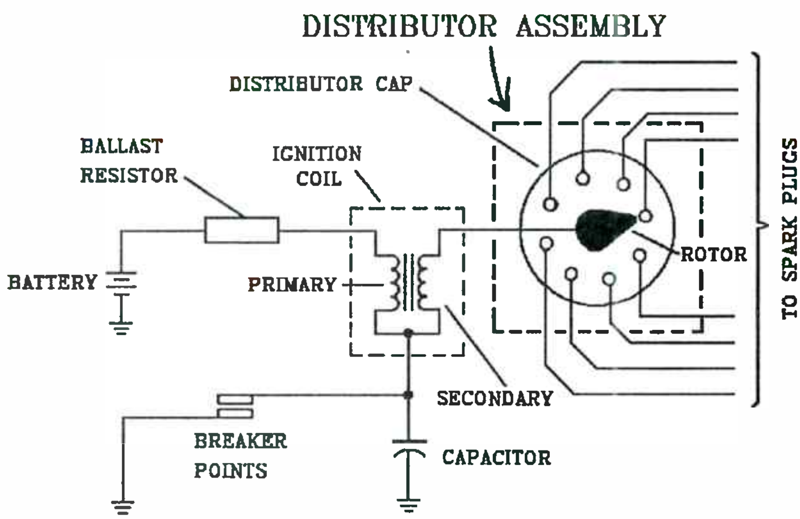


Fig.1: The basic Kettering-type ignition system, still in use after 70-odd years.

In 1951, Dr Kettering patented the first high-compression engine. (Mind you, I'm an old 'California Hot Rodder' — back in 1946, *I* had a 'four-banger' with so much compression I had to use aviation fuel. Oh well, as my old 'Hot Rod' buddies like Mickey Thompson would say, "When Detriot wants a new idea, they come to California and look around".)

In reality, the mass production of high compression engines was not feasible until Dr Kettering's development of an additive known as tetra-ethylene or 'ethyl' — i.e., *leaded* fuel. (Hence the old joke: "Is Ethyl in your tank? No, she's home doing the washing".) As most people know, the lead content in fuel was to give it anti-knock properties. Now we're trying to phase it out...

Dr Kettering devoted his life to the automotive industry. It will be a long time, if ever, before someone exceeds the number of his patents. He passed away in 1958, at the age of 88.

The spark

The basic Kettering ignition system provides an electric spark during the compression stroke, to ignite the air/fuel mixture. The spark is an arc across the spark plug electrodes. The spark plug has a center electrode and ground (the outer shell), which is electrically connected to the cylinder and engine block.

The spark plug gap distance, the compression ratio and AFR (air/fuel ratio), are the design factors for the system. These factors determine how much voltage is required to fire the plugs, under all conditions. With this in mind, the maximum high voltage pulse is generally from 20kV to 40kV, depending on system design.

Once the arc is started, the voltage required is less because of ionisation of the gas (ionised gas allows a *plasma* to form, and this permits free flow of elec-

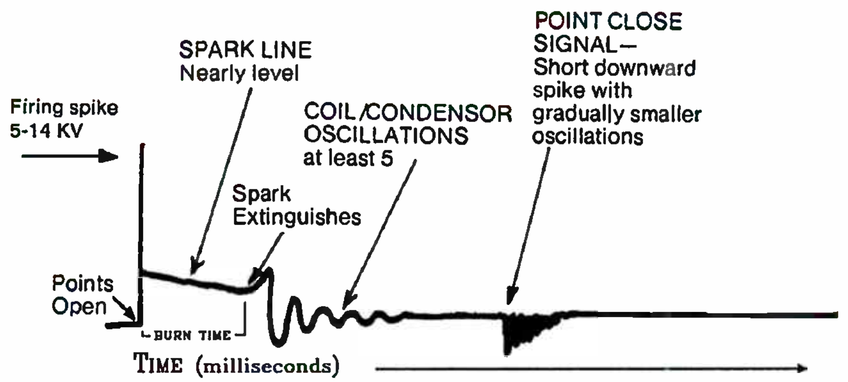


Fig.2: The waveform of a typical high voltage ignition pulse, as seen across a spark plug. The significance of each part of the waveform is shown.

trons). The arc is sustained long enough (the 'burn time') to ignite all the air/fuel mixture. Ionisation then ceases.

High voltage circuit

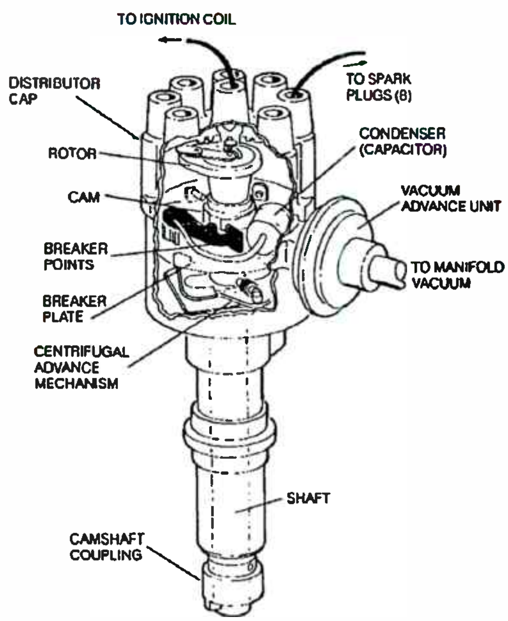
The high voltage pulse (Fig.2) to provide the spark is generated by the inductive discharge (collapse) of the ignition coil (an autotransformer). The coil output lead (high tension) goes to the rotor of the distributor, via the latter's centre cap terminal. The rotor distributes the spark to the appropriate cylinder terminals on the cap, where high-voltage insulated spark plug wires carry it to the individual plugs.

The distributor (Fig.3) shaft is driven by the camshaft, at half the speed of the crankshaft. Therefore, one ignition pulse is provided to each cylinder's plug, every *two* revolutions of the crankshaft.

Now let's review the weird actions of high voltage. You may remember from high school the teacher with his Tesla coil, drawing arcs and grinning. In an ignition system the wider the spark gap, the higher the voltage required to jump the gap. So what happens if there is a infinite (open) gap? Well, once the high voltage energy is generated, it has to go somewhere (ground) or return to its source.

Here's what happens in the ignition system. Let's assume a spark plug wire is off, and it's too far from earth to discharge. The voltage builds up to the maximum coil output voltage. It appears

Fig.3: A conventional distributor. The rotating shaft is driven from the engine's camshaft, and rotates at half the speed of the main crankshaft. The cam operates the breaker points, switching the current in the coil primary, while the rotor directs the HV spark to each plug in the correct order.



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at the end of the plug wire and cannot discharge, so it reverses direction and tries to return to its source, but will still be looking for the shortest part to earth (the engine block and car frame). The wires have good insulation, so it continues towards the distributor cap. When it enters the cap, it unloads by arcing to earth through many paths — often causing carbon tracking, or burning through the distributor cap and rotor. This is distributor arcing and has destroyed many distributors — and in later models, the electronics.

So, the next time you pull the plug wire off your engine — shame on you. Another point is that some electronic systems output up to 80kV, at 300 watts. Let's see you tangle with that, and remain smiling!

Primary circuit

The low voltage primary side of the ignition coil circuit (Fig.1) has current from the battery switched on and off through it by the breaker points, which are mechanically controlled by the distributor rotor. When the points are closed, they provide an earth path for the battery through the coil primary — which immediately saturates the coil. When the points are opened (Fig.4) the magnetic field collapses, inducing a greater voltage (normally 100) in the primary. This is the voltage that is stepped up to the kilovolt range by the coil's secondary, to drive the plugs.

Before the points close, the coil's 'back EMF' (there is always some) is transformed back to a lower potential and stored in the capacitor. This reduces the saturation time required, and reduces point arcing.

I once held a seminar on ignition systems. I had prepared about 15 pages on the operation of the coil, complete with illustrations. I thought 'they are really going to learn today'. But about a quarter of the way through, I noticed people were yawning. I paused, took a drink of water, cleared my throat and then exclaimed in a loud voice "Gentlemen, here is what you should know about an ignition system".

And here it is: the ignition system is designed to provide spark for a particular engine, under all operating conditions. The only improvements over Dr Kettering's original design has been better coil and ballast resistor design. The coils don't burn out as often, and they heat up less; the same applies to the ballast resistors.

The ballast resistor is temperature sensitive and allows a higher voltage at cold start. They may be located either inside the coil ('internal ballast') or external to it. Some systems use a ballast resistor that is not temperature sensitive; these are switched in after the engine has started.

The waveform of the coil's primary current is illustrated in Fig.4. The primary current increases with time after the points close (a), building up energy in the coil's magnetic field. At the instant the points open, the current begins to fall rapidly — it is during this rapid drop in primary current that the secondary high voltage pulse occurs (b).

The primary current oscillates — the wavy portion in (c) — because of the resonant circuit formed between the coil and capacitor. The frequency of oscillation changes when the spark extinguishes, as the secondary winding then has no 'loading'.

Ignition timing

Here's an important definition: ignition timing is the point (in degrees) at which ignition occurs, in comparison to TDC (top dead centre) of the piston's compression stroke.

The point where ignition occurs is actually some time *before* TDC. The timing is therefore specified in terms of *degrees of crankshaft rotation before TDC*, or BTDC. The basic timing is mechanically set and is most often adjusted by rotating the distributor.

As engine speed increases, the time to burn also increases, as a proportion of each cylinder's four-stroke cycle. Therefore, the timing must be *increased*. This increase in timing is the 'spark advance', which is done by rotating the plate on which the breaker points are mounted.

There are several ways this may be accomplished. The most common types use centrifugal force and a vacuum motor (Fig.3). This type automatically compensates for atmospheric pressure (from manifold vacuum), and more readily senses engine demand changes (again manifold vacuum).

For some cars, with automatic transmission, the system will retard at idle, with transmission engagement. This reduces emissions. People who truly understand ignition systems and the way they work are switching over to electronically controlled systems.

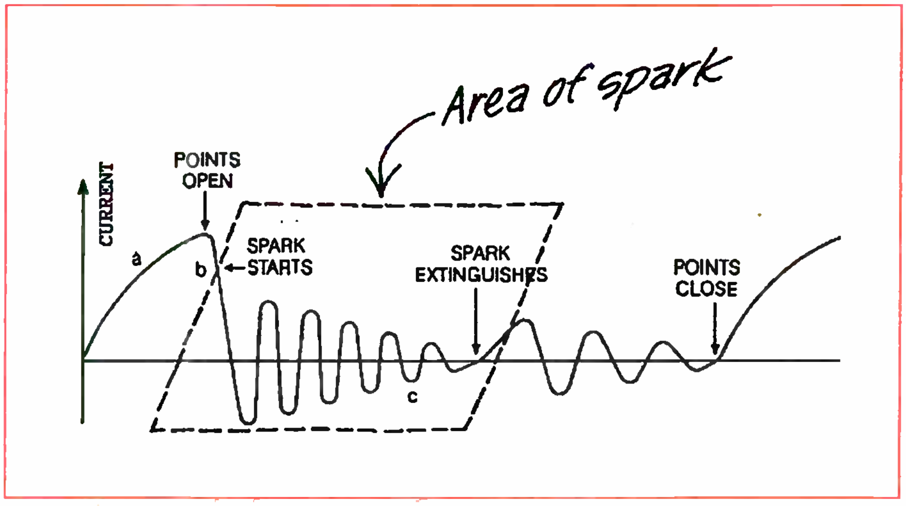

Fig.4: The typical current waveform through the ignition coil primary winding, showing how the current builds up before the points open, drops and oscillates during the spark itself — and then again, before the points close once more.

Review

Reviewing what we've covered this time, of critical importance is the basic timing, the breaker points and the plug gaps. These must be 'spot on'.

That vacuum plays a major role, too, and if you do not understand the functions of vacuum, pray — especially when working on an electronic system. Many a 'tech' has 'bitten the dust' over vacuum problems.

So step one, in fixing an automobile, starts with checking the timing. If it's off — why? Just continue from that point. You know what's next: the vacuum system.

Next month we'll discuss the intake, cooling and electrical systems. Most know their basic functions, but often overlook how they effect the engine's overall operation. ❖

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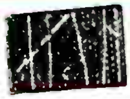
SOLAR POWERED PRODUCTS



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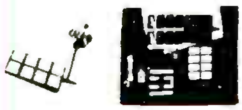

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Each kit contains a set of precut plywood, PVA cement, assembly instruction sheet, solar cell module, musical IC or small DC motor, wire and sand paper.
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Z19046 Gramophone......$19.95
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SOLAR BATTERY CHARGER FOR 'AA' SIZE BATTERIES
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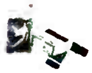

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for 2 'AA' size batteries
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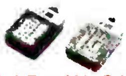

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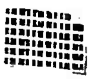
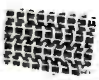
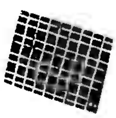


12V. Voc 16V (max) 18V
Isc 400mA (max) 500mA
Z19028..............$99.00



12V Voc 16V (max) 18V
Isc 800mA (max) 1000mA
Z19036...............$199.00



12V 16V (max) 18V
Isc 1200mA (max) 1500mA
Z19038...............$299.00

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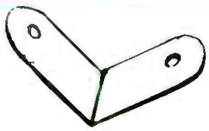

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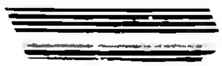

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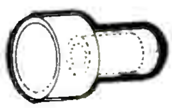

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-12 amp - Size: 0.5-1.5mm - Gauge: 22-16
100Pcs
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- Takes cable with a maximum width of 5 mm.

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for colour TV
- Double Insulated

Input:
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Rating :
2 Mins on - 30Minsoff
Field Strength:
4700 AT
Made in Australia
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Splits UHF/VHF/FM signals.
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1 x 75 ohm with AC power pass (8dB)
- Bandwidth: 5-890MHz

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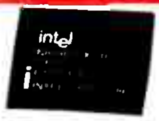

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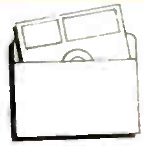

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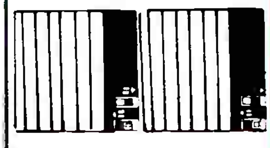

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(To fit 3.5" disks)
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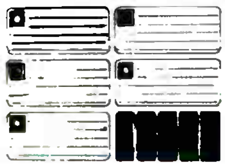

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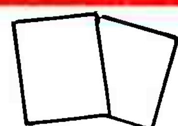

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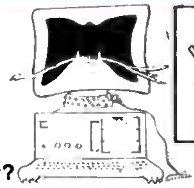

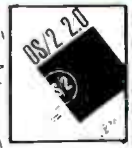

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Can't get it to do what you want it to do?
Do you think you should get more out of your computer and know that you could if only you had the right operating system?
Well here it is!
IBM's OS/2 version 2.
No more thinking of how your going to work your computer the most effective way. Now you can keep your mind on the job and not the computer.
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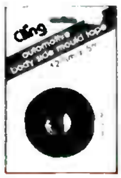

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Has one of your protection strips on your car come off, or perhaps one of the cars badges? Don't fret Simply get some of this automotive body side mould tape.
12mm x 5m
Double sided
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Don't ruin your walls by nailing hooks into them and then realize it's in the wrong place!
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27512	$12.50

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27C512	$11.50
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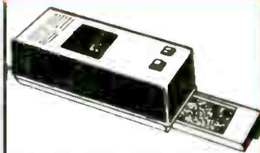
UV EPROM ERASER WITH TIMER.



This is not your average EPROM Eraser!
Sure it erases your EPROM's quickly and safely and will erase up to 9 x 24 pin devices in about 40 minutes.(less for less chips). But with this one you don't have to waste your time standing around waiting for them.
This EPROM eraser has timer to allow you to "set and forget". By using the timer function you not only save money by reusing your EPROM's but you also save precious time by doing other jobs while the eraser is working. And you'll never have to worry about forgetting to turn it off and "cooking" your EPROM's.
Choose from a range of different settings from 15 minutes to 40 minutes depending on the intensity of the UV source.
• The chip door has a conductive foam pad.
• High intensity at the chip surface ensures EPROM's are thoroughly erased.
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SPECS:
Operating Voltage:
100V~120V -50Hz
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Power Consumption:8 watts
Timer: 15 to 40 minutes
Capacity: 9 of 24 pins
UV Source Wavelengths: 253.7nm
UV Intensity: 7mW/cm2
Tube Life: approx. 3000 hrs
Dimensions:
21.7(H) x 6.8(W) x 8(D)cm
X14955............$169.00

SPARE UV TUBE FOR EPROM ERASER
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101 EXTENDED "CLICK" KEYBOARD
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SERIAL, PARALLEL, GAMES PORTS, 1MEG VGA CARD
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SERIAL, PARALLEL, GAMES PORTS
512K VGA CARD. IBM* COMPATIBLE
SVGA COLOUR MONITOR (1024 x 768 Resolution) 0.28"DP
MINI CASE & 200W POWER SUPPLY
4 YEAR PARTS & LABOUR WARRANTY
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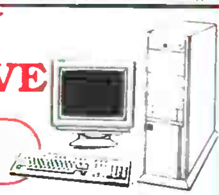

80486-33 CPU 256K ON BOARD CACHE. 4 MEG OF RAM
157Mhz LANDMARK SPEED TEST
200 MEG HARD DISK 12ms ACCESS TIME
1.2M JAPANESE BRAND F.D.D
3.5" 1.44M JAPANESE BRAND F.D.D
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- STABILIZING SUCTION CUPS
- 6 U.S MILITARY INSIGNIA STICKERS

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

* Requires Smart Games Card C14260....$39.95

SMART GAMES CARD

SUPPORTS 4.77 TO 80MHz

Complete with Calibration software

FEATURES:

- Intelligent software controlled game card
- Compatible with IBM PC/XT/AT/386/486
- Complete with easy-to-use menu driven calibration software on 5.25" floppy diskette
- Software selectable clock speed - from 4.77 to 80MHz
- Automatic clock speed adjustment for advanced users
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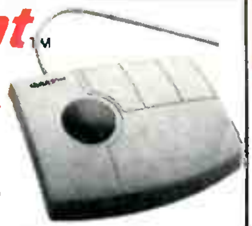
C14260.................$39.95

QuickShot™

QUICKTRAC 100



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The latest innovation in mice technology. Unlike a normal mouse the Quicktrac does not require any operating space other than that taken up by its tiny footprint.

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They're are great for laptops and notebooks or anywhere where there is very little desk space.

100% Microsoft Mouse compatible.

Includes Qtrac™ Driver software

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Menu making Utility

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- One 9-pin or 25-pin RS232 serial port.

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Is that precious photo of your loved ones in your wallet getting a bit tattery? Don't lose those precious memories protect them by laminating them with your own laminating machine

Important Business cards, membership cards, recipes etc. last a life time longer when laminated.

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Don't pay hundreds of dollars for some big machine

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Laminate Sheets....156mm x 112mm for photos

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MONITOR STAND

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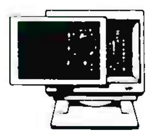

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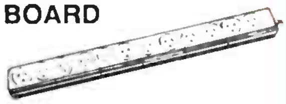
Relieve eye strain and headaches and increase production with these anti glare screens

12" Screen................$9.95

14" Screen................$19.95

NEW POWER OUTLETS

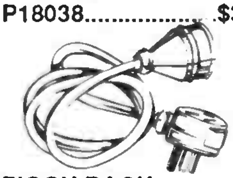
12 WAY POWER BOARD



This is the big daddy of them all. Get the most out of your power points with this 12 way power board. Don't kill youself by loading up the power point with Double adaptors. This is the save and neat way to use 12 appliances out of the one socket.

Comes with a 1 metre fitted cord and plug and is rated 10amps, 2400 watts. Also has overload protection.

P18038..................$34.95



PIGGY BACK EXTENSION LEADS

This is the new look in extension leads. Makes other extension leads look old fashion!

It's a 240 Volt, 10A extension lead which is fitted with a socket on one end and a piggy back double adaptor plug on the other. Turns your one point power point into two while giving you the benefit of an extension cord.

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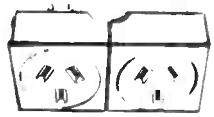
6 Metre P18090..................$11.95



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P18022................................$5.50

- Twin pack with left & right hand adaptors

P18024......................................$9.95

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- Designed for use with 240 volt AC operated appliances

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[illegible]

Construction Project:

Low cost Decision Maker

Take all the difficulty out of making decisions, with our elegant little Decision Maker. It uses only a handful of easily available parts, yet offers all the possibilities — 'Yes', 'No', or 'Maybe'. And if it's wrong, at least *you* can't be blamed!

by ROBERT PRIESTLY and PETER PHILLIPS

There are times when electronics can be really useful — like taking the drudgery out of deciding major issues. You might think that computers do this for us now, but have you ever tried asking a computer a question like 'should I marry this person?' Does an army general ask a computer 'should I push the button?' No! Because computers are basically pretty dumb — unlike our decision maker.

Using state-of-the-art technology (or close to), the Decision Maker allows anything of significance to be decided by merely touching two terminals. The answer then pops up and voila!

Although we can't confirm this, we believe a similar device is used in Canberra, although only for the really major decisions. Perhaps that's how Sydney's third runway got the go ahead!

On a lower level, our decision maker has great applications in the home. Mum might use it to decide if it's pork chops or stroganoff for tea.

You can let it choose a name for baby, even ask it if the egg came before the chicken; make a Monopoly game less traumatic, or turn chess into a breeze; there are no limits. Or perhaps it's the 'ideal gift'. Whatever its application, we're sure you'll agree that the concept behind this project has great scope.

The project

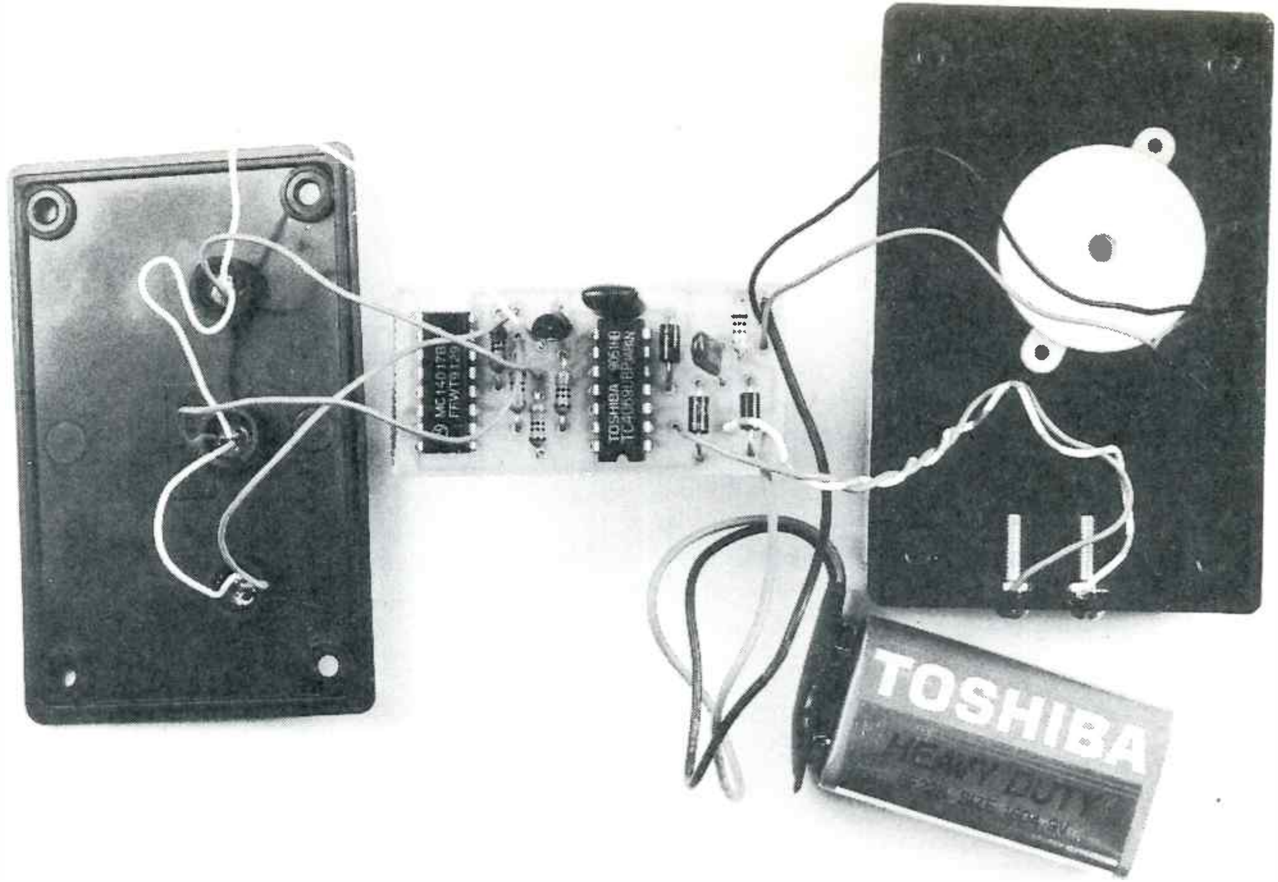
This simple idea is the brainchild of Robert Priestly, who designed it for promotional purposes. Not his own promotion (although he well deserves it!), but promotion for his employer. It's a fun idea and one that should appeal to quite a few readers.

As the lead photo shows, the whole thing is contained in a small jiffy box, with three LEDs marked YES, NO and MAYBE. If you wanted to, extra LEDs could be added for less definitive answers.

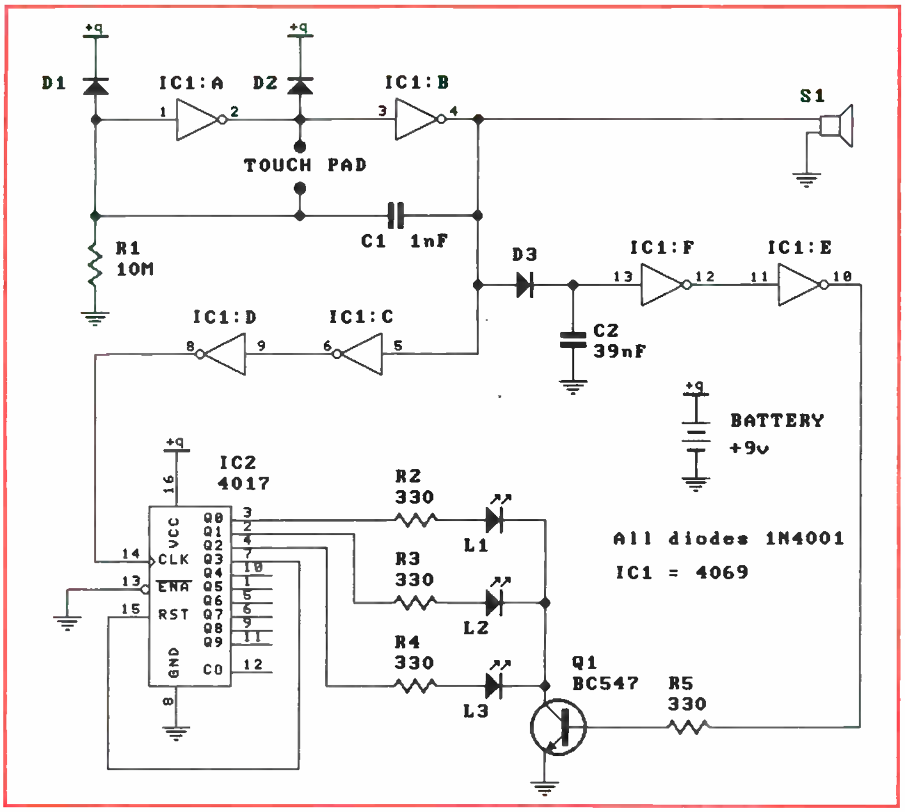
You could have WE'LL SEE (great for answering little Johnny's requests for yet another R-rated video), or ASK ME TOMORROW (for the procrastinator). The presidential utterance of READ MY LIPS could be included (a great cop-out, as the project has no lips!), and so on.

The clever thing about this project is that it has no on-off switch. As soon as you touch the terminals, the power is automatically switched on, the decision is made, and some time later the circuit goes back to sleep.

And to let you know it's thinking, a highly intelligent 'squawk' is produced while the pads are being touched. The pitch of the squawk depends on how



This photo shows an exploded view of the project. The transducer and the PCB are held with double-sided adhesive tape inside the box.



The intelligence of this project is contained in IC1 and IC2. When the pads are touched the oscillator around IC1a and IC1b starts, turning on the power to the LEDs and clocking the counter of IC2. Release your fingers and one of the LEDs is left on.

hard you press on the pads, and the harder you press, the more 'intelligent' the sound.

How it works

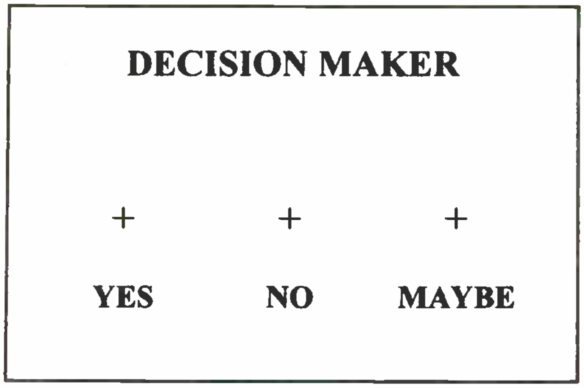
The circuit is based around two IC's (carefully chosen for their inherent capacity for logical thinking). When the pads are touched, the skin resistance of the toucher's fingers causes the oscillator formed by IC1a, IC1b, R1 and C1 to spring into life.

The frequency of oscillation is determined by C1, R1 and the resistance across the pads. The piezo transducer driven by IC1b converts the oscillation to sound, so you can hear the 'thinking' process in action.

The oscillator output is connected to diode D3, which forms a half-wave rectifier with C2. When the oscillator is functioning, C2 charges and produces a logic 1 at the input to IC1f.

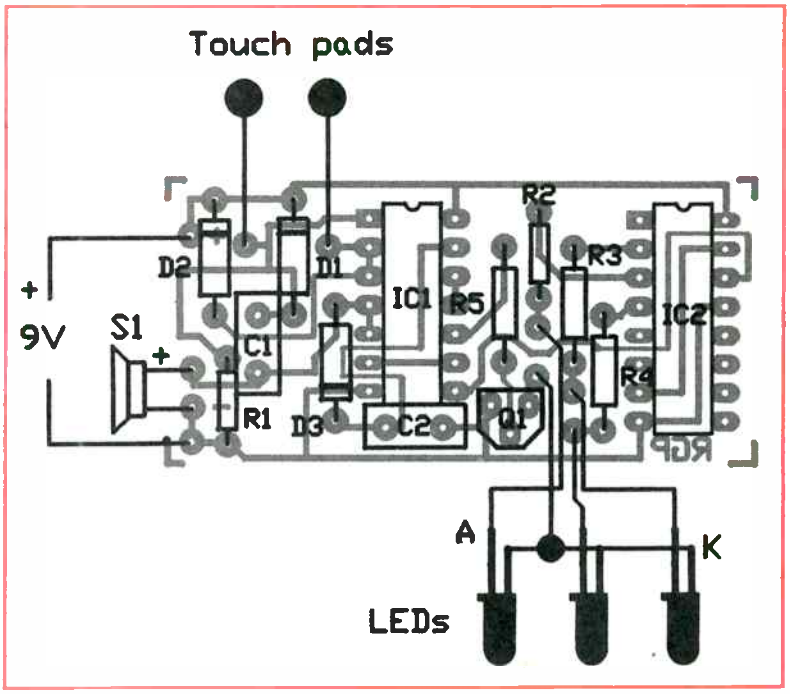
As a result, Q1 is turned on, driven by IC1e. This turns the power on to the LEDs, and power is turned off again when C2 has discharged.

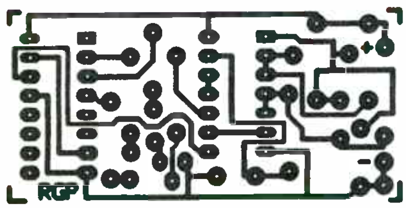
Because the ICs are both CMOS devices, their power consumption is virtually zero, increasing only when the oscillator is functioning. When idle, the circuit therefore takes negligible current,



Above: Use this artwork to give the project a finished look. Take a photocopy, spray the copy with lacquer then glue it to the lid of the case.

Right: The layout for the PCB. Watch the orientation of the diodes, the transistor and the LEDs. The long lead of each LED is the anode terminal. Connect the battery via a 9V battery clip.





The PCB artwork is shown full size so you can make your own board.

and the life of the battery is virtually equal to its shelf life.

The oscillator is also connected to the clock terminal of IC2, via IC1c and IC1d. IC2 is called a Johnson counter and each output pulses high, one after the other as long as a clock signal is present.

To reset the counter after three clock pulses, the fourth output is connected to the reset input of the counter.

When the oscillator stops, one of the three outputs will be high. The LED connected to that output will light, and remain on until the power is removed when C2 discharges.

(In case you think the output is random, note that IC2 is a 4017B, where B stands for brainy!)

PARTS LIST

Resistors

All 1/4W, 5%:
R1 10M
R2-5 330 ohm

Capacitors

C1 1nF polyester
C2 39nF polyester

Semiconductors

D1-3 1N4001 diode
IC1 4069 CMOS hex inverter
IC2 4017 CMOS Johnson counter
Q1 BC547 NPN transistor
L1-3 5mm LEDs, red, green, orange
S1 piezo transducer (Dick Smith cat no L-7022)

Miscellaneous

PCB coded RGP, 25mm x 53mm;
jiffy box, 28 x 54 x 83mm;
two 2.5mm metal thread screws and nuts;
double-sided adhesive tape;
9V battery and battery clip;
hook-up wire

Construction

Construction is very simple, and involves stocking the PCB, fitting the peripheral components to the box then connecting them together.

The layout diagram shows where the components fit, and the only thing to watch is the orientation of the ICs and the three diodes. Sockets are not really necessary unless you don't trust your soldering.

The contact pads used in the prototype were the heads of metal thread screws, held to the case with metal thread nuts inside. The three LEDs fit to the lid of the box and connect to the PCB with wires about 80mm long.

Note that the cathodes are connected together, with one wire connecting these to the PCB. The 9V battery connects via a battery clip, wired as shown in the layout diagram.

The transducer used in the prototype is a piezo device, and is operated by the AC signal from the oscillator. It is therefore not DC operated, although it has a red and a black lead. In case this has significance, connect the red wire to the positive terminal as shown on the layout diagram.

The easiest way to hold everything in the case is with double-sided adhesive tape. In the prototype, the transducer was fixed to the bottom of the case and the PCB to one side.

To make the project complete, we've included artwork for a front panel. A cheap and easy way to fit a front panel to the box is to photocopy the artwork, then coat the photocopy with plastic lacquer. When dry, the plasticised artwork can be glued to the lid with spray-on contact glue.

And that's all there is to this novel project. The parts are all basic garden-variety types and the overall cost should be cheap enough for anyone to build. And now technology can really help you decide things. At least I think it can — blast that battery going flat! ❖

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SUPER SPECIAL

PRIME SPEC INTEL BRAND 27512-25 UNBELIEVABLE $5.00 EACH 'TILL STOCKS LAST

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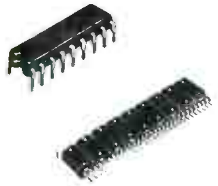

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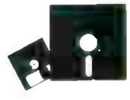

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3mm GRN	$0.20	$0.18
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723	$0.80	$0.75

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74LS139	$0.75	$0.65
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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
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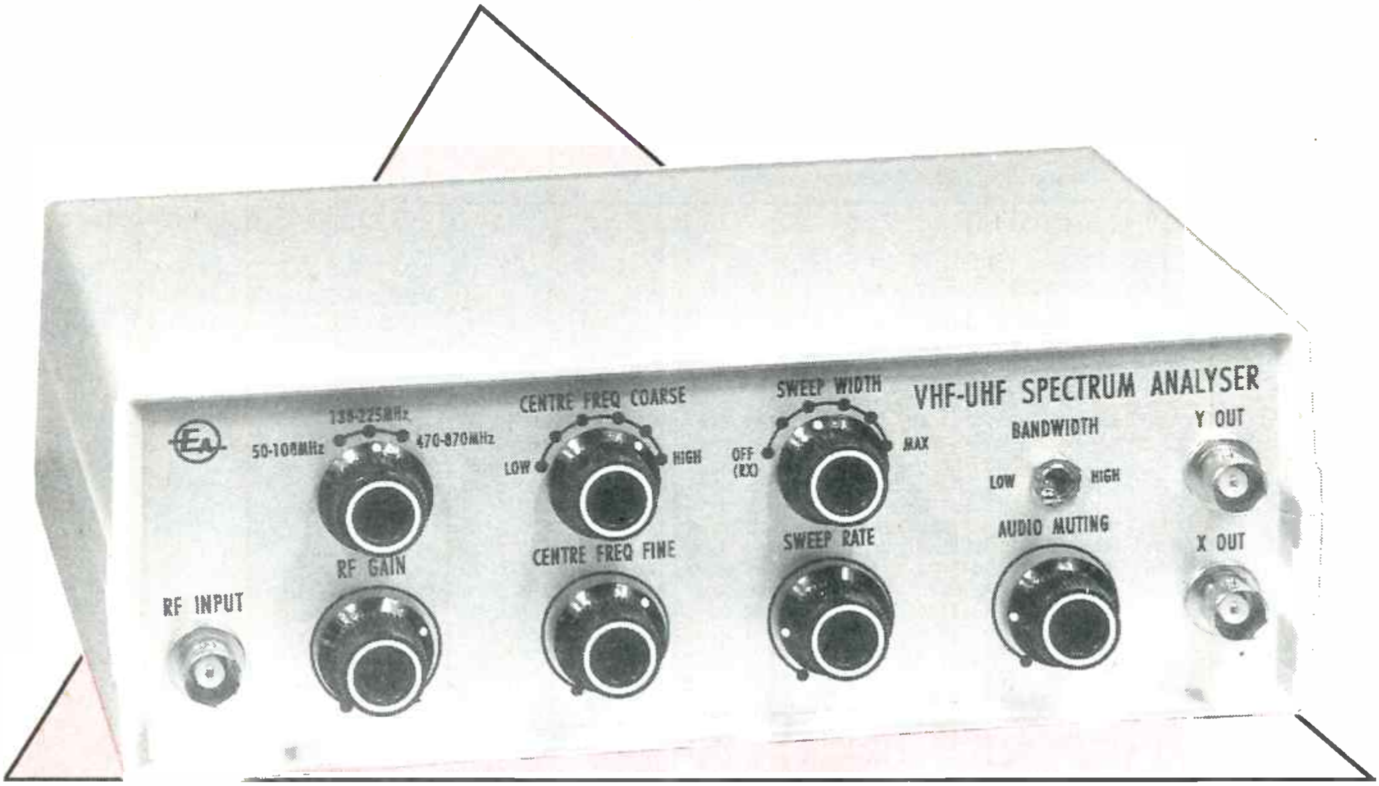


VHF/UHF SPECTRUM ANALYSER ADAPTER - 1

Ever wished you could afford one of those fancy spectrum analysers, which allow you to examine the spectrum and search for signals — either wanted or unwanted? Now you can build a simple but quite useful instrument of your own, with this low-cost project. It connects to virtually any CRO, turning it into a sensitive spectrum analyser which covers three major sections of the VHF and UHF frequency spectrum. And as a bonus, you can even use it as a wideband FM monitoring receiver!

by JIM ROWE

A true laboratory-grade spectrum analyser costs tens of thousands of dollars, and nowadays offers the ability not only to detect signals at any part of the desired frequency spectrum, but also to measure them quickly and accurately in terms of amplitude, frequency, bandwidth and possibly other parameters as well. There's no easy way to build this kind of instrument yourself, with the usual facilities available to an electronics enthusiast.

However it *is* certainly possible to build a much simpler and less expensive instrument, and one which with a little ingenuity (and the help of various other instruments) can be used to perform many of the same functions. Not as quickly, perhaps, and needless to say not as accurately, but nevertheless quite well enough to make it a very handy instrument.

The project to be described in this and the following article is very much in this category. It provides all of the circuitry and controls required to convert almost any standard oscilloscope or 'CRO' (even an elderly 'audio' model) into a sensitive and easy to use spectrum analyser, covering three major segments of the VHF/UHF spectrum: 50 - 105MHz, 138 - 225MHz and 470 - 870MHz.

These ranges cover many frequency bands of wide interest: all of the Australian and New Zealand VHF and UHF TV channels, most of the FM broadcasting band, 'low band' and 'high band'

VHF mobile radio bands, the 52MHz and 144MHz amateur radio bands, and many of the UHF bands used for essential services and other mobile communications.

How sensitive is the analyser? Typically you can clearly detect signals of less than one microvolt, over all of the three ranges. And although the analyser itself is not strictly calibrated, its vertical deflection is reasonably close to logarithmic, with a law of around 28dB/volt and a basic dynamic range of over 50dB. A further 40dB of adjustment is available with the RF Gain control, allowing the analyser to be used to check signals over a range of more than 90dB — from less than 1uV to over 30mV. Of course even larger signals can be handled, using an external attenuator.

If your 'scope is calibrated, then, you'll be able to make quite reasonable estimates of signal amplitude. Of course if you have access to a calibrated signal generator or attenuator, you'll be able to make somewhat more accurate measurements...

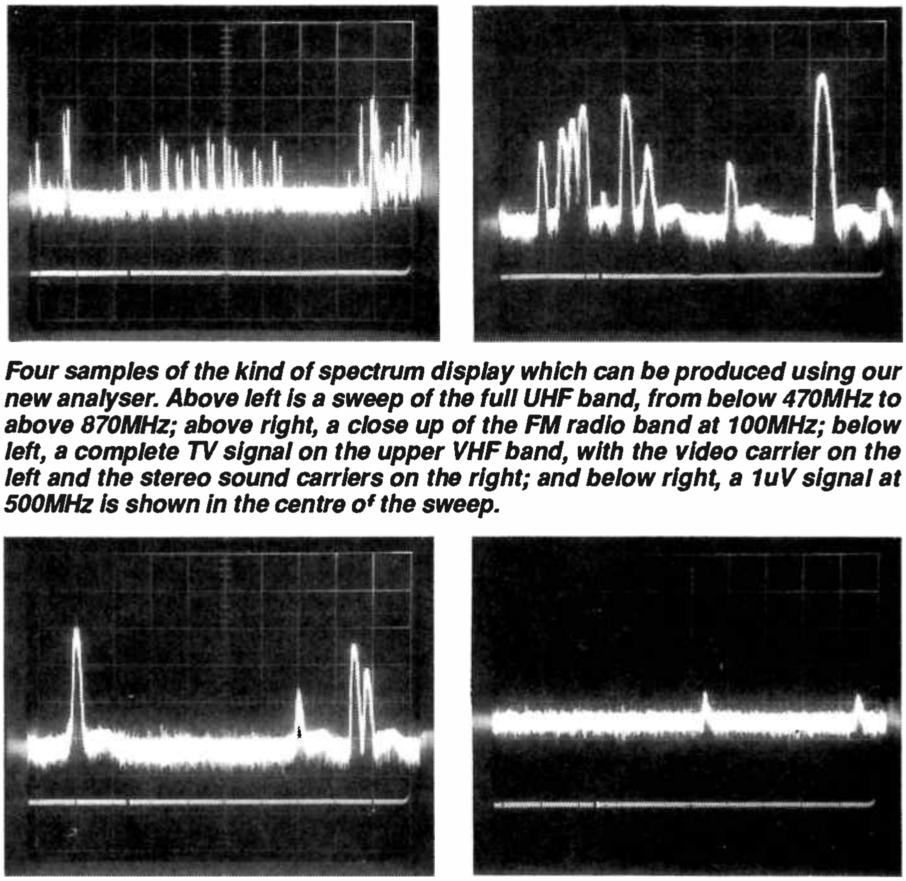
The analyser provides five stepped ranges for spectrum sweep width, allowing you to examine the full span of each range at one extreme, or alternatively 'zoom' in at the other to examine a particular signal or narrow spectrum segment of interest. The sweeping linearity is not completely linear, but is reasonably so.

For convenient examination of particular signals and/or spectrum segments, the sweep centre frequency is adjustable using two controls: a six-position 'Coarse' switch and a rotary 'Fine' control. Even on the UHF band, these allow reasonably easy 'zeroing in' on any desired signal.

Again, the centre frequency of the analyser is not itself calibrated. However if you have access to a signal generator (even a modest one) and a digital counter, it becomes quite easy to use these as a source of 'marker' signals, which can be used to measure the frequency of any signal in the swept display. More about this later.

As an added feature, the analyser's Sweep Width control has a sixth position, which allows sweeping to be effectively *stopped* at the current 'centre frequency' tuning point. In this position the instrument no longer functions as a spectrum analyser, of course, but now it becomes an FM receiver — tuned to the current centre frequency.

An audio output is provided at the rear, so that if you connect this to a suitable amplifier, you are then able to monitor any modulation on the signal at that frequency. By tuning slightly away from the signal's carrier, you can even demodulate AM. In this mode, the 'scope connected to the analyser's X and Y outputs temporarily becomes a logarithmic tuning or 'S' meter, to assist you in tuning. This is quite handy, in practice.



Four samples of the kind of spectrum display which can be produced using our new analyser. Above left is a sweep of the full UHF band, from below 470MHz to above 870MHz; above right, a close up of the FM radio band at 100MHz; below left, a complete TV signal on the upper VHF band, with the video carrier on the left and the stereo sound carriers on the right; and below right, a 1uV signal at 500MHz is shown in the centre of the sweep.

The basic detection bandwidth of the analyser is around 170kHz (-20dB), so that it's not capable of the fine resolution of a true lab instrument. However at the same time it's quite useful, as it will detect and display reasonably faithfully many of the signals of general interest.

By the way it would be possible to give the analyser a narrower bandwidth if desired, by using a crystal filter. More about this later.

Two output filter positions are provided for the analyser's Y output: a 'High' position, rolling off at about 30kHz, and a 'Low' position where the rolloff is at 3kHz. The filtering in the latter position reduces the level of 'noise grass', and allows easier detection of small signals in noisy segments of the bands.

Other features of the analyser include a sweep rate that is adjustable from about 20Hz to 70Hz, and an audio muting control which functions rather like a conventional 'squelch' control, when the analyser is being used as an FM receiver.

The FM receiver section of the analyser uses quadrature detection, and is capable of providing useful audio from a wide variety of signals — from wideband FM broadcast signals down to narrow-deviation mobile communications. But inevitably the narrow-band signals produce less audio than wideband FM or TV-sound signals, so your external amplifier needs a reasonable amount of gain.

Before we have a closer look at the analyser and how it works, I should make a small confession. Development of this project has taken a lot longer than I'd like — over three years, in fact. I started it way back in 1989, in response to a suggestion from Mr Ray Chapman, of Pakenham in Victoria.

Mr Chapman wrote in to suggest that a project along these lines would be very interesting, and sent details of a simple unit that he himself had built. He also very kindly sent copies of articles describing other small analysers, which had been published in the UK magazines *Wireless World* and *Radio Communication*, and also suggested ways in which such a unit could be made more useful.

After thanking Mr Chapman for what was an excellent project idea, I started to work on it — in between lots of other things, of course. But within a few weeks I was forced to put it aside, in order to take more urgent matters. And somehow it *kept* getting bypassed, for the next three years...

A couple of months ago, though, I suddenly remembered it — and also realised

yet again how interesting a project it would be. So the folder was fished out of my filing system, and I made a firm resolution to finish it without delay. Luckily I had kept adding to the file all of that time, with information about further published designs, new IC's and other components that seemed suitable, and so on. So it really wasn't too hard to pick up, from where I had left off.

At long last, then, the project has materialised. No doubt Mr Chapman himself has by now given up on ever seeing it — but hopefully the wait will have been worthwhile, at least for other readers. All I can do is apologise for the incredibly long time it's taken.

By the way, this has been a most interesting project to develop, and I'm sure if you build it you'll find it as satisfying as I have done. There's something quite fascinating about being able to tune over the spectrum, focus in on an interesting signal 'blip', check its frequency and amplitude, and then listen to its modulation to discover its identity...

How it works

Essentially, a spectrum analyser is a special kind of radio receiver, where the tuning is not set to receive a particular frequency, but is 'swept' repeatedly over a *range* of frequencies. Generally this is done by using a tuning system that can be controlled using a DC voltage, and then using a low-frequency 'sawtooth' signal to sweep its tuning.

Most spectrum analysers are based on the superheterodyne principle, as illustrated in Fig.1. Here the incoming signal is fed to a mixer, where it beats with a local oscillator in the usual way to produce sum and difference frequencies. One of these (usually the difference) becomes the 'IF' (intermediate frequency), which is fed through a relatively narrow filter and then amplified, before passing to a detector.

In a normal superhet receiver, the local oscillator would merely be set for a particular frequency — usually higher than the desired signal, by a frequency difference equal to the desired IF. However here we use a *voltage-controlled oscillator* (VCO), whose frequency is set by a combination of two control voltages. One is an adjustable DC voltage, used to set the oscillator's *centre frequency*, while the other is the low-frequency AC sawtooth signal used to sweep the oscillator above and below this centre frequency, over the desired range.

The output from the detector will normally be proportional to the received signal strength, at any instant. So if the receiver is being swept through a range of frequencies in this way, the detector output will vary according to the strength of any signals in the swept range. By feeding the detector output to the Y (vertical) input of a 'scope, and the sawtooth sweeping signal itself to the X (horizontal) input of the 'scope, we can therefore obtain a dynamic graph of incoming signal amplitude versus frequency.

Of course the selectivity of the system needs to be fairly high, to ensure that the analyser can 'separate' signals that are close together. The advantage of using the kind of modified superhet scheme shown in Fig.1 is that this selectivity can be provided mainly by the IF filter, as this stays fixed in its tuning. Laboratory-grade spectrum analysers generally use a crystal filter, to achieve very high selectivity.

Note that the basic analyser setup shown in Fig.1 needs to have quite a few refinements, in order to produce a practical instrument.

Generally there needs to be an RF amplifier ahead of the mixer, to give the analyser an acceptable noise figure and image rejection ratio. This means that the RF amplifier's tuning also needs to be controlled by the centre frequency and sawtooth control signals, along with the local oscillator.

To allow adjustment of the frequency range swept by the analyser, the amplitude of sawtooth signal fed to the VCO also needs to be variable. A large amplitude sawtooth sweeps the VCO over a wide range and gives an overview of a complete band, while decreasing amplitudes of sawtooth reduce the swept range, effectively 'zooming in' to a particular part of the spectrum in order to allow closer examination.

Further possible refinements include an input attenuator to prevent large input signals from overloading the analyser's 'front end'; switched IF filters of different bandwidths, to give adjustable selectivity; and a detector circuit whose DC output varies logarithmically with signal level, to make measurements and comparisons easier.

Of course a true lab-grade analyser will nowadays also tend to have digital frequency measurement and signal amplitude measurement facilities built in, for accurate measurements.

So much for the basic principles, then. Now let's look at the actual circuit of our low-cost analyser project.

The schematic

At the heart of our analyser are two key components: a varicap tuned VHF/UHF TV tuner module (M1), and a special multi-purpose FM receiver chip (U1). These two components between them make the whole project possible, because they perform virtually all of the RF and IF signal processing.

M1 is a standard TV tuner module, made by the Japanese firm Murata and known as the TUMUF4EA-721. It is reasonably widely available, being an updated version of the earlier TUMUF4EA-706 module which was used in a number of previous projects: the TV-Derived Time and Frequency Standard of July/October 1989, the TV Field Strength Meter of August 1988 and the Improved Teletext Decoder of June-August 1989. (The analyser PCB has actually been

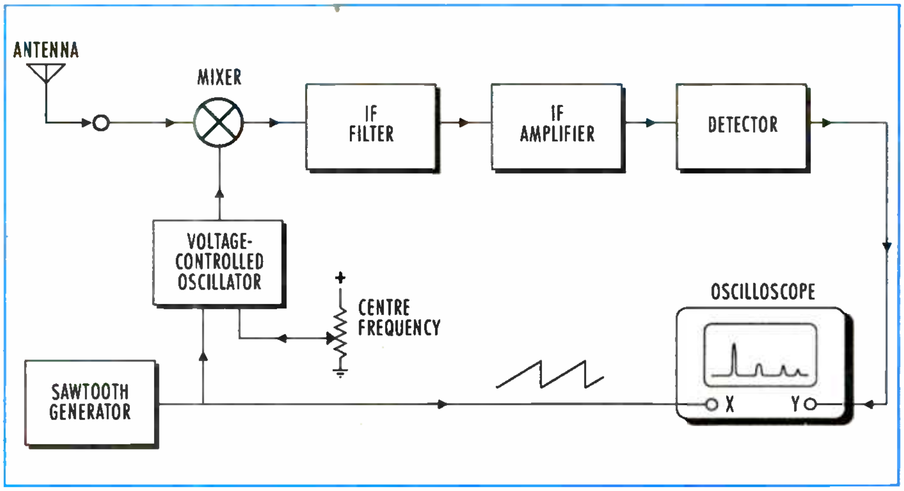


Fig.1: The basic block diagram for a heterodyne type spectrum analyser using an oscilloscope as its X-Y display. The local oscillator is a VCO, whose frequency is controlled using both a DC voltage and a sawtooth wave.

[illegible]

designed to operate with either module, so if you have one of the earlier units this can be used.)

Inside the module there are basically two complete tuners, one tuning the two VHF bands and diode-switched between them, and the other tuning the UHF band.

Both tuners share a common RF input, with high-pass and low-pass filtering to direct the incoming signals each way, and they also share a common mixer/IF output stage with relatively broad tuning centred on about 34MHz.

Both tuners feature RF amplifier stages using dual-gate MOSFETs, with gain control achieved by varying the voltage on G2 of each device. The common gain control voltage for both RF stages is fed in via the 'AGC' pin (pin 5).

Bipolar transistors are used for the mixers and local oscillators of both tuners. Varicap tuning is used throughout, with the tuning voltage fed in via a common 'VC' pin (pin 7). It is this pin which we use in our analyser to perform both the sweeping and centre frequency control.

Apart from the tuning varicaps, the circuitry of the module is designed to operate from a nominal 9V DC supply. This is supplied continuously to the shared mixer output circuitry, via the 'BM' pin (pin 2), but is switched to one of three additional pins to achieve operation on the three bands. Thus when +9V is connected to the 'BL' pin (pin 4) the VHF tuner is activated and operates on the lower VHF band, while if the +9V is connected to the 'BH' pin (pin 6), the same tuner is activated but on the upper VHF band. Finally if the +9V is fed to the 'BU' pin (pin 8), the UHF tuner operates. In our present circuit, switch S1 performs this band switching function.

Both tuners inside the module provide around 30dB of overall power gain, varying from a minimum of 24dB to a maximum of 38-40dB, on the various bands. Maximum gain is achieved with +6.3V applied to the 'AGC' pin, reducing by typically more than 40dB as this voltage is lowered to 0V. In our circuit potentiometer RV1 is used to vary this voltage, and provides a manual RF Gain control.

The remaining pin of the module is pin 3. This is labelled 'AFC', and is used for automatic fine tuning when the tuner module is used in a TV receiver. Here we simply connect it to a voltage divider providing +4.5V.

Because the module is designed originally as a TV tuner, it is a relatively broad-band device. The IF output, although centred on about 34MHz, actually extends from about 31MHz to 37MHz — about 6MHz, to span the full width of a TV signal. Needless to say this is far too wide for our present purposes.

Here's where chip U1 comes in. This is a Signetics NE605N, which can perform most of the functions required for a complete FM receiver. Inside the chip there's a balanced mixer, a transistor that can function as a local oscillator, two high-gain IF amplifier/limiter blocks which can be cascaded, and a quadrature FM detector stage (Fig.2).

There's also internal circuitry associated with each IF gain block, which produces a DC voltage at pin 7 varying logarithmically with incoming signal strength. This is normally intended to drive a 'Received Signal Strength Indicator' (RSSI), but is ideally suited as the basic output signal for our analyser.

By the way, the NE605N is essentially a combination of two earlier and fairly well-known Signetics chips: the NE604, which is an FM IF strip and quad detector (with RSSI output), and the NE602 balanced mixer/oscillator.

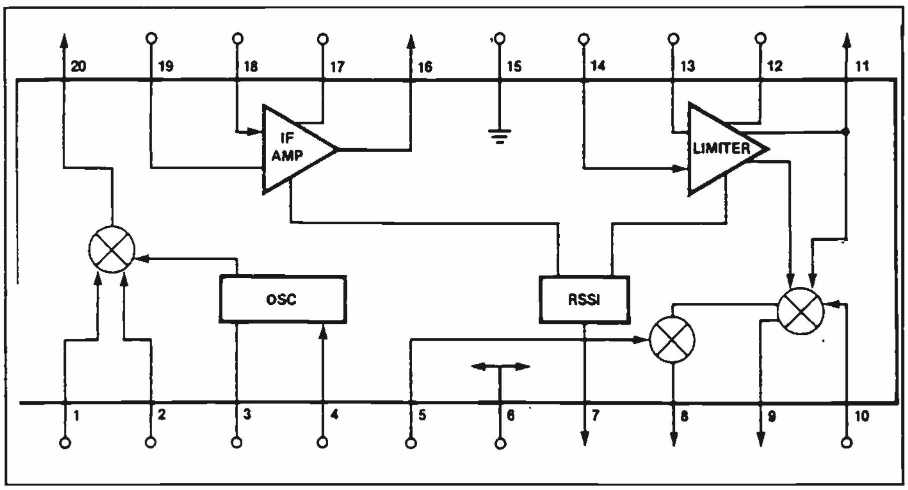


Fig.2: The Signetics NE605N chip provides a VHF oscillator and mixer, two stages of high gain IF amplification and limiting, a logarithmic signal strength detection circuit and a quadrature-type FM detector. Here's a look at what's inside it.

The NE605N is quite capable of operating at the 34MHz IF delivered by our tuner module, but it would not be easy to provide the necessary selective filtering at these frequencies. So to make filtering easier, we use the oscillator/mixer section of the chip to perform a second heterodyne conversion, down to the standard IF used by FM receivers: 10.7MHz. This allows us to perform quite effective FM filtering using a pair of low-cost ceramic filters: F1 and F2.

In other words, our analyser is essentially a 'double conversion' superhet. The second local oscillator operates on a fixed frequency of about 26MHz — i.e., 10.7MHz below the tuner output. It uses a low-cost quartz crystal, of the type used in CB transceivers, connected in a Colpitts-type circuit using the NE605N's internal oscillator transistor (pins 3 and 4).

Although shown on the schematic as cut for 26.175MHz, X1 can in fact be almost any crystal which resonates in the range 21 - 26.5MHz. As most such crystals are in fact cut to oscillate on their third overtone, components L2 and C17 are used to discourage oscillation at the fundamental.

To couple the unbalanced 75-ohm output of the tuner module into the balanced higher impedance input circuitry of U1 (pins 1 and 2), we use IF step-up transformer L1. This is hand wound, and tuned with C4 and a ferrite slug to resonate at the exact tuner output frequency corresponding to the crystal being used — i.e., 10.7MHz above the crystal frequency.

The output from the NE605N's internal mixer appears at pin 20, and this is coupled into the input of the first IF amplifier block via ceramic filter F1. The output of the first block is then coupled into the second block via filter F2. It's therefore F1 and F2 which provide the analyser's basic IF selectivity.

F1 and F2 are also made by Murata, and are very compact three-pin devices: type SFE10.7MH. Each is designed to provide a typical bandwidth of 260kHz at the -20dB points, centred on 10.7MHz and with an insertion loss of about 6.5dB.

Incidentally it is filter F1 which would be replaced with a 10.7MHz crystal filter, if you later want to give your analyser a narrower IF bandwidth and hence greater selectivity. However as a crystal filter will tend to have greater insertion loss, this will probably result in lower overall gain.

Resistors R4, R5, R6 and R7 are used to achieve correct impedance matching between the ceramic filters and the IF outputs and inputs of U1. This is necessary to get optimum operation from the filters. Capacitors C5, C7, C9 and C10 are

[illegible]

then used to prevent the resistors from disturbing the chip's internal biasing, while capacitors C6, C8, C11 and C12 are used to provide correct IF stage bypassing.

The RSSI output from pin 7 of U1 forms the analyser's basic Y output, and this is designed to be close to logarithmic when the pin is connected to ground via 90k of resistance. This is the purpose of R47 and R48. Capacitor C28 provides a small amount of low-pass output filtering, while S4 allows C29 to be switched in for additional filtering. S4 thus becomes the analyser's 'High/Low' bandwidth switch. Op-amp U5a is connected as a unity gain buffer amplifier, coupling the filtered signal to the Y output connector.

Sawtooth generator

At this stage, we should perhaps examine the section of the circuit which generates the sawtooth signal for the analyser's frequency sweeping and X output. This is shown below M1, and is centred around U4 and U6.

The basic sawtooth generator uses U4, a low cost 555 timer chip. This is connected as a standard astable oscillator, except that here we use transistor Q1 as a constant-current source to give a more linear sawtooth. Resistors R43-R44 and zener diode Z2 are used to hold the transistor's base at close to 5V below the +28V rail, so that it is forced to pass a certain emitter/collector current in order to match this voltage with the drop across its emitter resistance (plus Vbe).

By varying the resistance in the transistor's emitter circuit, we therefore control its current — which provides the charging current for the 555's timing capacitor C40. RV2 thus becomes the sawtooth generator's 'Sweep Rate' control, varying the sawtooth frequency between about 20Hz and 70Hz. Diode D3 is used to ensure that the voltage on pin 7 of U4 cannot rise higher than +12.6V.

Because the linear sawtooth voltage generated across C40 is to be used in two ways, it is fed to the inputs of both U6a and U6b — both sections of an LM324 quad op-amp. The first of these sections is used as a buffer for the X output, with resistors R35 and R36 used to give it a voltage gain of two. This provides a sawtooth output of 8V peak to peak, which should be more than adequate to drive the X input of most 'scopes.

U6b is also wired as a buffer, but with unity gain. Its output signal is then used to drive U6d, which is connected as an inverting amp with a gain of three. This produces an inverted sawtooth of 12V peak to peak, which is then fed to the tapped voltage divider R18-R26 and switch S3a, the Sweep Width control. The sawtooth amplitude selected by S3a is then passed to the inverting input of U6c, the tuning voltage output stage.

The non-inverting input of U6c is fed with the Centre Frequency tuning voltage, which is adjusted using S2 and RV3. These are connected in the Kelvin-Varley configuration, so that together they form a low-cost equivalent to an expensive multi-turn pot. The two poles of S2 effectively switch VR3 up and down the divider formed by R10-R16, in a way which provides six slightly overlapping voltage adjustment ranges, covering 0 - 12V.

The tuning voltage output stage around U6c performs three main functions. These are mixing the Centre Frequency and Sweep voltages together; inverting the sweeping sawtooth waveform, to give a logical 'lower frequencies on the left, higher frequencies on the right' display format; and finally, amplification of both the mixed signals to allow coverage of the full 28V peak-to-peak variation range required by the tuner module for full tuning range on each band.

As both the Centre Frequency voltage and the sawtooth Sweep voltage have a maximum range of 12V, the gain of the tuning output stage needs to be set to 2.33 (28/12) for correct operation. This is achieved by preset pot RV4, which allows fine adjustment of the stage's negative feedback.

At this stage you may be wondering about the the reason for bringing out a signal from pin 3 of U4, the sweep generator, and feeding it via R53 to a connector marked 'Trigger Output'. The function of op-amp U5c and transistor Q2 may also seem obscure.

Well, there may be some older 'scopes which don't have any provision for input of an external signal for X deflection. However even *these* should at least have provision for external triggering of their own timebase, so I've provided the trigger output to allow this alternative approach. The signal from pin 3 of the 555 is a narrow rectangular pulse, which is at 0V during the sweep flyback and +12V during active sweeping. It should therefore not be difficult to trigger the timebase of your 'scope, to lock it to the analyser's sweeping.

The purpose of U5c and Q2 is to gate off the Y output of the analyser during the sweep retrace (when the tuning voltage, and hence the tuner module's tuning, are dropping back to the low limit again for the next sweep). Gating the Y output off during this time prevents the display of a spurious 'retrace' curve on the 'scope screen, and in fact provides a rather more useful horizontal 'baseline'.

The actual gating is performed by Q2, driven by U5c which is configured as an inverting comparator. The comparator has the 'Trigger' pulses fed to its inverting input, with the non-inverting input fed from a small positive voltage established by R59 and D10. This results in Q2 being driven hard on during the retrace period, but held off during the active sweep.

Incidentally the rectangular pulses available at the Trigger output could be used to gate the 'scope display off *altogether* during the retrace period, if you prefer this and if your 'scope has a 'Z-axis' or intensity modulation input.

Receiver operation

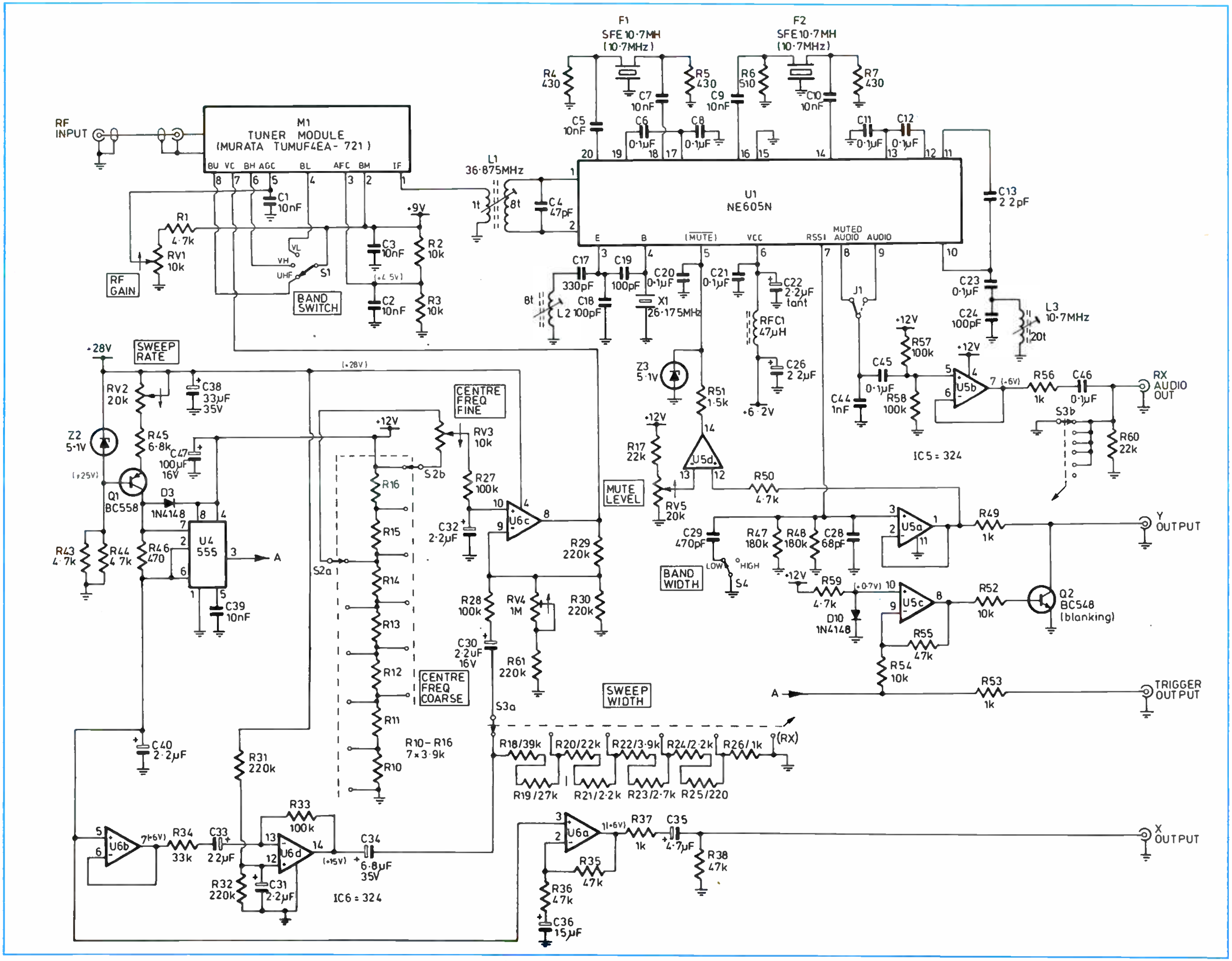
The circuitry we've discussed so far is basically that for the complete spectrum analyser section. The remaining section is that used to provide the instrument's 'bonus' function of FM reception.

As noted earlier, the NE605N chip includes a quadrature-type FM detector. This functions by effectively multiplying the output from the second limiter amplifier with a version of the same signal, shifted in phase by 90°. By making use of this detector, we can therefore derive an audio signal from any FM modulation on the received RF signals — because the analyser is, after all, a wide range superhet receiver.

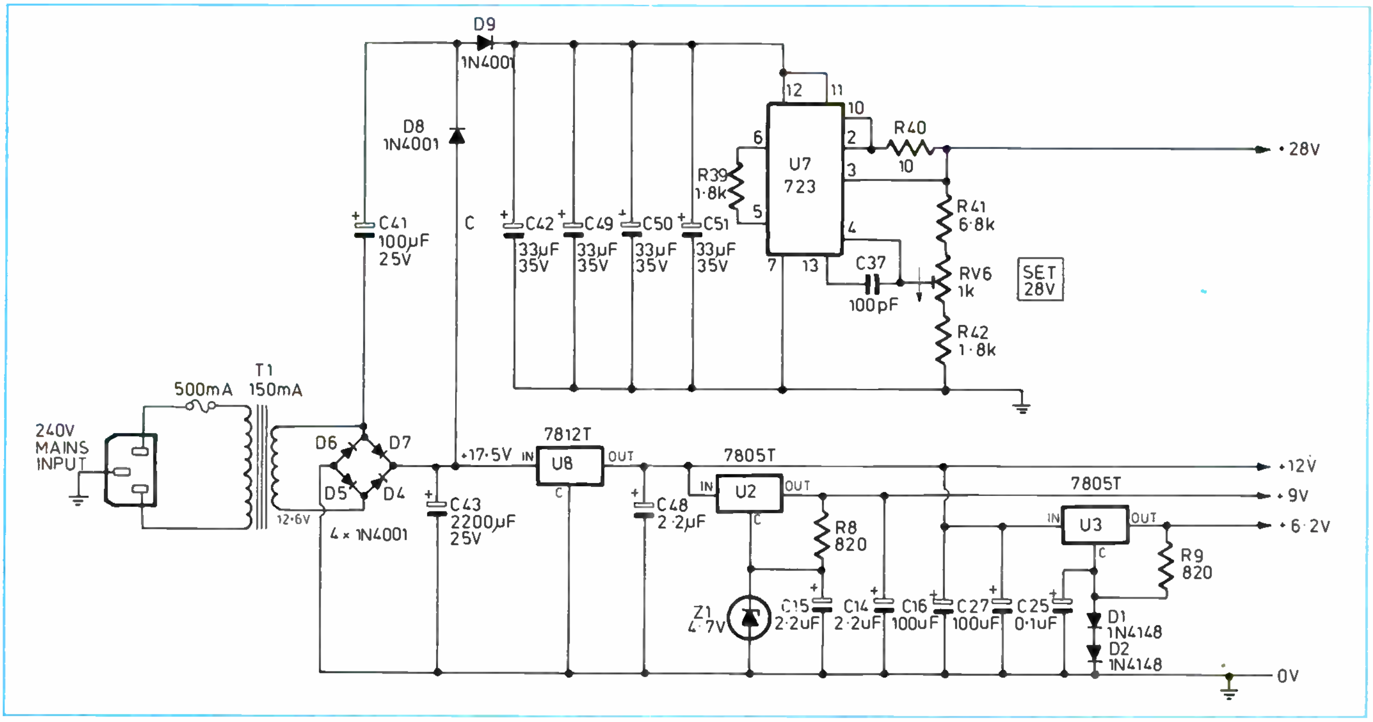
Needless to say it doesn't make much sense to try listening to this audio output when the analyser is actually sweeping over a range of frequencies. However if we stop the sweeping, with the Centre Frequency controls set to position a signal of interest in the centre of the analyser's display, we can then listen to any modulation on it.

The 'direct' IF input to U1's quadrature detector is made internally, as shown in Fig.2. External components C13, C24 and L3 are used to take a duplicate of this signal from pin 11 and develop the 90° phase shifted signal, which is fed back into the detector via pin 10. (C23 is purely a DC blocking capacitor.)

The detector actually has two alternative audio outputs, one a continuous output from pin 9, and the other a 'gated' output from pin 8 — controlled by the voltage on pin 5. Here we use the output from pin 8, although the analyser's PCB



Two key components form the heart of our new analyser: a varicap-tuned TV tuner module (M1) and a multi function FM receiver chip (U1). Together these form what is essentially a wideband VHF/UHF double conversion superhet receiver, which we use for spectrum analysis by sweeping its tuning with a low frequency sawtooth.



The analyser's power supply schematic, which produces a total of four different supply voltages for the rest of the circuitry. A +28V rail is needed for the tuning and sweeping, while +12V, +9V and +6.2V are needed for the rest of the circuit.

allows for using the pin 9 signal if you prefer.

The audio gating signal is developed by U5d, which is connected as a comparator. The non-inverting input is fed from the buffered RSSI output, and hence carries a DC level proportional to the received signal strength, while the inverting input is fed with an adjustable DC voltage from RV5.

This allows convenient adjustment of the signal level necessary for the audio to be gated on — in other words, RV4 acts as a fairly conventional muting or 'squelch' control, to gate off noise between signals. But note that this control effectively only operates when the analyser is in 'Receive' mode.

The audio output from pin 8 of U1 is given a small amount of low-pass filtering, via C44, and then fed through U5b — connected as a unity gain buffer. The buffered output from U5b thus becomes the received audio output. However S3b is wired so that when the analyser is sweeping, the output is shorted to ground. The short is removed only when S3 is turned to its sixth 'no sweep' position, where the analyser's tuning is fixed at the current centre frequency.

So S3 gives the analyser five possible sweep widths, from virtually the full band down to a narrow segment, plus a sixth position where it becomes a wideband FM receiver. And in this last position the Y output signal is still functional, so that it can be used as a DC 'signal strength' output. As the X output is also still functional, this means that the 'scope effectively becomes the receiver's 'S meter' — for easier tuning.

Resistor R51 and zener diode Z3 are used to limit the positive swing of the audio muting signal applied to pin 5 of U1. This is necessary because U1 operates from a +6.2V supply, while U5 operates from +12V.

Components C21, C22, RFC1 and C26 are used to bypass and decouple the supply voltage to U1, to ensure its stability.

Power supply

There are four basic supply voltages needed by the analyser's circuitry: +28V for tuning/sweeping; +12V for the sawtooth generator, centre frequency voltage source and output buffers; +9V for the tuner module; and +6.2V for the NE605N. These are provided in a fairly straightforward manner by the power supply circuitry, shown in a separate schematic for convenience.

A single low-cost 12V/150mA power transformer is used (T1), which drives two rectifier circuits. The main rectifier is a full-wave bridge using D4-D7, which develops a raw +17.5V across reservoir capacitor C43. The second rectifier is a half-wave voltage doubler using D8 and D9, which is 'piggy backed' on the first circuit so that it develops a raw +32V supply across the paralleled reservoir capacitors C42, C49, C50 and C51.

(Why four capacitors in parallel? Because 33uF is the highest value PCB-mounting 35V-rated electrolytic currently available, at a low price. So as we need about 120uF here for adequate regulation, four of them are used in parallel.)

The +17.5V line is used to derive a well-regulated +12V rail, via regulator U8. Similarly the +9V and +6.2V rails are derived in turn from the +12V rail, via regulators U2 and U3. The latter are both readily-available 7805 devices, with 'bootstrapping' via zener diode Z1 and diodes D1-D2 respectively, to achieve the desired output voltages. Resistors R8 and R9 are used to ensure that there is sufficient current through the bootstrapping devices to give adequate regulation, while capacitors C14, C15 and C25 are used to minimise noise and ripple.

Regulator U7 is used to derive the +28V tuning/sweep supply rail, from the raw +32V line. This regulator ensures that the tuning supply rail is stable and ripple free, so that the analyser has very stable tuning — even when it is being used as a receiver. Preset pot RV6 is used to set the output to the correct level of +28V.

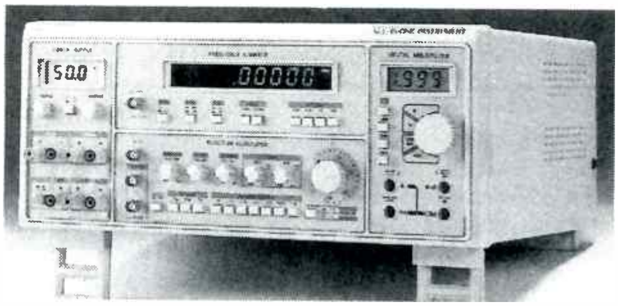
So that's the circuit of our new spectrum analyser. Next month, we'll look at its construction, adjustment and use.

(To be continued). ❖

[illegible]

Emona LAB4

Four instruments in one package!



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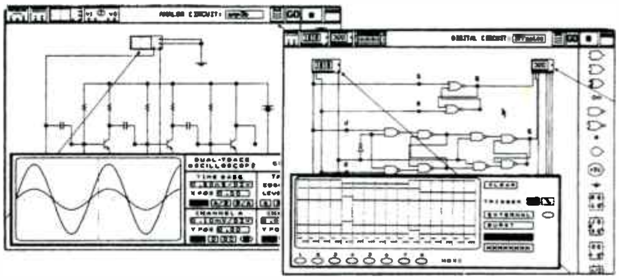

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READER INFO NO. 18

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.

Multi-flash unit

If you've ever wanted to take multi-flash photos of moving objects and people, but baulked at the cost of a real strobe — here's a cheap solution. Instead of using one flash tube fired many times, as in a true strobe, you use several flash tubes fired once each.

The flash tubes, and indeed the whole flash guns, come free! How? Ask the local one-hour film labs to save all those Fuji throw-away camera bodies with flash guns. With a bit of luck, they'll still have a little-used AA alkaline cell in each one.

When you get the bodies, and start working on them, remember that, although they run from a 1-1/2V supply, they generate over 300V and charge a capacitor of unmarked value. This is enough to give anybody a nasty wallop — and the capacitor can hold its charge for days.

Opening the bodies is easy. They're 'clicked' together, not stuck. Simply remove the front of the camera to expose the back of the circuit board. Don't remove the flash unit completely, so that you can still use the battery holder and contacts. You need to get at the four contacts shown in Fig.1.

A and B are switch contacts and should be connected to a simple toggle switch. C and D are the trigger and battery negative contacts, respectively.

The trigger contact stands at about 230V below (surprisingly) the negative contact. To try out the flash unit, insert, or leave in, the AA cell. Join the contacts A and B, and when the neon light is flashing, join C and D. A flash should result.

Now for the electronics. The circuit

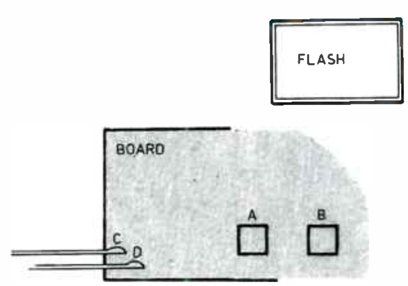


Fig.1

for the control unit is shown in Fig.2. IC1 is a 555 timer used in the astable mode. When pin 2 is connected to ground, it will set off a series of flashes, which continues for about 2 seconds. This should be enough for most multi-flash photos.

While IC1 is 'on', its pin 3 output goes high and enables IC2, another 555 also in its astable mode. IC2 sends pulses to IC3 (a 4017 counter), at a rate determined by RV1. This rate varies from about four per second to very high.

Until the IC2 pulses arrive, IC3 has been sitting with its output-0 high, having been reset automatically by the 1nF capacitor and 100k resistor connected to its pin 15. When the pulses arrive, IC3 starts to count, and its outputs 1-9 go high in turn. For each flash gun to be used, connect a LED, and a 400V SCR (C106D) to fire the flash, to these outputs (pins 2,4,7..). Note that no flash gun is connected to output-0 (pin 3), and the LED on pin 3 is lit when the unit is standing by. Fig.2 shows the first two flash units connected.

To operate, follow this procedure. First switch on S1. Then press the test button and observe the flashing rate of the LEDs — set as required with RV1. Switch off S1 to ensure that IC3 will restart with output-0 active, and not one of the flash unit outputs.

Switch on S1 again, and switch on all the flash units. When the neon indicators on all units are flashing, you're ready to start your photo. Switch off the flash units to ensure that they can't recharge and fire twice. Then press the 'fire' button (in the dark of course), and the flashes will trigger in turn to take your strobe photo.

If the action is continuous, triggering can be done by the camera shutter contacts; or if it is reasonably slow, by a pushbutton. Other triggering systems could be activated by sound, making or breaking contacts, etc.

A.J. Lowe,
Bardon, Qld $45

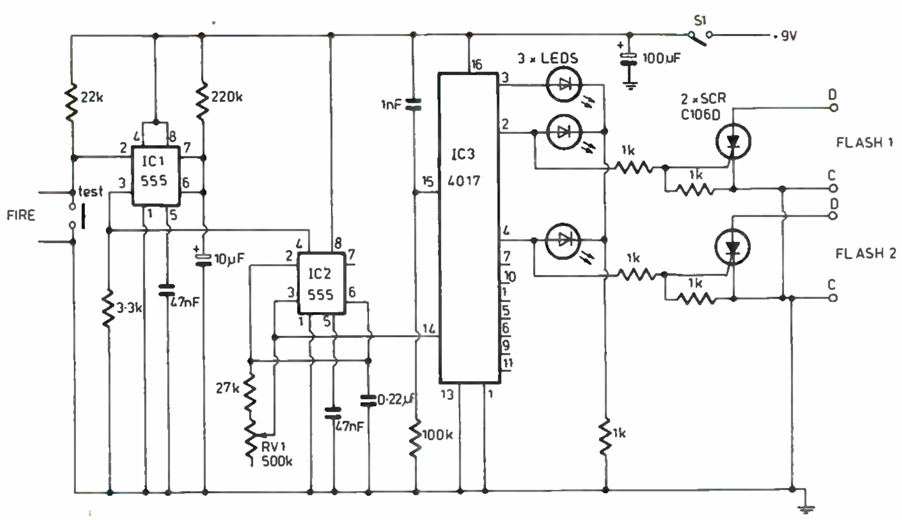


Fig.2

[illegible]

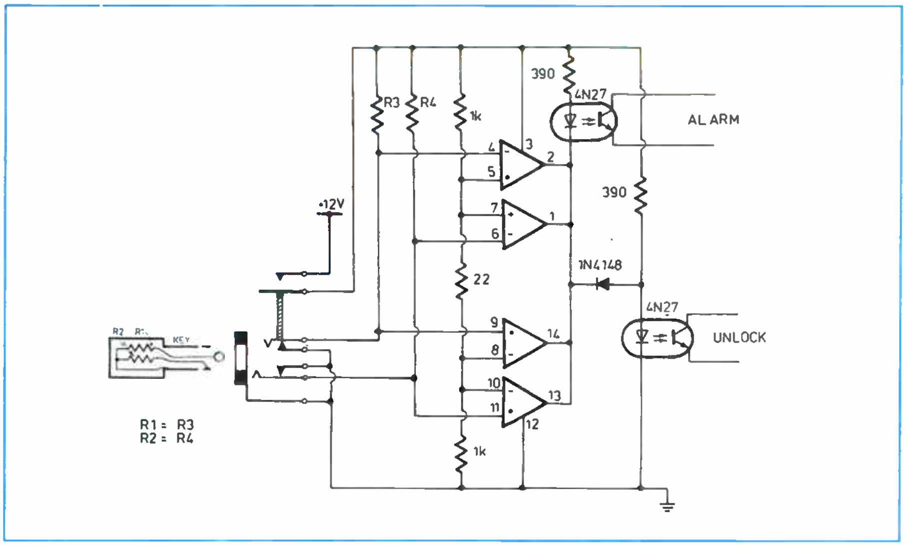
[illegible]

[illegible]

[illegible]

[illegible]

Electronic lock



This design allows a lock to be constructed from oddment parts. It gives reasonable security, and may be suitable for disabling a car or house alarm system. The 'key' is a 6.5mm stereo phono plug. It contains two resistors, and could easily be carried on a key-ring.

Each resistor in the key forms a voltage divider with an identical resistor in the lock, i.e. R1=R3 and R2=R4. Thus, with the correct key inserted, the voltage on both the tip and ring of the plug will be half the supply.

The four comparators of the LM339 check that both voltages fall within a narrow window. Their open-collector outputs are wired as an OR gate, so that, if either key voltage is too high or too low, the output will be pulled low. This low will energise the 4N27 'alarm' opto coupler and will allow the diode to shunt the current around the 'unlock' opto. If, however, the correct key is inserted, no comparator will pull the output low, and so the 'unlock' will be energised. Any value in the range 100 ohms to 1 megohm may be used for resistors R1-R4. Anything lower will dissipate excess power, and higher values may have problems with tolerance or leakage. If the full E24 5% tolerance series is used, this gives a total of 97 possible values, thus the lock has 97 x 97 or 9409 possible keys.

The contacts on the jack apply power to the circuit only when a plug is inserted. The tip and ring contacts in the socket are grounded when not in use, which makes it harder for a thief to measure the internal resistors by probing into the jack. The unit communicates with an alarm system, or whatever, by current loops. The alarm system should ignore any input for about 100ms to ensure that it is stable. There will be glitches on both outputs when any key, correct or not, is inserted or withdrawn.

Graham Leadbeater,
Ringwood, Vic $40

Foolproof battery charger

This charger is reverse-polarity proof, shortcircuit proof, and will not attempt to charge a 6V or 24V battery if such were accidentally connected. In fact, there is no output at all, until it is connected to a battery with a terminal voltage somewhere between 10-14.3V.

And it is also very compact, measuring only 20 x 20 x 5cm. These dimensions include its toroidal transformer (Altronics M3085), and also a heatsink which sticks out some 5cm from the back.

The basic 20A charger can still deliver about 8A into a battery at 14.2V. Of course, once the battery is charged to around this voltage, the unit will start to cycle on and off — its on- time becoming smaller and smaller, until the relay just gives a brief click (in/out) every couple of minutes. So the circuit can not overcharge the battery. At around 14.3V (when the battery is fully charged) it will switch off completely, and stay off until the voltage drops to 13V.

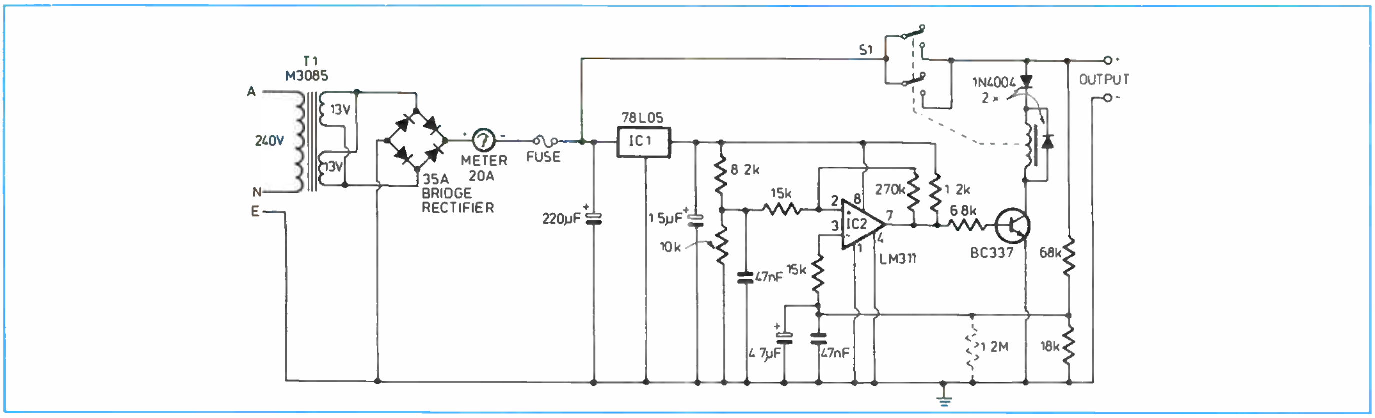
IC2 (LM311) is a comparator which controls this switching. Note that 14.3V is a nominal value, which will vary slightly, depending on the voltage drop in your charging leads, battery clips, etc.

The 270k resistor connected between pins 2 and 7 sets the switch on/switch off voltage differential (hysteresis); and the 68k/18k divider across the charger output sets the upper limit to the battery voltage. The 1.2M resistor is added in parallel with the 18k to set the exact voltage. A pot could have been used, but I prefer fixed resistors for reliability.

Note that for the relay to turn on, after the transistor (BC337) turns on, the battery being charged must supply the necessary current. This sets the minimum battery voltage at about 10V. (Once the relay is on, it holds itself on via switch S1.) So a 6V battery cannot be charged with this unit. The fuse is needed for that rare case of a large, dead-flat battery which still shows a terminal voltage above 10V, and hence tries to take more current than your charger can supply.

The relay I used is a Tandy, 275-218. The 35A bridge rectifier was mounted on a heat sink. And I added approximately four turns to each secondary winding of the transformer to get my 13V output (the M3085 is rated 12+12V).

Mike Taylor,
Dalby, Qld $40



DICK SMITH ELECTRONICS

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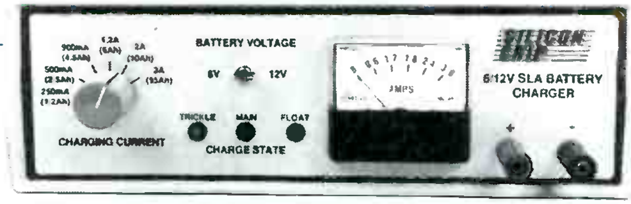

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Cat K-3204

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$129

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EA MAY '92

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SILICON CHIP MAY '92

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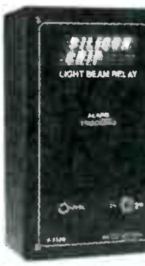

INFRARED LIGHT BEAM RELAY

Ideal as a doorminder or to monitor areas around the home or shop. This simple project triggers a one second alarm when someone walks through its beam. You can connect it to a buzzer or trigger relay depending on the application. It's a full form kit with all components, PCB, case, front panel label, plug pack and relay for greater flexibility.

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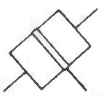

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Cat K-5600

EA SEPT '88

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SPECIFICATIONS

Power Output	One Channel	Both Channels
4 ohms	42W	32W
8 ohms	28W	26W

Dynamic Power (IHF-A-202)		
4 ohms	56W	48W
8 ohms	38W	38W

Harmonic Distortion

8 ohms	0.025% at 25W
4 ohms	0.065% at 25W (Typically less than 0.015% at normal listening levels)

Frequency Response

Phono Input	RIAA/IEC equalisation within +/-0.5dB (30Hz to 20kHz)
Line Inputs	+0/-1dB from 20Hz to 20kHz

Hum and Noise

Phono input	-76dB unweighted (ref:10mV/1kHz, terminated in typical MM cartridge)
Line Inputs	-91dB unweighted (ref: 250mV/1kHz)

Damping Factor

Approximately 80 (8 ohms load)

Channel Separation (ref:28W ouput)

100Hz	-83dB
1kHz	-72dB
10kHz	-54dB

Input Sensitivity (ref:28W ouput)

Phono input	4mV (overload at 1kHz: 150mV)
Line inputs	250mV
CD inputs	2V (as set by optional pad resistors)

Tone Controls

Bass	+/- 12dB at 60Hz
Treble	+/- 12dB at 16kHz




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True RMS
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Dangerous voltage beeper
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Tilt stand

Ranges:

DCV:	200mV, 2, 20, 200, 1500V
ACV:	200mV, 2, 20, 200, 1000V
AC/DC Current:	200uA, 200mA, 20A
Resistance:	200ohm, 2K, 20K, 200Kohm, 2M, 20Mohm
Capacitance:	20, 200nF, 2, 20, 200uF

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Ranges:

DCV:	200mV, 2, 20, 200, 1500V
ACV:	2, 20, 200, 1000V
AC/DC Current:	2, 20, 200mA, 2, 20A
Resistance:	200ohm, 2K, 20K, 200Kohm, 2M, 20Mohm

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Features:
3.5 digit display
Auto off
Dangerous voltage beeper
Diode and continuity test
Tilt stand

Ranges:

DCV:	200mV, 2V, 20, 200, 1500
ACV:	200mV, 2V, 20, 200, 1000
AC/DC Current:	200uA, 200mA, 20A
Resistance:	200ohm, 2K, 20K, 200Kohm, 2M, 20Mohm
Capacitance:	2, 20, 200nF, 2, 20, 200uF

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Auto off
Data hold and reset buttons
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Logic, diode and continuity test

Ranges:

DCV:	2, 200, 1000V
ACV:	2, 200, 750V
Resistance:	200ohm, 2Kohm
Capacitance:	200uF

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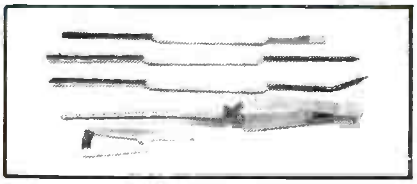

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150 Watts!

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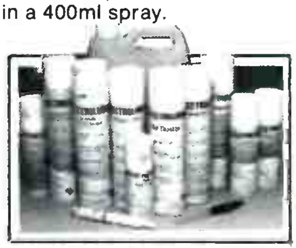

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- In the long run NiCads are far less expensive than normal disposable batteries
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UNIVERSAL CHARGING CABINET

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High capacity NiCad batteries last up to 3 times longer (between recharges) than standard NiCad batteries. This mains powered unit charges up to 8 high capacity NiCads at once... in almost any combination! Charge 600mAh 'AA', 1.8Ah and 2Ah 'C', 4Ah 'D' cells and up to 4 x 9V at their correct rates. With LED indicator lights and reverse polarity protection.

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'AA', 'AAA' & 9V!

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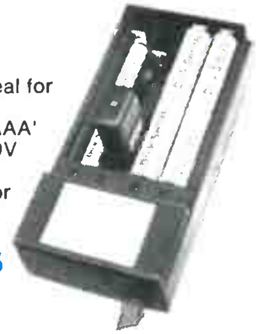

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BASIC CONCEPTS: ATOMS AND ENERGY

In this first chapter, we look at some of the basic concepts needed for an understanding of what happens inside solid state devices. This includes atomic structure, the dual nature of electrons, orbits and energy levels, and energy absorption/emission in the form of discrete 'quanta'.

by JIM ROWE

The concept of an atom as a microminiature 'solar system' is a familiar one to many people in electronics. According to this picture, atoms consist of a central and relatively heavy *nucleus* having a positive electrical charge, around which orbit smaller, lighter and negatively charged *electrons* whose number is such that in the 'normal' state, the positive and negative charges balance, and the atom carries zero nett charge. For each of the chemical elements, the atomic nucleus has particular values of mass and positive charge, and is accompanied in the 'normal' state by the appropriate number of orbiting electrons.

Consistent with this picture is the idea that electrical conduction is a mechanism in which an applied electric field causes outer orbiting electrons to be freed from their atoms, whereupon they can wander through the material to form the traditional 'current flow'. Conducting materials such as metals are thus understood as materials in which the outer electrons are 'loosely bound' to the atomic nuclei, while insulating materials, are in contrast, those in which the electrons are 'tightly' bound, and normally unable to wander.

For many years, this simple and quite easily grasped concept of atomic structure and its relationship to electrical conduction proved quite satisfactory for most purposes. It was generally adequate, for example, for an understanding of the operation of thermionic valves and the circuits in which they were used.

However as science, and consequently technology, progressed it was found increasingly that the simple picture could not adequately explain many of the new discoveries. It became necessary, as with so many scientific concepts, to both revise and expand our conception of atomic structure, and with it our understanding of electrical conduction.

Hence it is that, in order to gain a clear knowledge not only of the mechanisms of electrical conduction as it is currently understood, but also and in particular of the operation of the many different semiconductor devices which are used in — and have virtually revolutionised — modern electronics, one must begin by becoming acquainted with the atom as it is now pictured.

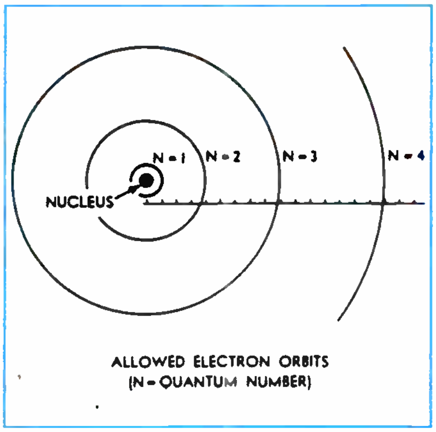

Fig.1.1: The electrons of an individual atom can only occupy orbits with certain 'allowed' radii, corresponding to fixed energy levels.

Unfortunately, perhaps, a full understanding of modern atomic theory and the physics of electrical conduction requires a thorough grasp of the abstract and highly mathematical science of Quantum Mechanics, and this is beyond many professional engineers.

However a full understanding is really only necessary for the scientist, research student and device development engineer. A somewhat more limited understanding at a basically 'qualitative' level is usually found both adequate and satisfying for most other purposes, including that of preparation for further detailed study. It is at this level that the following treatment is pitched.

Perhaps the first thing to be noted about the modern view of the atom is that it is somewhat more 'fuzzy' than before, and in consequence, it tends to be less satisfying.

Although disconcerting, this must unfortunately be accepted as a fact of life. The reality is that the apparent clarity of the simple 'solar system' picture was an illusion, with no real justification on the basis of our actual knowledge.

We are unlikely to know for some considerable time, if indeed we will ever know, the 'real' nature of electrons and other sub-atomic 'particles', or of such fundamental things as mass, energy, time, electric and magnetic fields, and electrical charge.

The modern picture of the atom and its behaviour tries to take this lack of knowledge into account. In producing a theory which 'works', in the sense that it can satisfactorily explain most of the little we do actually know, it aims at the same time, at preventing us from kidding ourselves that we know more than this!

At this stage you may well be wondering if the modern picture of the atom bears any resemblance at all to the simpler one. The truth is that there is a resemblance, although only a general one.

In broad terms, the atom may still be pictured as consisting of a central posi-

BASIC CONCEPTS: ATOMS AND ENERGY

tively charged nucleus, surrounded by a number of negatively charged electrons. As the nucleus plays no more than a nominal part in electrical behaviour, we need not concern ourselves here with its structure. And in fact, it's just as well that this is the case, because the closer physicists examine the nucleus, the more complex it seems to become!

The electrons are still held to be the components of the atom which are mainly responsible for its electrical and chemical behaviour.

Elusive electron

However, they can no longer be regarded simply as tiny physical particles orbiting around the nucleus, nor can the part which they play in electrical conduction be pictured as a straightforward one whereby an electric field 'loosens' those in the outermost orbits and whisks them along to form a current flow. As with the nucleus, the closer the electron and its behaviour are examined the more complex — and in this case, the more elusive — it becomes.

It has been found that, in some circumstances, the behaviour of electrons can indeed only be explained by visualising them as small particles. Yet, equally, there are other situations in which their behaviour can only be explained as consistent with that of small bursts of oscillations or 'waves' — of a type similar to, but different from, those responsible for sound, heat and light.

In other words, an electron must now be regarded as a somewhat vague thing which sometimes behaves as a physical particle, and at other times, alternatively behaves as a 'packet' of some sort of waves.

As it happens, it is the wave aspect of their 'personality' which seems to play the major part in determining the behaviour of electrons as they surround the nucleus of an atom. So that in place of the simple picture of a number of electron 'planets' orbiting around the nucleus, we must now try to visualise a system of spherical and elliptical 'surfaces' at various distances from the nucleus, and each somewhat fuzzy and indistinct because of wavelike variations over the perimeter.

Whereas it would appear that at the more familiar macroscopic level, planets may orbit around a sun at virtually any radius providing they have the appropriate orbital velocity, this does not occur in the microscopic level of the atom.

Electrons are only able to 'orbit' (the term is still used for convenience) around the nucleus at **certain definite radii.** In terms of the wavelike aspect of the electron these radii can be interpreted broadly as those whose perimeter corresponds to an integral (or whole-number) multiple of a compatible electron 'wavelength'.

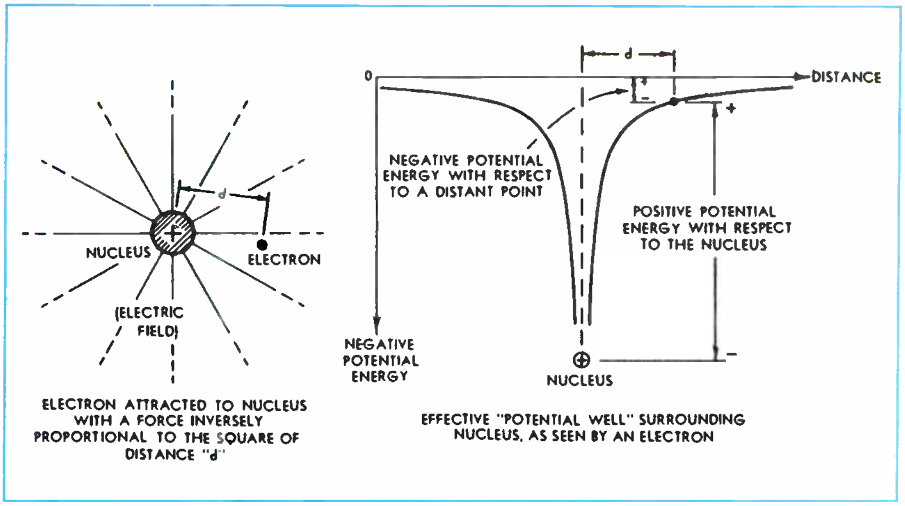

Fig.1.2: Each atomic nucleus is effectively located at the bottom of a negative 'potential well', and the orbit of each electron corresponds to a balance between that orbit's potential energy and the electron's kinetic energy.

Although this concept may seem strange and rather hard to accept, the full reasoning behind it is quite abstract and involves mathematical 'gymnastics' which we cannot deal with here. However, for the present it may help to compare the situation with the more familiar one involving the production of standing waves in a stretched string: waves can only occur at frequencies at which the string length corresponds to a single wavelength, two wavelengths, three wavelengths, and so on.

Allowed orbits

The electrons of an individual atom, then, can only occupy orbits corresponding to certain 'allowed' effective radii. This is illustrated by the diagram of Fig.1.1. As may be seen, the various possible orbits are each assigned a so-called **quantum number,** commencing at '1' for the innermost. The effective radius of the orbits increases with the square of the quantum number, i.e., one unit, four units, nine units, and so on.

Some idea of the size of the orbits may be gained from the fact that the innermost or N = 1 orbit corresponds to an effective radius of approximately 5×10^{-11} metre, or about 50 picometres (million-millionths of a metre).

Associated with each possible orbit is a corresponding **energy level;** i.e., an electron occupying a particular obit will have a particular amount of energy. This will consist of both the *kinetic* or 'motional' energy associated with its orbiting momentum, together with the *potential* or 'latent' energy which it possesses by virtue of its position in the electric field surrounding the nucleus.

Because of the opposite charges of electrons and nuclei, an electron is attracted to the nucleus with a force which varies inversely with the square of its distance from the nucleus centre. In view of this, an electron at a particular point in the electric field surrounding the nucleus has a *positive* potential energy with respect to that nucleus, and at the same time a *negative* potential energy with respect to any point more distant from the latter.

If these polarities seem wrong, remember that positive potential energy corresponds to the ability to perform work or release 'internal' energy, while negative potential energy implies a need for energy to be externally supplied.

From the point of view of the electron, therefore, the vicinity of the nucleus represents an area of lower or 'more negative' potential energy than elsewhere. In fact the field around the nucleus forms what may be visualised as a potential energy 'pocket' or *well*, with the nucleus at its centre and the 'sides' sloping exponentially. Viewed in this light, a free electron wandering near the nucleus and attracted to it effectively 'falls into the well'. These ideas are illustrated in the diagrams of Fig.1.2.

According to this view, an electron which is orbiting around the nucleus does so (rather than 'fall') by virtue of its orbital momentum — in effect, it 'rolls around' the walls of the potential energy well, at a sufficient speed to prevent itself from falling. An orbiting electron thus possesses a positive kinetic

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Atoms and Energy

energy, and because the required orbital momentum increases with decreasing effective orbit radius, the kinetic energy similarly increases.

In fact, it turns out that the positive kinetic energy follows the same exponential curve as that of the negative potential energy, but with opposite sign and with an amplitude half as great — if spherical orbits are considered.

As the total energy of an orbiting electron consists of the algebraic sum of its potential energy (negative) and its kinetic energy (positive), and both these follow exponential laws with the former larger than the latter, the total energy will thus be negative and will also follow an exponential. In short, the vicinity of the nucleus represents for orbiting electrons a **total energy well,** similar to that for potential energy but 'less deep'. A two dimensional representation of this well is shown by the dashed curved lines in Fig.1.3.

An example may help in clearing up any possible confusion at this point. An electron in an orbit of effective radius 'r' is seen to occupy an energy level represented in Fig.1.3 by the line C-C', with a total negative energy of Wb. From the shape of the dashed outline of the energy well, it may be seen that the smaller the effective orbital radius, the greater the negative energy possessed by an electron in that orbit.

Binding energy

It should be fairly evident at this stage that removal of a particular orbiting electron from the influence of the nucleus (i.e., taking it to an effectively distant place) will involve doing *positive work,* to a degree which corresponds exactly to the negative energy level of the orbit concerned.

Hence an electron occupying the energy level C-C' in Fig.1.3, in order to be 'freed' from the nucleus altogether, must acquire a positive energy equal and opposite in sign to Wb. In short, the negative energy level of an orbit simply corresponds to the degree to which an electron in that orbit is 'bound' to the nucleus — the orbital **binding energy.**

As we saw earlier, in an individual atom electrons can only occupy orbits having certain allowed effective radii. Hence, in terms of the energy level diagram of Fig.1.3, an orbiting electron must occupy one of the discrete energy levels represented by such lines as A-A', B-B', C-C', and so on. Level A-A' might correspond to the N = 1 orbit of Fig.1.1, for example, and level B-B' to the N = 2 orbit.

Although only three of the permitted energy levels are shown in Fig.1.3, there is in fact a very large number, corresponding to allowed orbits with effective radii increasing rapidly with the squares of successive quantum numbers.

Because of the exponential shape of the energy well around the nucleus, the energy differences between successive orbits actually *decreases* however, so that if further levels were shown in Fig.1.3, they would be seen to form a series of horizontal lines with decreasing vertical spacing, above level C-C' and approaching the zero energy level represented by O-X.

You might perhaps imagine, from the foregoing, that in an individual atom of an element all of the electrons surrounding the nucleus would be found occupying the lowest (most negative) energy level, at least when the atom is in the **ground state,** with no additional energy or 'excitation' received from external sources. But this isn't so...

In fact it is found that, in effect, each energy level has a definite electron 'capacity'; only two electrons can occupy the N = 1 level, only eight can occupy the N = 2 level and so on. The maximum number of electrons which may occupy the first five allowed energy levels are 2, 8, 18, 32 and 50 respectively.

TABLE 1.1

Element	Number of Electrons (Atomic Number)	Occupation of Orbits/Energy Levels					
		N=1	N=2	N=3	N=4	N=5	N=6
Hydrogen	1	1					
Helium	2	2					
Lithium	3	2	1				
Beryllium	4	2	2				
Boron	5	2	3				
Carbon	6	2	4				
Nitrogen	7	2	5				
Oxygen	8	2	6				
Fluorine	9	2	7				
Neon	10	2	8				
Sodium	11	2	8	1			
Magnesium	12	2	8	2			
Aluminium	13	2	8	3			
Silicon	14	2	8	4			
Phosphorus	15	2	8	5			
Sulphur	16	2	8	6			
Chlorine	17	2	8	7			
Argon	18	2	8	8			
Potassium	19	2	8	8	1		
Calcium	20	2	8	8	2		

Although quantum mechanical theory provides an adequate explanation of the electron capacities of the various energy levels, the detailed arguments involved are beyond the scope of our present discussion. For the present it should be sufficient to note that in addition to their energy level, electrons in orbit have other important characteristics such as degree of orbit ellipticity, magnetic moment, and spin polarity.

It is believed that only certain combinations of these characteristics are permitted at each energy level, and further that no two electrons at the same energy level can have the same combination.

The latter 'law' is held to apply to any

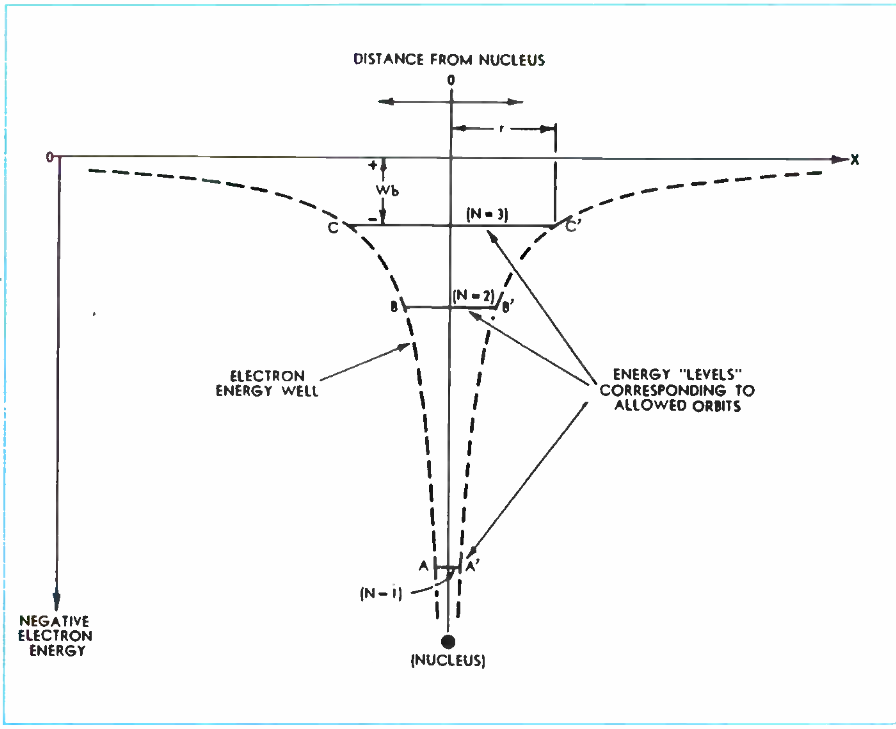

Fig.1.3: Each allowed orbit in the atom has a corresponding energy level, which gives the energy binding the electrons in that orbit to the nucleus. Electrons at the 'lower' orbital levels are therefore much harder to remove from the atom.

unified system involving electrons, and is known as *Pauli's exclusion principle.*

In an individual atom in the ground state, then, the electrons occupy the lowest permitted energy levels to a degree determined by the various energy level capacities. For example in a boron atom, with five electrons, two occupy the N = 1 level, which is thus 'filled', while the remaining three occupy but only partly fill the N = 2 level; the remaining levels are empty.

Similarly the 14 electrons of the silicon atom are disposed with two filling the N = 1 level, eight filling the N = 2 level, and the remaining four partly filling the N = 3 level. Table 1.1 gives the electron dispositions of the first 20 elements of the 'periodic table', illustrating the way in which the various energy levels are progressively 'filled'.

Outer electrons important

It is those electrons in the outermost of the occupied energy levels of an atom which almost completely determine its external behaviour, both chemical and electrical. The electrons which may be present in any filled lower energy levels generally play little part in external behaviour, because they are relatively strongly bound to the nucleus.

Accordingly the latter are usually called the 'core' electrons and can often be considered as 'lumped together' with the nucleus, whereas the former are called the valence electrons (from the Latin 'valere', meaning strength — an allusion to the part played in chemical bonding) and are almost always considered separately and in detail.

The energy level occupied by the valence electrons of an atom of a particular element is consequently known as the valence level for that element. Each of the allowed energy levels is the valence level for atoms of certain elements; for example the N = 2 level is the valence level for atoms of elements such as boron, while the N = 3 level is the valence level for elements such as silicon.

In the foregoing description of the structure of an atom as it is currently pictured, we have considered the atom in the so-called ground state. Actually, this state is a purely hypothetical one; it would only occur if an atom could be placed in a light-tight and radiation proof container, and kept at a temperature of absolute zero (-273°C). Let us therefore look briefly at the more usual situation, where an atom is at a somewhat more comfortable temperature and is accessible to light and possibly other forms of radiation.

Most readers will probably be aware that light, heat and other forms of radiation such as X-rays are essentially energy, in the form of electromagnetic waves. As such, they are related to the

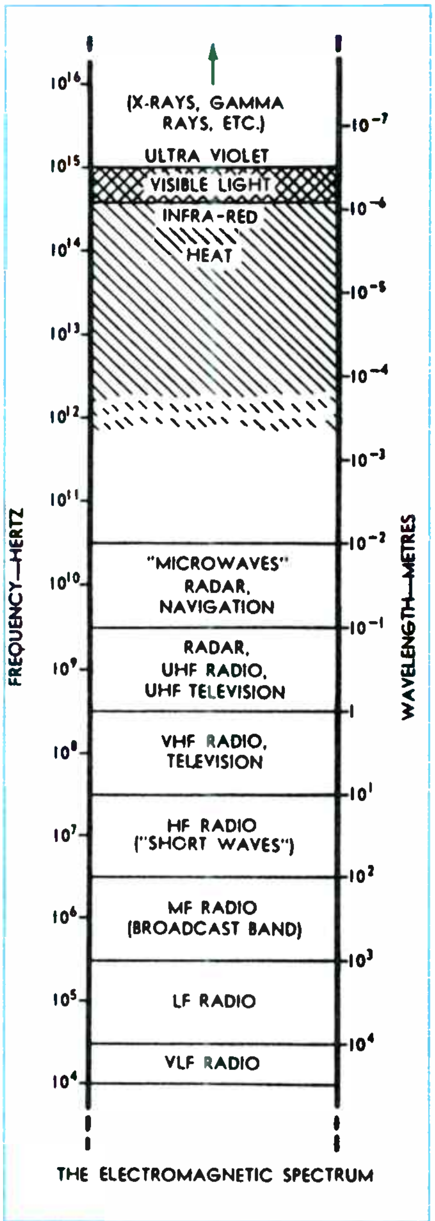

Fig.1.4: A representation of the electromagnetic spectrum, which extends all the way from DC and VLF radio up to light and gamma rays.

familiar waves used for communication and for sound and television broadcasting. They differ from the latter almost solely in terms of frequency, or wavelength; in fact heat radiation corresponds virtually to 'super-super-high frequency' radiation, or 'ultra-ultra-short waves', while light and X-rays correspond to even higher frequencies and shorter waves again.

These relationships are illustrated in Fig.1.4, which shows the relevant portion of the electromagnetic spectrum.

In view of this, it should not be hard to understand that an atom which is in any practical situation involving light, heat and the other forms of radiation is virtually subjected to a constant bombardment of energy. And it should be no surprise that in such a situation the atom will tend to be found not in its ground state, but in one of many possible 'excited' states, which correspond to its having absorbed — at least temporarily — additional energy.

As you might perhaps guess, the mechanism by which an atom 'absorbs' energy to become excited is a rather complex and obscure one; so too is the converse mechanism whereby the atom 'ejects' energy to return to either the ground state or a less excited state.

For a full explanation, as before, one must delve quite deeply into quantum mechanics. However, there is a basic and important principle involved, and one which we can consider here briefly.

Excitation quanta

Stated simply, the principle is as follows: the absorption of energy by an atom corresponds to the transfer of electrons to higher energy levels. Because there are only certain allowed energy levels in an atom, as we have seen, this means that energy can only be absorbed by the atom in 'lumps' or quanta of definite sizes. The sizes of the quanta correspond to the energy differences between the various allowed levels.

Hence an atom can absorb an amount of energy corresponding to the transfer of an electron from the N = 1 level to the N = 3 level, for example, or to the transfer of perhaps three electrons at the N = 2 level to the N = 4 level. But, whatever the quantum of energy absorbed, it must correspond to the transfer of a whole number of electrons from one of the allowed energy levels to other higher levels.

And the same principle holds for emission of energy, which as one would expect involves transfer of electrons from higher down to lower allowed energy levels. An atom can again only emit energy in quanta of fixed sizes, corresponding to the transfer of whole numbers of electrons from higher to lower allowed energy levels.

At this point, you may well be asking how it is possible for atoms to be able to absorb and emit energy in discrete quanta, when the energy absorbed and emitted is in the form of supposedly continuous radiation such

Atoms and Energy

as light or heat. The answer to this is that in fact electromagnetic energy, like the electron, behaves in many ways as if it too has a 'split personality'. In contrast with its continuous wavelike nature, it can equally readily behave as if it consists of small particles or quanta of energy. These particles have been named **photons.**

It happens that the amount of energy represented by a photon is independent of the intensity or 'strength' of the radiation concerned; this only determines the *number* of photons present.

Rather, the energy of a photon is directly proportional to its frequency.

This is a very important relationship, which was discovered by the physicist Max Planck in 1900 and developed by Albert Einstein 1905.

According to this relationship, photons of 'blue' visible light represent larger energy quanta than photons of lower frequency such as 'red' light, and the latter in turn, represent larger quanta than photons of heat radiation.

Also, and very importantly for our present purposes, heat photons corresponding to higher temperatures represent larger energy quanta than those corresponding to lower temperatures. This arises because temperature is a direct function of frequency.

From the foregoing it may be seen that, because it is only capable of absorbing energy quanta of certain fixed sizes, corresponding to electron transfers between allowed energy levels, an atom can effectively only be excited by radiation of particular frequencies (wavelengths).

Each frequency will correspond to an electron transfer between a particular combination of levels; hence a transfer from the N = 1 level to the N = 3 level might result from absorption of a photon of frequency f1, while a photon of another frequency f2 might produce a transfer of an electron from the N = 3 to the N = 4 level.

Similarly the ejection of energy, by an atom dropping to the ground state or to a lower excitation state, results in the emission of radiation only at particular frequencies. An electron transfer from the N = 2 level to the N = 1 level might result in the emission of a photon of frequency f3, for example, while a transfer from the N = 5 to the N = 3 level would result in the emission of a photon at the different frequency.

These concepts are illustrated in the diagrams of Fig.1.5.

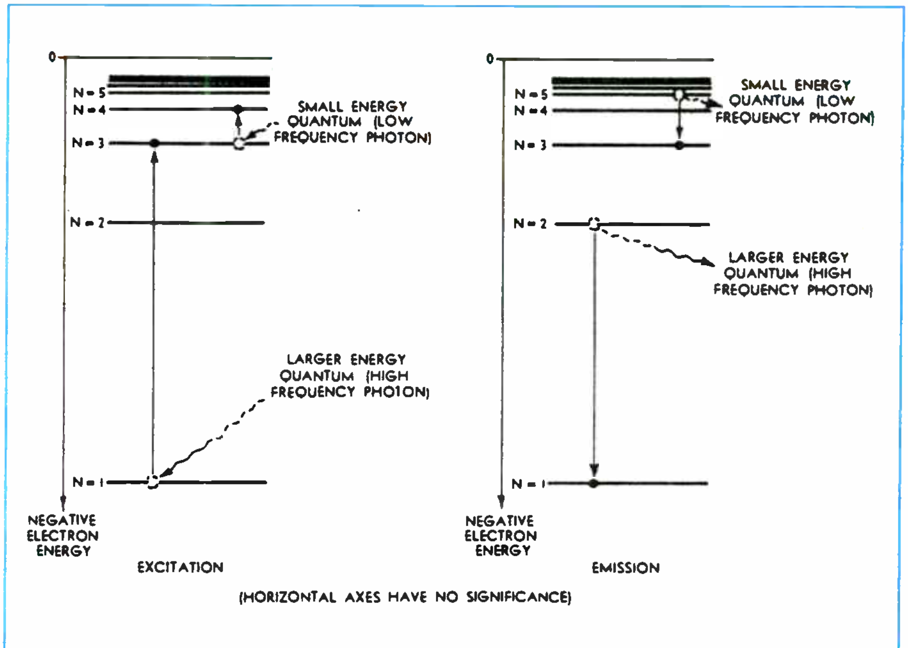

Fig.1.5: Because of the fixed orbital energy levels, and the fact that an atom's absorption or emission of energy corresponds to movement of electrons between levels, energy can only be absorbed or emitted in fixed amounts or 'quanta'. And each energy quantum corresponds to an electromagnetic photon of a particular frequency, giving rise to an atom's characteristic spectrum lines.

Explains line spectra

In practical situations, atoms can thus be found tending to continuously absorb and emit radition at a number of specific frequencies, each of which corresponds to one of the possible energy level transitions.

It is this behaviour which accounts for the so-called 'line spectra' obtained by analysis of the wavelengths by light and heat absorbed and emitted by atoms of the various elements under suitable conditions.

As one might expect, the number of specific photon frequencies involved in atom energy absorption and emission tends to be quite large, as there are many possible energy level transitions.

This is particularly so with elements having many electrons surrounding the nucleus. However, due to differences between levels concerning the allowed 'secondary' electron characteristics of orbit ellipticity, magnetic moment and spin, some level transitions tend to be more prevalent than others, in a fashion which varies from element to element. As a result, each element tends to have a characteristic pattern of 'dominant' absorption and emission frequencies.

An atom in the excited state contains, as we have seen, electrons which are occupying higher energy levels than they would occupy in the ground state. It is interesting to consider whether we can make any inferences regarding which of the electrons will be more likely to be found at such higher levels.

As it happens, we can. Earlier, we saw that the energy differences between the allowed energy levels *decrease* with increasing orbit radius and quantum number. Hence, somewhat greater energy would be required to transfer an electron from the innermost N = 1 level to the next or N = 2 level for example, than to transfer an electron from the N = 3 level to the adjacent N = 4 level. Thus even for transfer between adjacent levels, the electrons at the lower levels require larger energy quanta.

There is also the electron capacity of the various levels to be considered — i.e., Pauli's exclusion principle. As the capacity of the various levels does not alter with excitation, this means that a transfer of an electron to a particular energy level can only take place if there is a 'vacancy' at that level.

From this it can be seen that transfer of electrons from the *higher* levels is more likely to occur than from the lower levels, both because the lower levels are more likely to be 'full' and also because the capacity of the levels increases with increasing energy.

We can say then, that for a given degree of excitation, the 'excited level' electrons will tend to be those from the higher levels. In particular, there will tend to be a high proportion of the electrons from the valence level of the atom concerned. ❖

[illegible]

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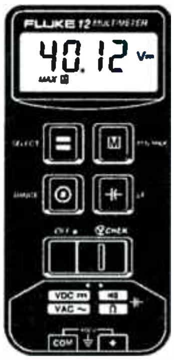

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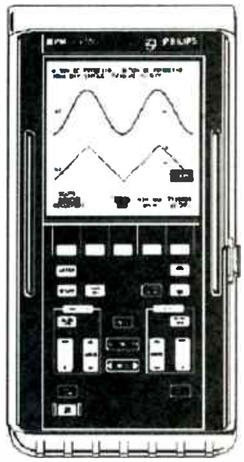

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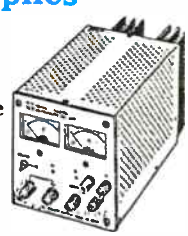

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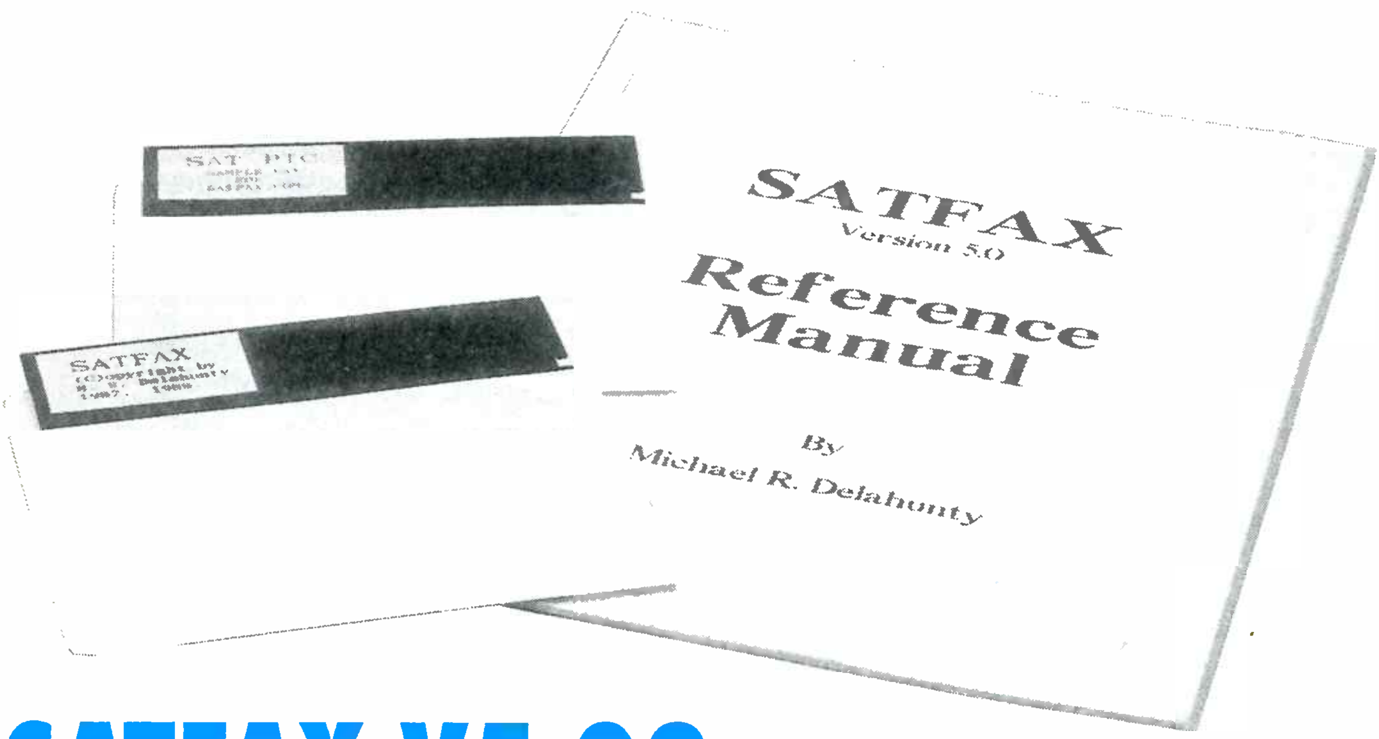
Review: PC Software for WESAT reception



SATFAX V5.02

In recent months there's been a renewed interest in using PC's for low-cost reception and display of weather fax images transmitted by satellites. Here's a review of the latest version of an Australian software package for serious WESAT decoding and display, which has been popular for some time: Michael Delahunty's SATFAX.

by JIM ROWE

For many years now, the world's weather bureaux have been relying on orbiting satellites to gather information about our planet's constantly changing weather patterns. The satellites are equipped with optical and infra-red sensors, which scan the surface of the earth; this information is then beamed down wards via radio.

In the early days, the equipment needed to receive and display these 'weather satellite fax' or 'WESAT' images was far too complex and expensive to be within the grasp of private individuals and enthusiasts.

But thanks to the ongoing revolution in solid state devices and computer technology, in the last few years this has become more and more feasible.

Nowadays it's possible to achieve quite satisfying results with a low-cost VHF receiver, a suitable antenna and a PC fitted with a low-cost adaptor and running appropriate software. This was demonstrated by Tom Moffat, in his recent series of articles (*EA*, June-August 1992). Mind you, by going a little further, in terms of both hardware and software elaboration, it's possible to get results which come even closer to those achieved by the professionals — for whom the satellite signals are intended, of course.

The more 'serious' enthusiasts have equipped themselves to receive high quality WESAT images from not just the orbiting VHF satellites operating at around 137MHz, but also from the 'geostationary' satellites which down- link in the UHF 'S band', at around 1690MHz.

In Australia, many of these enthusiasts have been using a low cost software package developed and marketed by Michael Delahunty, of New Farm in Queensland. Mr Delahunty's *SATFAX* package has been refined and enhanced quite a bit since he first developed it, and now offers many features in terms of both performance and flexibility.

Hardware requirements

Satfax is designed to allow reception of WESAT fax images from the orbiting NOAA (USA), Meteor (Russia) and Fengyun (China) satellites, and also from the geostationary GEOS (USA) and GMS (Japan) satellites, using an IBM-compatible XT, AT or 386-based PC. It is designed to work with a hardware decoder/converter, which takes the amplitude-modulated 2400Hz audio subcarrier from a suitable VHF or S-band FM receiver, and performs A-to-D conversion to allow digital image processing in the PC.

In his SATFAX literature, Mr Delahunty recommends a low cost decoder/converter produced by fellow Queenslander David Hopkins, of Capalaba; this takes the form of a 'short' card which fits inside the PC itself, and simply accepts the incoming audio via an RCA socket.

Quite a few existing VHF receivers can

apparently be used for satisfactory reception of the 137MHz orbiting satellite signals. The main requirement is that they must have a 'Wide FM' receiving mode, as the VHF WESAT signals use a deviation of around 30kHz. The other requirement is a suitable omnidirectional antenna, such as a 'turnstile with reflector', a Lindenblad or in favourable areas a 5/8-wave ground plane. A masthead preamp and a bandpass filter may also be necessary, as the WESAT signals can be quite weak and vulnerable to interference.

Reception of S-band WESAT signals from the geostationary satellites is rather more tricky, not only because these are up at 1691MHz, but because they use much wider deviation: around 260kHz. This means that many of the standard VHF-UHF receivers which will tune directly to the frequency (like the Icom and AOR scanners) are not really suitable. Nor are they suitable as a tuneable IF for a downconverter, for the same reason.

Here Michael Delahunty recommends a specially-designed receiver available from yet another Queensland firm, PH Communications of Albany Creek. PH can supply a 137MHz (+/-2MHz) receiver with a typical bandwidth of 280kHz and a sensitivity of 0.5uV for 12dB SINAD, which can be used for both direct reception of the VHF WESAT signals, and as a tuneable IF for a 1691MHz downconverter to receive the S-band signals.

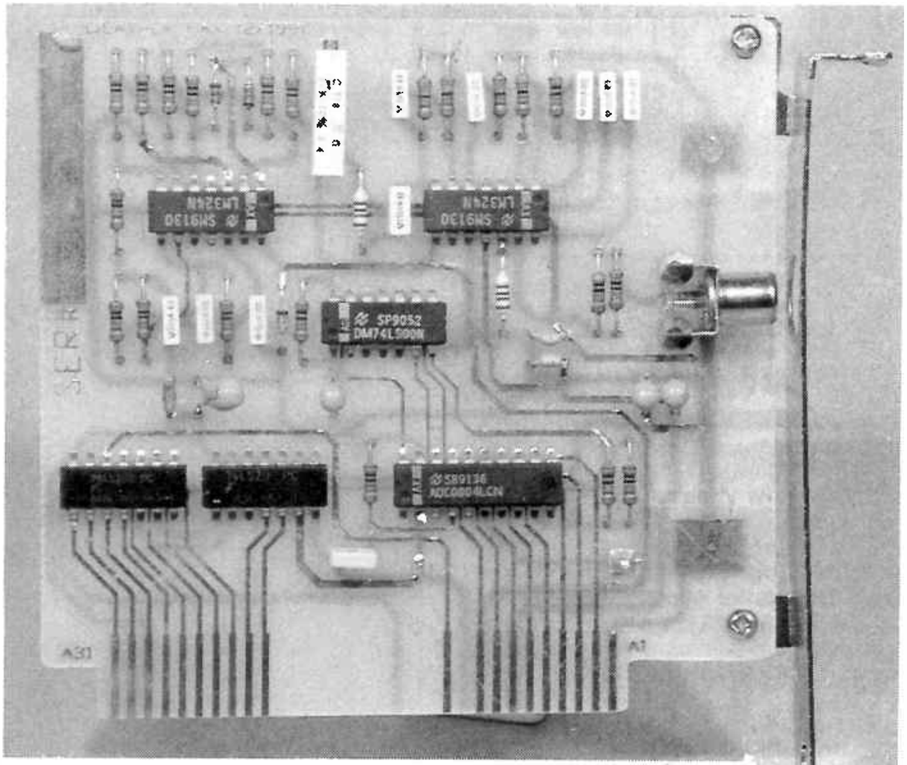
The same firm can also supply a matching 1691MHz low-noise (around 1dB) preamp (LNA), a crystal locked downconverter and a dipole feed for a 1.5m dish reflector with an F/D ratio of 0.4. As you can see, reception of the S-band WESAT signals calls for somewhat greater commitment than for the VHF signals.

By the way, full address information for all of the above firms will be given at the end of this article.

Software features

In its latest implementation (Version 5.02), the SATFAX package offers a wide variety of functions and features. For a start, it will operate with a wide range of video adaptor cards — EGA, VGA and S-VGA — and can provide a matching range of display resolutions. These vary from a basic 640 x 200 resolution in 16 colours, up to 640 x 480 resolution in 64 colours.

(If you're wondering about those colours, it's true that the WESAT images themselves are all essentially monochrome 'shades of grey' in their native form. However SATFAX and decoders like the Hopkins card effectively convert the signals into 6-bit digital samples, which can therefore represent 64 discrete signal levels. The SATFAX software has the ability to let you convert these levels into different 'pseudo colours', making the images not only much more interesting, but also easier to interpret.)



The SATFAX software package is intended to go with David Hopkins' Weather Sat decoder card, shown here. It slots directly into a standard PC.

SATFAX can decode WESAT signals of virtually any transmission speed. It has a total of nine speed options, seven of which are preset at the speeds most commonly used: 20, 60, 90, 120, 180, 240 and 360 lines per minute. The last two options are 'user definable' — i.e., you can set them up for virtually any speed you wish.

The decoding speeds are normally derived using timing loops accessing the PC's 8253/4 timer chip, but for machines where this 'hardware timing' causes lock-up due to BIOS incompatibility, SATFAX also provides an alternative 'software timing' option.

There's also an 'external timing' option, for use when decoding WESAT signals that have been saved using a stereo tape recorder. For both 'hardware' and 'software' timing, the program has provision for both coarse and fine adjustment of each of the nine speed options, by the user.

Other parameters that can be set are video display mode; the computer's I/O port to be used for signal input (either the decoder card address, or an alternative port for external decoders); and the number of picture lines that are to be stored in RAM and saved to disk (SATFAX automatically checks your RAM, and indicates the largest file size possible).

Depending upon the video adaptor and video display mode you're using, you can also set up various colour 'palettes', for the program's conversion of the WESAT grey-scale images into pseudo colours. Generally with EGA you have a fixed palette of 16 colours, while with standard VGA you have a choice of 16 colours out of 262,144, and with S-VGA you have a choice of 64 colours chosen from the same wide range.

To make things easier when receiving and decoding signals from each main kind of satellite, SATFAX also provides a choice of 10 programmable 'acquisition modes'. These are virtually complete 'recipes' for the program's various configuration settings, allowing you to instantly reconfigure it at the touch of a key. A very nice feature...

To assist you in setting up your system for optimum image decoding, SATFAX also has another very nice feature. This is a 'Test' screen, with bar-graph indication of either your decoder's output level range (to allow correct gain adjustment), or the input frequency of an external timing clock (allowing a PLL to be set up for decoding from a tape).

Once you've used this facility to set things up, and want to start decoding a suitable signal, the program provides a number of options. Initially you can

Satfax V5.02

choose either 'Acquire', which chooses one of the 10 programmable configuration modes; or 'Begin', which uses the default configuration. Then you are moved to the 'receive' screen, and here you can select from either 'A: automatic starting on the next sync pulse' or 'B: immediate starting, ignoring any sync pulses'. Once the picture has started to appear, you can also clear the screen at any time and 'start again' at the top of the screen, by pressing the 'C' key.

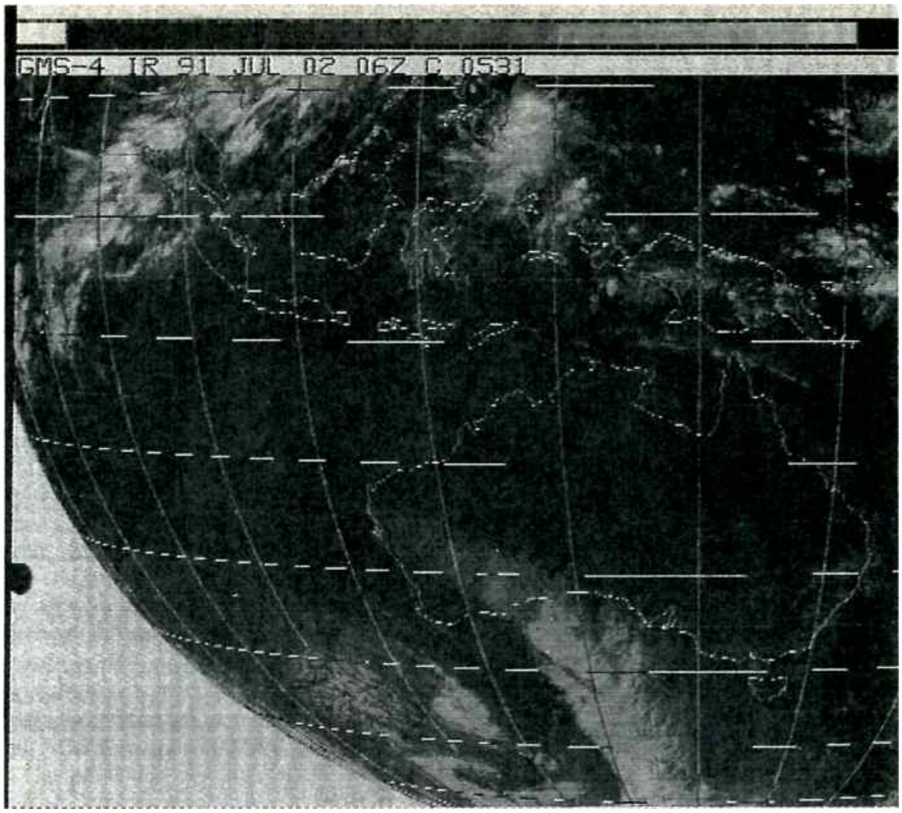
(For images decoded and stored using options which ignore sync pulses, the stored image can be manipulated later using SATFAX's 'Re-align' facility — another handy facility.)

Once you have received and decoded an interesting image, you can of course save it on disk as a file. Here SATFAX provides the usual range of file management facilities, accessed from the main menu screen via a 'Files' screen. As you'd expect you can save a file, load one into memory from disk, get a listing of the files on disk, nominate a new subdirectory and so on.

There are also various further options when it comes to examining an image you've either just received, or re-loaded from disk. You can simply 'View' it in its entirety, by pressing the 'v' key; or in 'Magnified' form, by pressing the 'm' key; or finally in even *more* magnified form, by pressing the 'z' key (for 'Zoom' mode). Each of these three viewing options also has a choice of either standard aspect ratio or 'doubled-height form', and in each case the latter is achieved by either holding down the shift key or having the keyboard in caps-lock mode. That is, 'v'-'m'-'z' give the three standard aspect ratio views, and 'V'-'M'-'Z' the three vertically stretched views.

For any particular image in memory, you can jump between these views simply by pressing the appropriate keys. Similarly with the magnified views you can pan and scroll around the image using the cursor arrow keys. You can also invert the picture using the 'U' key, flip it horizontally using the 'S' key, reverse its data weighting (i.e., light becomes dark, etc) using the 'I' key, or average the two side-by-side images for a NOAA picture, using the 'A' key.

As if these options aren't enough, you can also enhance the image's contrast range, by pressing the '*' key, and/or lighten it digitally by pressing the '+' key. And finally you can accentuate the image area transitions, for a kind of '3D' effect, by pressing the '3' key. This last feature can improve the apparent detail, particularly with IR images.



A sample printout from SATFAX, using an HP compatible laser printer. The image shown is from the GMS-4 geostationary S-band satellite.

Needless to say, you can also send images to a printer, to get them in hard copy form. Printing is only in monochrome, but here SATFAX again gives you a wide range of options.

First, there's a choice of printers. The program will work with Epson/IBM compatible 9-pin dot matrix or 24-pin types, H-P Laserjet II (PCL speaking) compatible lasers, or Canon BJ130 and compatible bubble-jet models. Then with three out of the four printer types you have a choice of various printing modes, offering different compromises between print density, resolution and grey-scale approximation. You have a choice of 'double' or 'quad' density with a 9-pin printer, 'triple' or 'hex' density with a 24-pin, 150 or 300dpi with a PCL laser. The Canon bubble-jet option is fixed at 360dpi.

Other options available when you move to the 'Print' screen are a choice of printing aspect ratios, and the ability to print out either the complete image or an enlarged version of one side (i.e., 'large left side' or 'large right side'). The latter options are designed to allow separate printout of the two images sent side by side from NOAA satellites.

Note that with the dot-matrix and bubble-jet printers you have a choice of three aspect ratios: 1:1, 1:1.5 or 1:2 (H:V), while with PCL printers you only get the first and last — the 1:1.5 ratio is not available.

Getting back to SATFAX's on-screen display facilities, there is one of these that's especially impressive. This is an 'animation' option — which lets you save a series of received WESAT images in carefully aligned form, and then 'play them back' in sequence as a kind of 'slide show'. Sequences of up to 99 images can be handled in this way, giving SATFAX the ability to give very graphic presentations of the progress of tropical cyclones, and other dynamic weather events...

The rate at which the images can be displayed can be varied, with a range of 10 options available. Options 1-9 correspond to nine automatic rates, with '1' the fastest and '9' the slowest, while selecting '0' allows manual timing using the keyboard's space bar.

The exact rates for the automatic options will vary with your computer's processor, video card and disk drive accessing speed, but with a typical 20MHz '386SX machine and all of the images on a 20ms hard disk, the highest '1' rate gives about three images per second — quite impressive!

Trying it out

To allow us to try out SATFAX, Michael Delahunty very kindly sent down a copy of the package and manual — together with a number of floppy disks containing interesting and notable

WESAT images received by both his customers and himself, using it. He was also good enough to obtain a sample of David Hopkins' Weather Fax decoder card, which was enclosed to make it easier for us to get things going.

We don't have the necessary facilities to try out such a system in the *EA* lab, so I decided to check it out at home using my 'test bed' computer (an Epson AX2) and Icom IC-R100 VHF receiver — which is normally hooked up to either a 1/4-wave ground plane for two metres, or a wideband discone for general listening.

It didn't take long to fit the decoder card to the computer, and I tried to see if I could receive any WESAT signals using either of the existing antennas. But after a number of sessions, I had to conclude that this was hopeless; if the signals were there, they were buried in interference. There were mobile radio signals, FM broadcasting stations, aircraft, pagers, and all kinds of other 'crud' — with negligible gaps in between.

It was then that I decided it would be necessary to build up one of Tom Moffat's Lindenblad antennas, cut especially for 137MHz, and probably also one of the VK2 preamps to provide additional low-noise gain and preselection. So there was an inevitable delay, while the necessary items were procured and then assembled and tested.

To cut the story short, I eventually had both the Lindenblad and the preamp fully operational and could resume the tests. The results were certainly much better, with far less interference from FM stations and mobiles. But there was still a surprising amount of breakthrough from pagers, passing mobile radio amateurs on 2m, and — worst of all — aircraft communications (I live not far from Mascot airport, unfortunately).

In fact, after a number of further sessions, it's so far been impossible to capture anything like a complete WESAT image. Every time a satellite has passed over, Murphy's Law has triggered off even more frequent bursts of activity from the pager and/or aircraft brigade. Very frustrating, to say the least!

Some time soon, I'll have to try fitting a fairly selective bandpass filter up at the antenna, before the preamp. Hopefully this will help to reduce the interference. But if *that* doesn't do the job, I guess I'll be forced to try capturing WESAT signals only during the aircraft 'curfew' period in the wee small hours, and perhaps on public holidays when there are 'lull' periods...

So at this stage, it hasn't really been possible to give the image receiving part of SATFAX a proper workout — nor the Weather Sat decoder card, for that matter (sorry, folks). But I *have* been able to try out all of the other features of SATFAX, using the many sample image files which Michael Delahunty provided.

And basically, I've found these very impressive. In operation, SATFAX offers a very high degree of flexibility, coupled with high performance. The ability to magnify, 'zoom in' and manipulate captured images (both in terms of alignment and adjustments to contrast/brightness) is great, as is the ability to choose your own pseudo-colour palettes, and save complete configuration mode options.

I was particularly impressed by the 'animation' facility, too. Mr Delahunty sent down a set of 30 images captured during the life of Cyclone Betsy, and these provided a most dramatic demonstration of SATFAX's animation potential.

Another thing I really liked was the program's ability to let you 'interrogate' an image in detail, using a 'cross hairs' cursor controlled by the mouse. You can manipulate the cursor to any point on the image, and SATFAX gives you a readout of that point's value on the 64-level greyscale. I imagine this would be great for interpreting temperature contours and so on — assuming you have set up your system so that it's reproducing the satellite sensor's calibration in a linear manner.

In terms of functions and features, then, SATFAX seems excellent. I guess the one area where I feel it could still stand a little improvement is its ease of use. This isn't bad, being based in the main on reasonably intuitive menu screens, but there are certainly a few places where it could be made more 'friendly'.

For example it currently isn't possible to call up a reminder of the various options available to you in image viewing/manipulation mode, and the keys which call them up. These are displayed on the main menu screen, before you move to the image screen; once you get there, you simply have to either remember them, or else 'bail out' and return to the main menu to remind yourself.

I also found the program a bit confusing in terms of the various places where you either can, or need to, save any changes you've made to the program's configuration settings.

A couple of times I spent quite a lot of time setting up a new psuedo-colour palette, and went through the motions of saving the new palette so that it would come up next time as the default. Or at least I thought I had saved it — but next time I fired it up, SATFAX didn't seem to be able to find it.

I also discovered that although SATFAX will let you save its image files on a subdirectory below the one that it resides on itself, it doesn't seem to save the full path information in its own settings file. Next time you fire it up, you seem to have to tell it where the image files are all over again, or it can't find them.

I have to say that the operating manual is a little rough in places, too. Some of the program's functions and facilities are not explained all that well, and in some cases you really have to fire it up and try them for yourself to get a clear idea of what it does.

On the whole, though, SATFAX is undoubtedly an excellent program for serious reception and manipulation of WESAT images — especially when you consider its very modest price. If Michael Delahunty can make it just a little more friendly, it will be really outstanding.

Version 5.02 of SATFAX costs only $45, on either 5.25" or 3.5" floppy disk, with manual. It is only available direct from Michael Delahunty, of 42 Villiers Street, New Farm 4005; phone (07) 358 2785.

Packing and postage anywhere in Australia costs an additional $3.00, while postage to New Zealand costs $5.00. Airmail to Asia and the Pacific costs $8.00, which increases to $12.00 for the rest of the world.

Finally, as promised earlier, here's the information about the supporting hardware items:

The plug-in Weather Fax decoder card for PCs is available from David G. Hopkins, of 4 Handsworth Street, Capalaba 4157; phone (07) 390 3328 (after hours). It is supplied in built-up and tested form, for $80 including postage and insurance anywhere in Australia.

The wideband WESAT receiver, 1.69GHz LNA, downconverter and dipole feed for S-band reception are all available from PH Communications (Peter Williamson VK4AWP), of 6 Cuthbert Street, Albany Creek 4035; phone (07) 264 1575 (after hours).

The receiver is priced at $400 plus $10 for insured freight anywhere in Australia; the 1.69GHz LNA at either $150 or $165, depending upon the gain option desired; the 1.69GHz/137MHz downconverter at $250, including postage and insurance within Australia; and the dipole feed at $55, again including postage and insurance within Australia.

My thanks to both Michael Delahunty and David Hopkins for the opportunity to try out their products, and for being patient while I did so.

I only wish that my location in an EMI-ridden area of Sydney hadn't made this such a difficult and time consuming exercise! ❖

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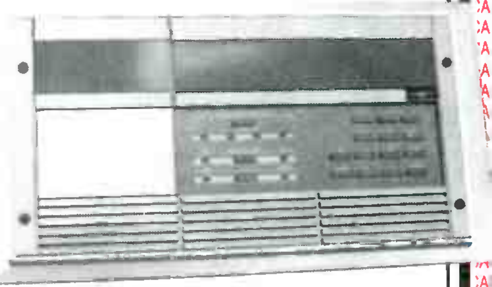
The quality is unsurpassed and if your home hasn't a burglar alarm now, then this is the time to buy one.

THE ALARM

The LA-5050 is a versatile micro-processor controlled system with memory analysis which is displayed on the unit. It is housed in an attractive grey ABS box, which incorporates all the control functions, including the access buttons, digital status display, panic button, etc. It will mount in a wall just inside the front door and requires a cutout hole 300 x 140mm. The control panel can be mounted in the ceiling, etc., if the optional remote keypad is purchased. There is also a small quantity of telephone diallers available.
The alarm has many features - some of which include - a clock, automatic mode - which enables you to program the system to arm and disarm itself at preset times, 4 zones including some 24 hour zones (for arming the perimeter of the house at night leaving the inside PIR's off), alarm activation recall - the unit will record the time of day the system was activated together with the zone number that triggered the alarm.
What can be connected? • Remote keypad • telephone dialler • strobe • panic switch • 4 zones i.e. 4 PIR's etc • 2 horns • backup battery
The system is supplied with a very comprehensive, easy to follow 22 page instruction manual. Overall front panel size 400(W) x 210(H) x 100(D)mm.
Also required:- plugpack to run from 240 volt Cat. MP-3021 $22.50. Backup battery 1.2Ah Cat. SB-2480 $26.50



KEYPAD
Cat. LA-5151
$59.50

TELEPHONE DIALLER
Cat. LA-5152 **$129.50**
WAS $242

PANEL Cat. LA-5150
$199.50
WAS SELLING FOR $428

NEW FROM JAYCAR

UNIQUE DIGITAL TECHNOLOGY SCRAMBLER PHONE

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.

STOCKS ARE RUNNING OUT

Unit requires 9V DC to operate.

PLUGPACK MP-3007 $15.95

Were $299
Cat YT-7000 **Now only $39.95 ea**

PULSE COUNT PASSIVE INFRARED DETECTOR UNDER $50 - UNBELIEVABLE!!!

Another first for Jaycar.
The Bellmate PIR is a high quality unit directly imported by Jaycar. It has pulse count triggering which up until now was only found in units of $80 or more.
The Bellmate has switchable pulse count operation with single pulse trigger and three pulse trigger. When set to three pulse the unit requires three movements before the alarm is triggered. This will virtually eliminate false alarms.

FEATURES AND SPECIFICATIONS
- Incorporates S.S.C. (slide seal chambers)
- 24 element zones in 3 layers
- Wide angle 90° coverage
- Coverage 15 x 15 metres
- Operating voltage 9 - 16V DC
- Tamper switch for 24 hour zone
- Pulse count switchable, normal or 3 pulse
- Sensitivity adjustment
- LED indicator
- Sliding PC board
- Size 110(H) x 70(W) x 55(D)mm
- N.C. terminals
- 1 year warranty

Cat. LA-5016
$49.95

NEW FROM JAYCAR

Installers - contact us for wholesale prices

1 YEAR WARRANTY

DUAL DISPLAY DMM

Jaycar are proud to announce the first handheld dual display DMM available, and it's under $200!!
The dual display allows the user to select a wide variety of measurement combinations. It is particularly useful in applications requiring two different measurements of the same signal, i.e. a Vac value can be viewed on the primary display while its frequency is shown on the secondary display. This meter also has all the features you could ever ask for on a DMM.

FEATURES
- 3 3/4 digit, 4000 count
- Bar graph
- 0.1% accuracy DCV
- Autoranging and manual
- Min/max hold
- Measurement hold
- Relative mode 1 (value difference)
- Relative mode 2 (% value difference)
- Stop watch 0.1 sec - 10 min
- Frequency counter 10Hz - 200kHz
- Capacitance 4nF - 40µF
- Transistor test • Diode test
- Audible continuity tester
- Auto power off

Cat. QM-1525
$199.50

NEW FROM JAYCAR

POTENTIOMETER MADNESS - INCLUDING SWITCH POTS!

We have purchased a large quantity of Philips brand pots. These include single gang, dual gang, single gang with switch and dual gang with switch, in log and linear. Switchpots are almost impossible to buy. This may be your last chance. We have available two packs of pots. One is a log pack, the other a linear pack. Each pack is supplied with some nuts to suit, as Philips pots have a unique nut.

LINEAR PACK

Total 25 pots. Types supplied are single, dual, single switched, dual switched. Values included in packs are 220R, 47k, 100k, 220k, 470k, 2.2M, 4.7M. Other values may be supplied but we can't guarantee every pack will get one. Cat. RP-3900

ONLY $10 per pack
That's only 40c a pot and the majority supplied are switch pots!

LOG PACK

Total 25 pots. Types supplied are single, dual, single switched, dual switched. Values included in packs are 470Ω, 47k, 100k, 220k, 470k, 1M, 2.2M. Other values may be supplied but we can't guarantee every pack will get one.
Cat. RP-3901

High Quality Polycarbonate/ MKT Capacitor Pack

This pack includes approximately 75 high quality capacitors. They are mostly Philips and Wima brand high quality European made capacitors.
Capacitance values include: 270pF, 0.0015, 0.015, 0.022, 0.033, 0.047, 0.068, 0.15, 0.18, 0.22, 0.27, 0.33, 0.39, 0.47, 0.56, 0.68, 0.82µF in voltages including 50V, 63V, 100V, 250V, 400V, 630V, and 1000V.
Most of these capacitors cost around $1 each, so 75 pieces for $10 represents an absolute bargain. There is a limited quantity of packs available.
Cat. RG-5195
$10

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 designed 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
Only $12.95 ea

ABOUT 1/2 PRICE

STOCK UP NOW

PRICES REDUCED ON Professional Rack Cases

See our 1992 catalogue page 58. Save up to 22% off our normal prices.
Made from grey enamelled steel. 3mm aluminium panel with extruded handles. Supplied with punched internal rail bars for transformers, etc., mounting. Internal sub front panel. Supplied in flat pack.

	NOW	WAS	Cat. No
1 UNIT	**$69.50**	$89.00	HB-5120
2 UNIT	**$89.50**	$109.00	HB-5125
3 UNIT	**$99.50**	$119.00	HB-5130
4 UNIT	**$125.00**	$139.00	HB-5135
5 UNIT	**$139.00**	$149.00	HB-5140

10" WIDERANGE SPEAKER BARGAIN

These speakers were purchased from Philips, manufactured in Asia and designated for a stereo system that never happened. We are happy to pass on the savings we made to you.
The speakers are a twincone widerange unit with a foam roll surround. The cone is black, with the twincone's white. Their impedance is 4 ohms.
These would be ideal for use in car stereos or extension speakers for Hi Fi. Most stereos will happily accept 4 ohm loads. Power handling is 50 watts RMS.

Full Specifications

Power Handling	50W RMS
Impedance	4 ohms
Resonant Freq.	38Hz
Freq. Response	38 - 20kHz
SPI	90dB 1 watt
Magnet Weight	17.7 grams
Total Weight	1,500 grams

Cat. CE-2330
$20 ea

ABOUT 1/2 PRICE

THE 1992 JAPANESE TRANSISTOR SUBSTITUTION MANUAL

All transistors manufactured in Japan are registered with the EIAJ under 2S < es, not 5 numbers, and their specifications are available to the public. There are about 9000 registered. Many of them can substitute one another despite differences in their type numbers. This book is compiled for the user to identify the transistors of 8 major manufacturers with different type numbers but identical performances.
This book is a "Must" for anyone involved in repair and maintence of equipment which uses Japanese transistors 2SA, 2SB, 2SC, 2SD.
282 pages, softcover, size 210 x 150mm.
Cat. BM-4570
$17.95

Wholesale enquiries - contact Bruce Routley 02 743 5222

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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
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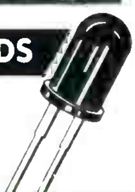
Finally available at a realistic price. These are waterclear (i.e. they look clear but light up blue) because waterclear have a higher light intensity.

Size	mCd	Cat	Price
3mm	14	ZD-1751	$3.95
5mm	14	ZD-1727	$3.95

10mm FLASHING LEDS

Now available separately

Red	Cat. ZD-1965	**$4.95**
Green	Cat. ZD-1966	**$4.95**



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









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NEW from Jaycar

Nimrod is the very latest in gas soldering irons. Nimrod features include:
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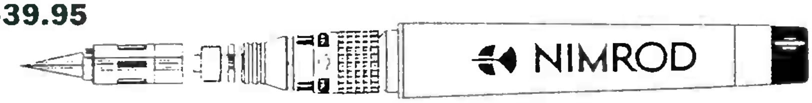
Nimrod is the trademark of Nimrod Company, Marlborough, Willshire, England. See our ads next month for details on tips, etc.
Replacement tips: 1mm TS-1431 $6; 2mm TS-1432 $6; Torch tip TS-1436 $12; Catalyst TS-1438 $6.50
Cat. TS-1430
$39.95



DATACE DISKS 100% ERROR FREE

NEW FROM JAYCAR

LIFETIME WARRANTY

At last. High quality disks without the high quality price. We had these disks independantly tested and they consistently outperformed that other expansive brand we used to stock. The Bit dropout was up to 30% less! Call into any store for your copy of the report. After the quality, the next best thing is the price.

5.25"	DSDD	$9.95	Cat. XC-4740
5.25"	DSHD	$14.95	Cat. XC-4742
3.5"	DSDD	$14.95	Cat. XC-4746
3.5"	DSHD	$23.95	Cat. XC-4748

STUDIO 3-55L SPEAKER KIT SALE

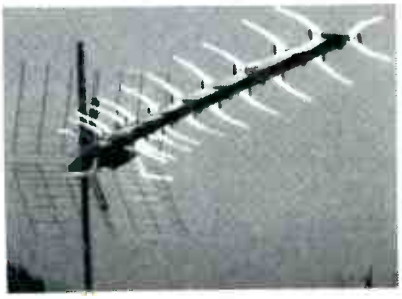
12" 3 way speaker kit incorporating Magnavox 12w woofer, midrange and Philips dome tweeter. Power handling 80 watts programme. Cabinets are black and fully built. See the 1992 catalogue for full details.
Cat. No(s) CS-2480/2

Normally $499
SEPTEMBER PRICE $449
SAVE $50

UHF TV ANTENNAS

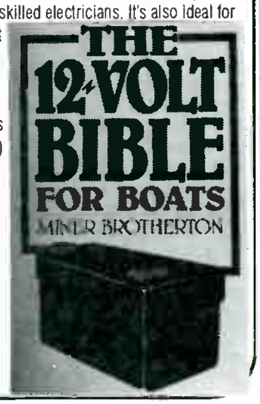
Cheapest in Australia?

23 Element	Cat. LT-3178	**$34.95**
43 Element	Cat. LT-3181	**$49.50**
91 Element	Cat. LT-3182	**$79.50**



THE 12 VOLT BIBLE FOR BOATS

By M. Brotherton
This book is a nuts and bolts primer on 12 volt electrical systems for boat owners who are not skilled electricians. It's also ideal for anybody interested in 12 volt power systems. Chapters include: Basic Theory of Electricity, Electric Circuits, The Battery, Wiring, Controls (switches, fuses, meters, etc) Transducers (lights, motors, pumps, fridges, consumption, etc.), Recharging the Battery, Troubleshooting.
174 pages, softcover, 147 x 230mm
Cat. BT-1342
$28.95



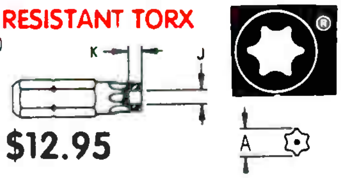
OBSCURE SCREWDRIVER BITS! ATTENTION SERVICEMEN

Up until now these have been almost impossible to obtain. We have the two most common of the really obscure bits now available. You can buy all the standard obscure bits in our screwdriver sets. TD2000 and TD2002 (see catalogue) These two new ones are extremely expensive because they are made and patented in the United States. They are Tri-wing and Tamper Resistant Torx. These special screws are commonly used in video recorders, household appliances, power hand tools and most aircraft including jumbos are held together with these. Both are 1/4" hex insert which fit all power drills and our screwdriver kits.

TRI-WING
Recess size 3
Tension head 6-32
shear head 8-32
Overall length 25mm

$12.95

TAMPER RESISTANT TORX
Driver size T-20
Size:
A - .151"
J - .062"
K - 0.78"
Cat TD-2032



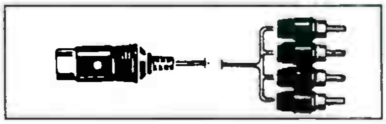
$12.95

AUDIO LEAD MADNESS - INCLUDING GOLD

We've made a scoop purchase of Audio and Video leads. Stock up now at never to be repeated prices.

Cat. No.	Description	Length	Normal Price	SPECIAL PRICE
WA-1000	5 pin DIN plug to 5 pin DIN plug	1.2mt	$4.95	**$2.95**
WA-1007	5 pin DIN plug to 5 pin DIN plug	3mt	$6.95	**$3.95**
WA-1006	5 pin DIN plug to 4 x RCA plugs	3mt	$8.95	**$4.95**
WA-1002	5 pin DIN plug to 4 x RCA plugs	1.2mt	$6.95	**$3.95**

NEW FROM JAYCAR



GOLD LEADS - these leads have gold plated plugs

WA-1030	5 pin DIN plug to 5 pin DIN plug - gold	1.8mt	$7.50	**$4.95**
WA-1032	5 pin DIN plug to 4 x RCA plugs - gold	1.8mt	$9.95	**$6.95**
WA-1034	1 RCA plug to 1 RCA plug - gold	1.8mt	$5.95	**$3.95**
WA-1035	2 RCA plugs to 2 RCA sockets - gold	1.8mt	$9.95	**$6.95**
AV-6508	BNC plug to BNC plug - gold	1.8mt	$12.50	**$7.95**
PA-3599	RCA skt to RCA skt adaptor Pk 2 - gold		$7.95	**$4.95**

BUILD THIS NiCAD BATTERY DIS-CHARGER KIT

REF: SC JULY 92. This battery discharger is specifically designed for video camera or mobile telephone batteries. It can be set for different types of batteries from 6-12V and will save you money by reviving that dud battery. This circuit is powered by the battery under discharge and, therefore, doesn't require a plugpack, making it completely portable. The Jaycar kit is supplied with diecast box, PCB and all specified components.
Cat KC-5120
$27.95

SUB C NiCad

Sub C NiCads are commonly used in battery packs to power RC racing cars and cordless power tools. Up till now, if a battery pack failed you would need to purchase a new pack from the manufacturer of the product. These battery packs are very expensive. The most common voltage used is 7.2 volts which is made up of 6 x Sub C NiCads. So instead of being forced to pay $70 - $100 for a replacement battery pack, you can now fix it yourself and save a fortune. The Sub C's are supplied with solder tabs and are rated at 1.2Ah.
Cat. SB-2456 **$6.95 ea**





JAYCAR DEALERS

Jaycar Electronics is proud to announce our first list of Authorised Dealers.

These dealers currently purchase goods from us on a regular basis. If they do not have the product in stock you wish to purchase, they will be happy to order goods in for you.

We cannot guarantee that our resellers will have the same prices as Jaycar, as they are privately owned businesses in all parts of Australia, and are subject to extra costs including freight, etc.

If you have a retail business and are interested in becoming a Jaycar Dealer contact Bruce Routley (02) 743 5222.

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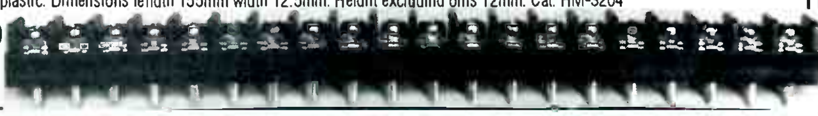
OK BRAND WILL WRAP, UNWRAP AND STRIP Cat. TH-1830

TERMINAL STRIP BARGAIN

This is a high quality terminal strip with 20 screw down connectors. All screws have a wire protector under them which holds and protects the wire. Each of the 20 connectors has a PC pin for easy soldering to a PC board. Pin spacing is about 7.5mm. Made with ABS black plastic. Dimensions length 155mm width 12.5mm. Height excluding pins 12mm. Cat. HM-3204

$1.00 ea



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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
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RHODES	6 Leeds St (02) 743 5222 Mon-Fri 9 - 5.30

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Construction Project:

A LOW COST AUDIO SWEEPER - 2

In this second article describing his low cost audio sweep oscillator and analyser, the author explains how to build the unit and get it going. He also describes how to make a low cost measuring microphone for testing speaker systems, using a readily available electret insert.

by ARTHUR D. SPRING

The complete audio sweeper is housed in what is nowadays regarded as a 'large' plastic instrument case. Sold by Jaycar Electronics as the 'Jaybox', it measures 250 x 170 x 75mm — still quite compact, by many standards. Dick Smith Electronics has a slightly larger case, measuring 250 x 190 x 80mm, and this could also be used if minor changes are made to the front panel.

Inside the case, most of the circuitry apart from the connectors, front panel controls and power transformer is mounted on a small PC board. This measures 145 x 81mm, and is coded V-192.1.

Thought was given to the home constructor wishing to make their own PCB via 'bath tub' processing facilities, by drawing the pattern with reasonable spacings and no 'skinny' computer-drawn conductors to over-etch or break if the board is flexed.

Similarly no tracks pass between IC pads. Only four jumper wires are needed. The pattern was developed using a 'DRH' program (designer's right hand — Parkinson's shakes permitting!).

The location and orientation of the various parts on the PCB should be fairly clear from the PCB overlay diagram and the internal photo.

Take the usual precautions to ensure that the polarised components (IC's, diodes, transistor and electrolytic caps) are fitted the correct way around, and also avoid damaging the components by over-heating them while soldering.

Note that IC1 and IC2 are CMOS devices, and require care when handling them and soldering them into the PCB, to prevent damage from static charge buildup.

Alternatively you might care to follow my own example, and use IC sockets (of suitably high quality) to minimise the risk. Don't forget to fit the four links to the PCB, preferably right at the start.

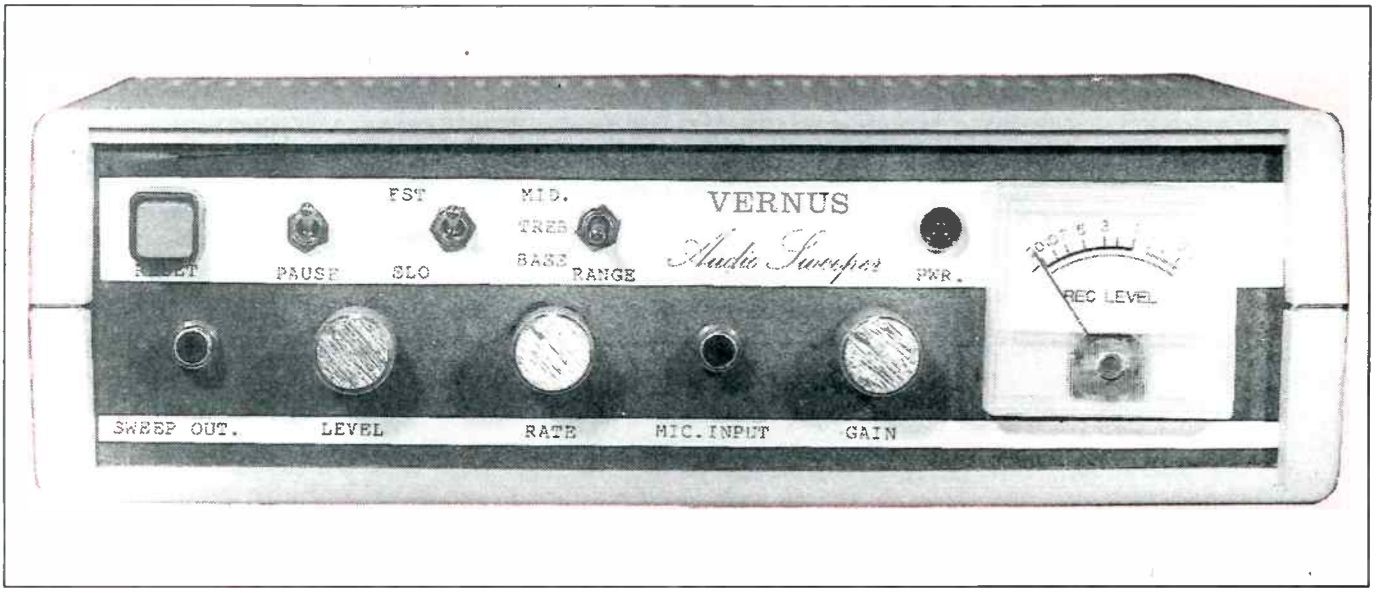
There is one component which mounts on the copper side of the board, by the way. This is the 25uF electrolytic, used to bypass pin 5 of IC4 to ground. Solder its positive lead to pin 5 of the LM833, and its negative to pin 4 (earth).

The 60k resistor at the top of the ladder network (near PCB pin 4) can be made up with two 120k resistors in parallel. One can be fitted under the PC, if this is convenient.

The overall construction of the sweeper is relatively simple and self-evident, but a few points are worth making.

Due to the disposition of the moulded mounting pillars in the case, the PC board fits close to the front plate — underneath the potentiometers. This makes it necessary for the pot shells not to exceed the standard 24mm in diameter.

Also, make sure the control knobs



A LOW COST AUDIO SWEEPER - 2

are compatible with the control shafts — i.e., to suit 'metric' (often splined) or 'imperial', which are different in diameter.

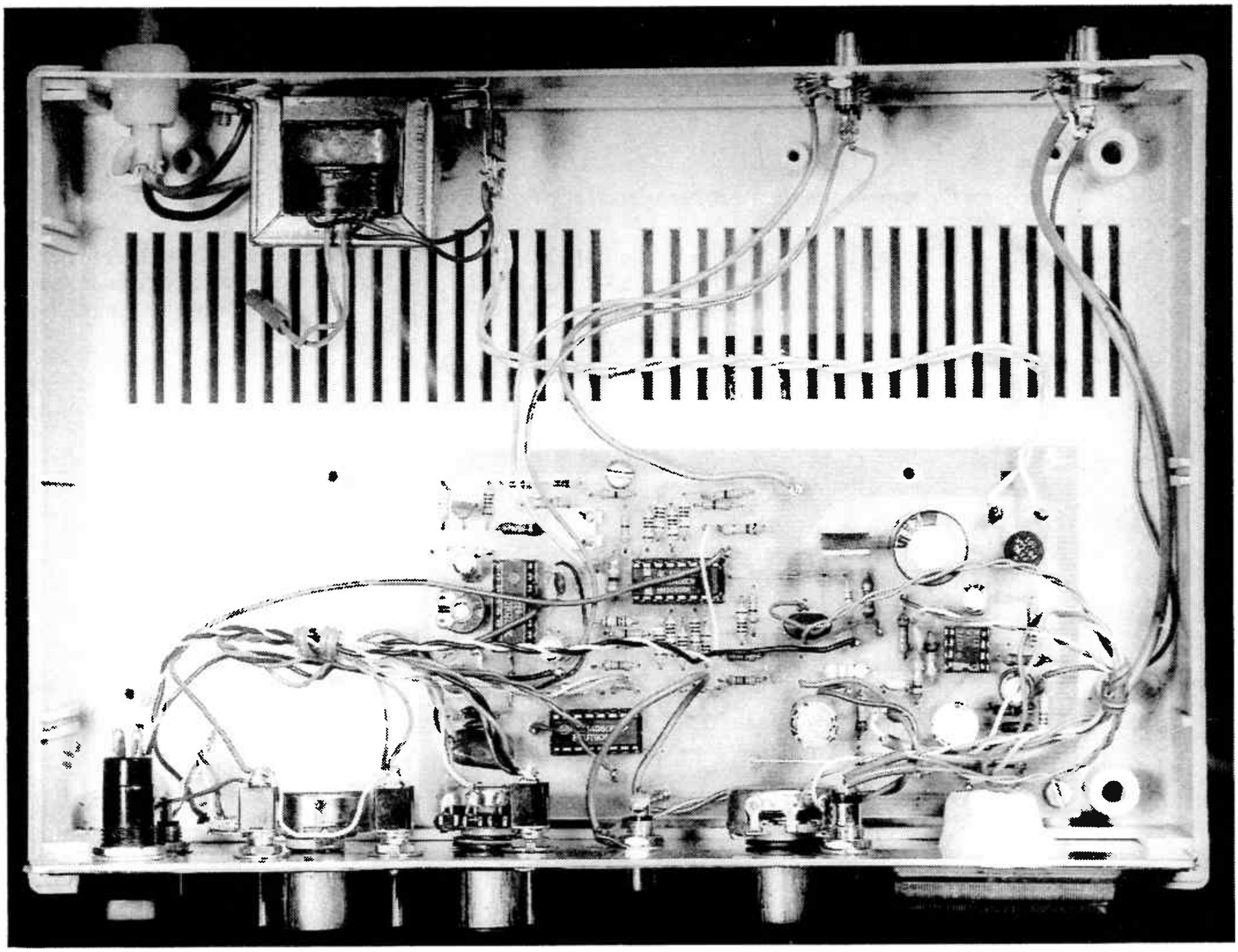
For simplicity, most of the panel holes are drilled circular with the exception of the meter hole. Needless to say, these should all be checked against their matching pot, switch or connector, for correct clearance size.

The meter is not equipped for screw mounting. So it is mounted by applying four tiny (rice grain size) dabs of 'Blu-Tac' or similar adhesive, one behind each corner, and then pressing it (gently) against the front panel. A very generous 'ring' of the same adhesive can then be applied around the meter barrel, on the back of the panel.

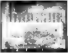
The circuit schematic and the PCB overlay diagram are both marked to show the PCB pins (23 in number) which are used to make the connections between the board and the front-panel controls, connectors and so on. Use flexible insulated wires, of sufficient length to allow the front panel to be laid flat on the bench for convenient soldering.

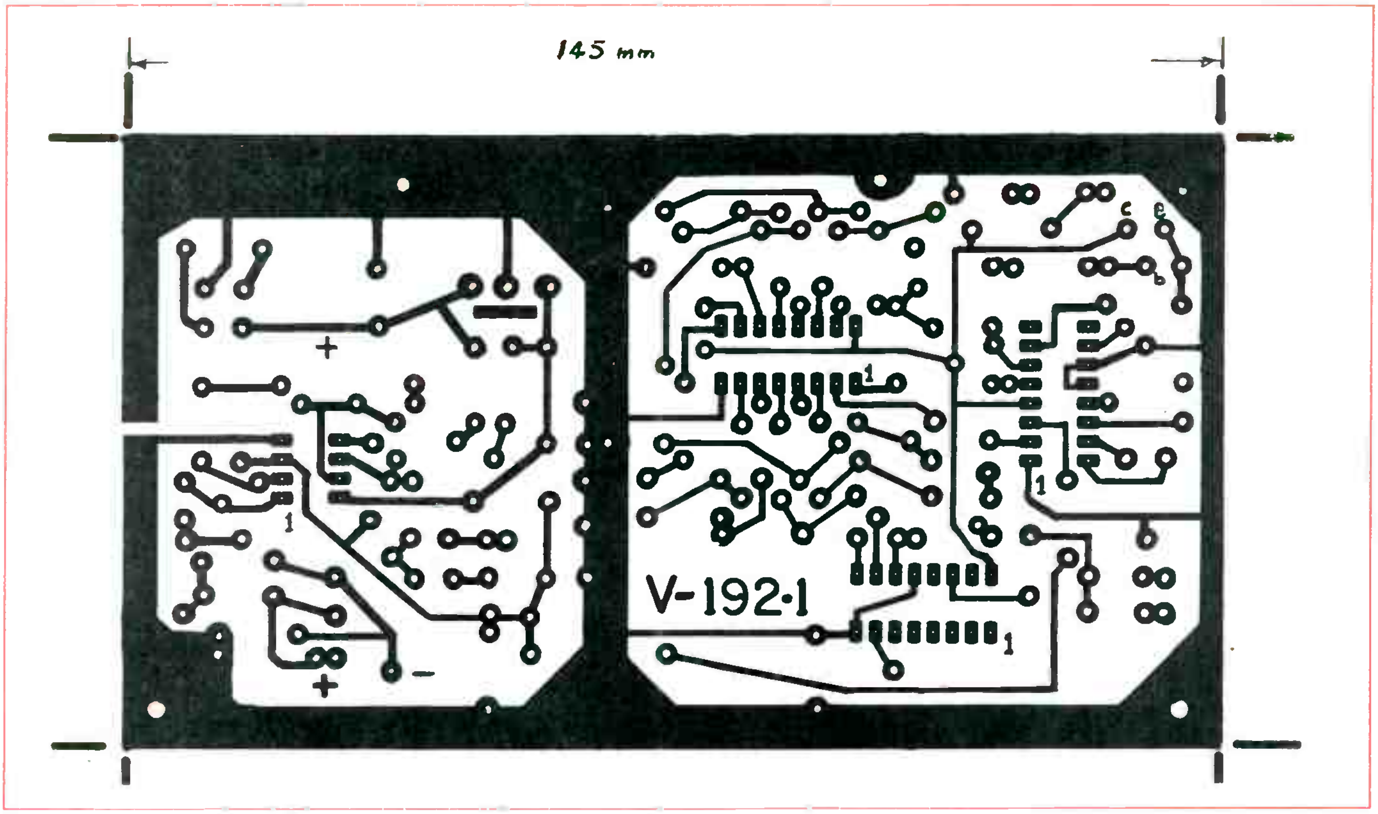
Here is the recommended wiring schedule. Connect the following PC board pins (or stakes) to the nominated component lugs:

1. Connects to the top (BASS) lug of the RANGE switch.
2. Goes to the bottom (MID) lug of the RANGE switch.
3. Goes to the centre lug (rotor) of the RANGE switch. Dress this group away from the others, towards the bottom of the case.
4. Goes to the rear-panel RAMP OUTPUT socket. Solder the 5.1V zener diode across this socket. (The earthy side of all rear-panel sockets connects back to the earth pin at the centre rear of the PCB.)
5. Goes to the LEVEL pot (clockwise end), and also to the rear-panel FREQ METER and CRO sockets. Connect the anticlockwise end of the LEVEL pot to the earth lug of the SWEEP OUT socket, and connect a short wire from the centre of the pot to the centre contact of the SWEEP OUT socket.
6. Goes to the centre lug of the RATE pot.
7. Goes to the top (SLOW) lug of the RATE switch.
8. Goes to the bottom (FAST) of the RATE switch. Connect the centre of the switch to the bottom (RUN) lug of the PAUSE switch.
9. Goes to the clockwise end of the RATE pot.
10. Goes to one side of the RESET switch.
11. Goes to the centre (rotor) lug of the PAUSE switch.
12. Is an earth pin; this can also be used to connect to the earthy side of the rear RCA sockets.



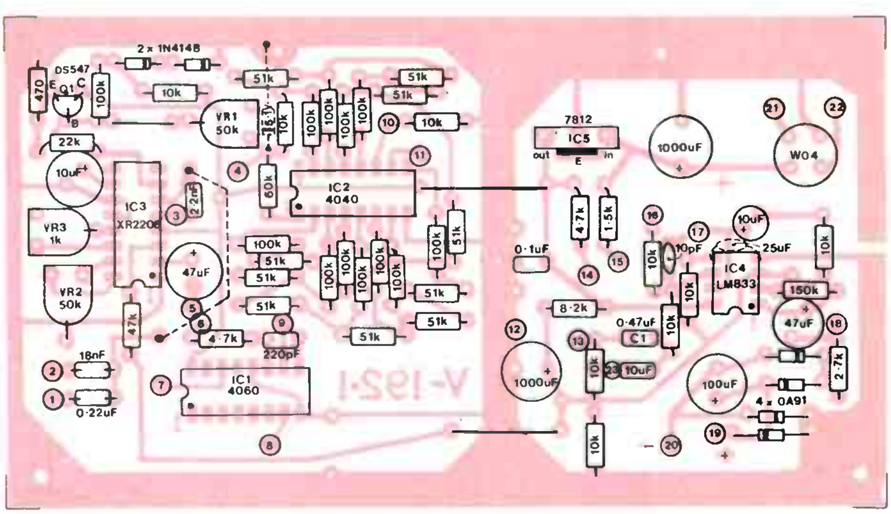
Inside the new sweeper. As you can see, there is plenty of room for everything. The power transformer is mounted on the inside of the back panel, which is firmly connected to mains earth for safety. The main advantage of using this size case for the project is that there is adequate room on the front panel for all of the sweeper's controls.





This is the PCB pattern for the sweeper, reproduced here actual size for the benefit of those constructors who wish to etch their own board.

13. Goes to the active centre lug of the MIC INPUT socket. Connect the earthy side of the socket to the PC board, at pin 12.
14. Goes to the other contact of the RESET switch.
15. Goes to the anode of the POWER indicator LED (the longer of the two LED leads). The cathode of the LED is connected back to PCB pin 12.
16. Goes to the centre lug of the GAIN pot.
17. Goes to the anticlockwise end of the GAIN pot.
18. Goes to the rear-panel MIC SIGNAL OUT socket.
19. Goes to the positive (+) lug of the VU meter (the left lug, as seen from rear).
20. Goes to the negative (-) lug of the VU meter.



The overlay diagram for the sweeper's PCB, to guide you in wiring everything up. Note that two components are fitted underneath the board — the 5.1V zener diode (near VR1) and the 25uF electrolytic (near IC4).

21 and 22 are wired to the 12V AC secondary of the power transformer. If the transformer leads are too short, mount a three-lug tagstrip next to the transformer on the rear panel, and extend the leads with hookup wire. But do NOT earth either lead. Note that after securing the mains cable in the plastic feedthrough in the rear panel, connect the brown and blue wires to the transformer primary lugs and cover with insulating tape.

Connect the green earth wire to the metal back plate, using a solder lug attached via a 3mm diameter bolt, nut and locking washer.

Finally, PCB pin (23) connects via a shielded wire to the INPUT 2 socket, on the rear panel RCA socket INPUT 2.

The technique of fitting the front Scotchcal (Dynamark) front panel has been described by others. I usually do it as follows: First, trim the artwork exactly to the shape of the panel and WITHOUT removing the backing, temporarily tape it in position. This lets you use it as a template, to centre pop all significant drilling positions. Then

PARTS LIST

Semiconductors

1 4060 CMOS oscillator/divider
1 4040 CMOS divider
1 XR2206 function generator
1 7812 12V regulator
1 LM833 low noise dual op-amp
1 BC547 or similar NPN transistor
1 W04 or similar bridge rectifier
1 5mm red LED, with bezel
2 1N4148 silicon diodes
4 OA91 germanium diodes
1 5.1V 400mW zener diode

Resistors

All 5%, 1/4W carbon film:
1 x 150k; 2 x 120k; 1 x 100k; 1 x 47k; 1 x 22k; 9 x 10k; 1 x 8.2k; 2 x 4.7k; 1 x 2.7k; 1 x 1.5k; 1 x 470 ohms
All 1%, 1/4W metal film: 11 x 100k; 10 x 51k
1 1M linear pot
1 470k (500k) linear pot
1 5k linear pot
2 50k horizontal trimpot (VR1, VR2)
1 1k horizontal trimpot (VR3)

Capacitors

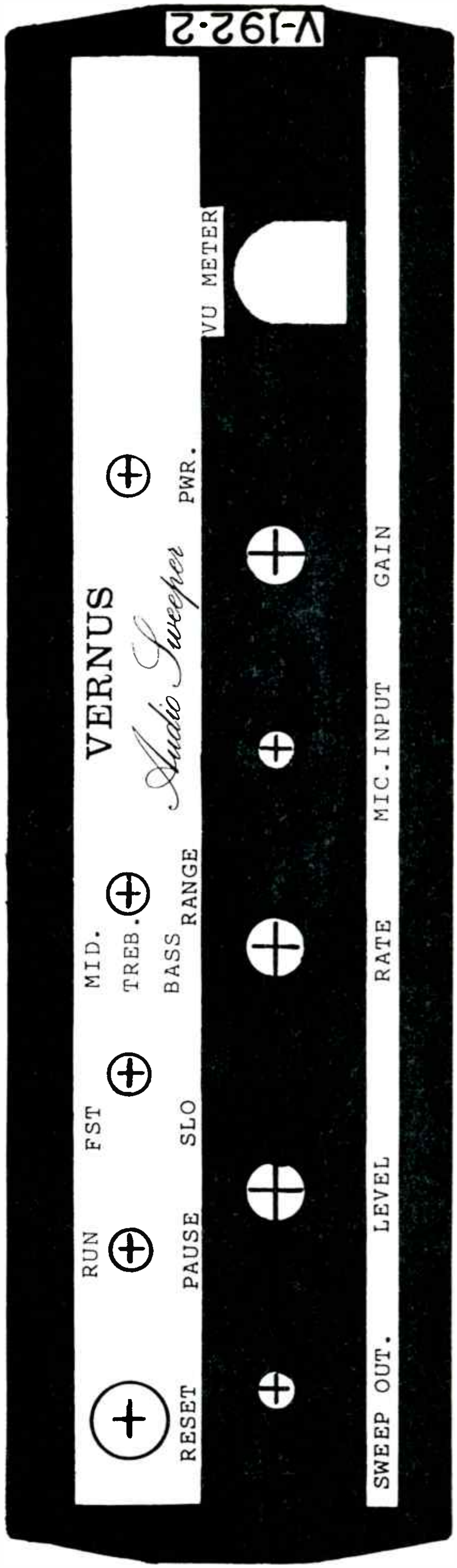
All PCB-mounting electrolytics:
2 x 1000uF 25VW; 1 x 100uF 16VW; 2 x 47uF 16VW; 1 x 25uF 16VW; 1 x 10uF 16VW.
2 10uF 25VW tantalum
(associated with PCB pins 17 and 23)
1 0.47uF monolithic (C1)
Metallised polyester, 100V:
1 x 0.22uF; 1 x 0.1uF; 1 x 18nF; 1 x 2.2nF
1 220pF ceramic
1 10pF ceramic

Miscellaneous

1 Case, 250 x 170 x 75mm
1 Front panel, to published pattern (Dynamark)
1 PC board, 145 x 81mm (V-192.1)
1 Power transformer, 12V at 150mA
7 RCA type sockets, single hole mounting
3 Control knobs, 16mm diameter
1 Pushbutton switch, N/O momentary action
2 SPDT mini toggle switches
1 SPDT mini toggle switch, centre off
1 VU meter, 48 x 45mm (see text)
23 PCB connection pins
3 16-pin DIL IC sockets
1 8-pin DIL IC socket
Power cord, cord grip and connector (if required);
insulated hookup wire;
solder lugs;
'Blu-tac' or similar adhesive;
I'd suggest also about six RCA screw-cap plugs and 200mm of light shielded wire, to make connection cables.

Microphone parts

1 Electret microphone insert, Jaycar type AM-4010 or similar
2 RCA plugs
1 RCA line socket
1 Belling-Lee type co-ax plug
200mm of aluminium tubing,
12mm OD x 11.5mm ID;
200mm each black and red light stranded insulated hookup wire;
200mm x 13mm diameter heatshrink tubing, black;
10m length of lightweight microphone cable
(single core, shielded).



Here is the author's artwork for the sweeper front panel, again reproduced actual size for those who wish to make a replica.

Audio sweeper - 2

remove the artwork and do all mechanical work, like drilling and de-burring the holes. NOW strip off the backing and replace the art panel, being as accurate as you can — the adhesive is 'sudden death'. Finally with a stencil knife, carefully trim out the holes.

Those who do not anticipate rough service for their instrument may choose to do as I did for the prototype, and use a photographic printed card made with modern medium weight, glossy, resin-coated paper. The card was attached by a few tracks of roll-on adhesive. Because of their frequent use, it is suggested that quality switches be used.

The layout of the back panel is not critical, but it is desirable to keep the power wiring at one end and signal circuits at the other, with a few 'stick on' labels to identify their function.

Oh — by the way, both front and back panels of the case must be of metal, for the sweeper to operate correctly.

Testing, adjustment

Now that the unit is completed, you are ready for testing and adjustment.

After switch-on and having established that all voltages are correct, there are only three preset pots to adjust: VR1, VR2 and VR3. VR1 is adjusted to set the overall swing of the sweeping ramp signal so that its minimum is 0.2V and its maximum is 3V, at the emitter of transistor Q1. This is best measured with a DC coupled CRO, measuring with respect to earth. VR3 adjusts the maximum sinewave output amplitude of the generator, to approximately 6V peak to peak as measured at the CRO or FREQ METER outputs.

Finally, VR2 is used to set the output signal's waveform symmetry. Again this is best done with a CRO, connected to its usual output. Simply set VR2 until the positive and negative half-cycles are symmetrical.

The audio sweep signal may now be sampled from the SWEEP OUT socket and fed to an amplifier or phones. It can also be used to test the microphone amplifier, by feeding it through a high value series resistor (say 470k) into the INPUT 2 socket. Always take care not to overload the amplifier.

And that's it. By the way, if leakage from the oscillator section proves to be a problem when you're using the metering amplifier section at maximum gain for other purposes (i.e., checking sound intensity levels), this can usually be eliminated by switching the oscillator to the 'TREB' range, switching to PAUSE and then pressing the RESET button. This holds the oscillator fixed at around 18.5kHz.

Footnote: The VERNUS name serves to identify the source of the project and prototype. I do not supply kits or parts — for these you'll have to go to the usual suppliers.

The microphone

Here again, I have tried to come up with a design which allows for the limited facilities available to the average home constructor. The aim has been to produce a mike that will give fairly known and reproduceable performance — as 'flat' as possible over the audio spectrum — while also being low in cost and easy to build.

The 'electret insert' style of microphone was chosen because it is inexpensive, widely available and offers the possibility of being able to reproduce the performance on which the design is based — even though I have found some variation in output from inserts derived from different sources.

As with most matters concerning absolute standards, it is difficult to decide on a good starting point. In this case I have used as a performance reference the AKG D224C dynamic microphone. This is equipped with a bass mic, a treble mic, a crossover network, a stepped bass attenuator switch and a hum bucking coil! But most important of all, it comes with an individually plotted performance graph.

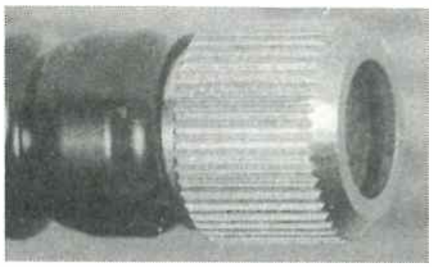
Now, I wouldn't for a moment claim that the $5.00 mic I describe here can match the AKG costing hundreds of dollars. But at least we can get some idea of where and by how much it deviates in performance and make some effort to compensate for same.

The first thing we notice is that the noise level is fairly high; fortunately this is of no consequence with the relatively high signal levels we are using.

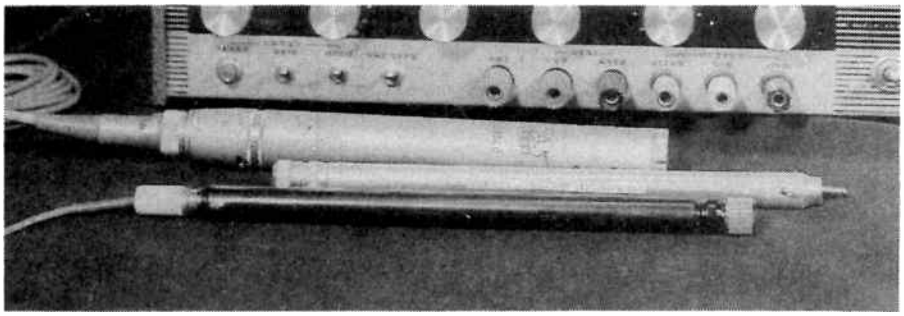
Assembling it

First, cut a 180mm length of 12mm OD aluminium tubing. Dress the ends square, and remove all burrs from inside and outside. Drill a 1/8" hole 7mm from one end.

Thread a fine insulated wire (say, black) through the hole, taking it inside the tube to the far end and leaving its tinned end protruding through the hole. Then take an RCA plug, discarding its plastic cap, and clip the 'wings' off its earth lug. Form the lug up into a hook (as in detail photo 1). Solder an insulated wire (red) to the centre pin. After threading the red wire up the tube to the far



Photos 1 to 5: Stages in the assembly of the author's low cost 'calibrated' microphone, developed to go with his sweeper. Photo 1 shows the modified RCA plug; Photo 2 shows the fitted plug and earth wire solder joint; Photo 3 the same after fitting the heatshrink sleeve; Photo 4 the mic insert ready to be fitted into the Belling-Lee plug body; Photo 5 the assembled mic end.



Here is the author's completed microphone (foreground), shown together with both an earlier version and his calibrated AKG D224C reference microphone.

end, insert the earth hook through the hole from the inside and press the plug firmly into the tube.

The lug and black wire can now be pressed down flat and neatly soldered (detail photo 2). After discarding the internal parts of a Belling-Lee style coaxial RF plug, thread it over the two protruding wires and press it firmly into the tube, at the other end. To avoid reaming out, make sure you have a plug with an internal diameter large enough to accept the mic insert; some are not. Do not yet connect the mic insert, though.

Take a 200mm length of heatshrink tubing, just large enough to go over the fittings, and feed it up to the Belling-Lee screw cap.

Evenly shrink the tubing by whatever means available (even a candle flame will do, if you're careful — but don't burn or smoke it). You'll be surprised how firmly this holds everything together.

With a sharp blade, trim the heatshrink tubing back on the RCA plug, close to the end of its shell (detail photo 3). Then remove the Belling-Lee cap.

Now comes the delicate bit. Cut back the red and black wires to protrude by only about 20mm, and strip and tin about 3mm on the end of each. Then lightly tape the mic insert to the bench, and carefully solder the wires to the pins.

IMPORTANT: It will be seen that one pin is already connected to the shell of the insert. This is the earth — i.e., the pin to which the black wire connects (detail picture 4). Tuck the insert down into the barrel of the Belling-Lee connector, carefully so that you don't short the leads. Then screw on the cap.

Your microphone is now complete. After preparing 10 metres of shielded cable with an RCA plug at one end and a 'line socket' at the other, it's ready for business...

The performance of this 'el cheapo' test microphone turns out to be quite reasonable. Be careful, though: meaningful observations can only be made if the microphone input is kept below the overload level — which is reached when 'flats' become visible on the waveform peaks, as displayed on the CRO.

A final note. When you're using the sweeper to analyse the performance of a speaker, the results may not sound as bad as they look on the sweep plot!

The displayed vertical amplitude on the CRO is on a linear scale — not a logarithmic decibel scale as indicated by the VU meter or perceived by the ear. So what may appear on the CRO as a worrying peak or dip may in reality be barely audible.

Good luck with your new sweeper, and I trust you'll be able to put it to good use. ❖

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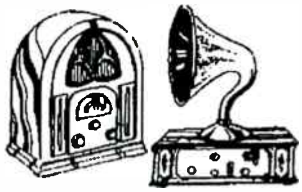
Vintage Radio

by PETER LANKSHEAR



Hints on restoring old cabinets

It is very rare for early equipment to be found in pristine condition. Most will have suffered from one or more varieties of a long list of mistreatments — ranging from rodent damage, through rust and rot to vandalism and missing parts. This month we discuss remedying exterior damage.

What can or should be done when you find a vintage radio that is in a poor state? Restore it, or merely conserve it? The key words here are restraint and caution. Early receivers can be valuable, both historically and financially. Like most antiques, their values are governed by originality, condition, age, rarity and fashion — and lately they have been appreciating quite markedly. Many enthusiasts lament this new situation, but it is the inevitable result of the growing interest in vintage radios and their increasing scarcity.

The natural temptation with a newly acquired receiver is to fire it up, and see if it still works. Don't do it! Most sets were discarded because they were faulty, and prolonged storage may have caused further deterioration. Chances are that there will only be a disappointing silence; and more seriously, components may be damaged. My recommendation is to restrict initial action to cleaning the equipment for careful evaluation.

There is some debate about restoration. At one extreme there is the example of vintage car restorers, whose aim is perfection — their pride and joy finished to a standard often never achieved in the factory. On the other end of the scale there are museum curators who insist on 'warts and all' originality, accepting the inevitability of deterioration with age and use, and with little concern that the artifact may not be in working order.

A consensus of opinion amongst most experienced vintage radio collectors is that work done on a receiver should be a balance of these extremes. It has been argued that we have a significant responsibility in owning a rare or historic radio, and that we have something of a custodial function, to give it good care and to pass it on to succeeding generations — who will not thank us if we have modified or botched it.

Well meaning but ill-advised efforts can ruin an artifact. There are stories of coin collections that were devalued because the misguided owner polished the tarnished specimens with Brasso! It is important to realise that a radio in reasonable original condition is more valuable than an immaculate example which shows evidence of restoration. In many cases, however, some judicious work will be warranted.

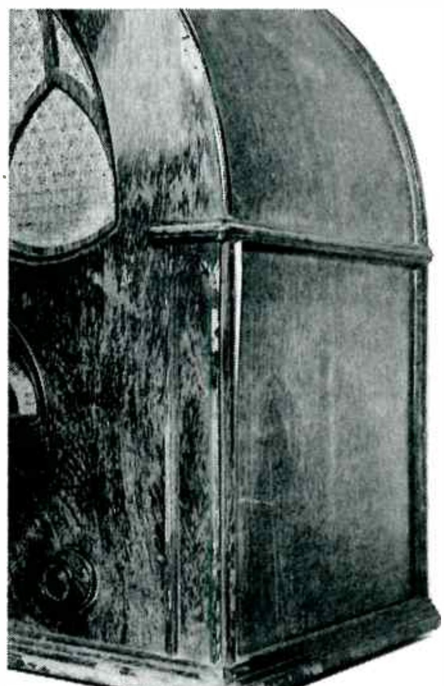
Seek professional aid

The ideal is that any restoration work should be undetectable. Major skills involved in cabinet restoration are cabinetmaking and finishing, but there are others. Occasionally there is even panel beating needed, on corroded and battered metal! Special machinery not often found in the home workshop may also be necessary, at times.

Naturally, to save money, there is a temptation to 'have a go' at cabinet restoration, and in many cases, such as the regueing of a piece of veneer, the job may not be too difficult. At the other end of the scale, to make a new panel or lid with elaborate mouldings involves the use of special cutting knives or routers.

Much depends on your own level of skill, and the available facilities. Expertise comes only with experience, and it is not very wise to practice on a vintage receiver cabinet. Always keep in mind the fact that you may have a potentially valuable item and that some mistakes are not reversible. It does not make sense to ruin several hundred dollars worth of radio for the sake of saving $50.

Although, with the exception of some very expensive consoles, radio cabinets were not usually made to the same stan-



Left: The lacquer on this valuable 60-year-old Atwater Kent model 84 'Golden Voice' cabinet had deteriorated to the point where repolishing was the only remedy. Done professionally (above), this has really enhanced the set's value.

dard as fine furniture, the techniques used were much the same. There is available a wide selection of books dealing with cabinet and furniture restoration and refinishing, and these can be of considerable assistance.

Repairing veneers

In some instances, structural repairs will be needed, but the most common problem is lifting and damaged veneer. Regluing and patching can be undertaken in the home workshop, but large areas should be tackled only if you have the correct equipment and experience. Locating and matching of replacement veneers can provide plenty of problems today. Unfortunately, iron-on plastic is the present fashion, and the availability of genuine veneers is limited. Even if veneer of the right species is available, matching of grains can be difficult. Geographic origins and differing sub-species influence grain and colouring. Careful staining may be required to achieve a good match.

Some cabinets featured what appears to be expensive exotic veneers. But they were in fact paper, printed with photographic copies of the real thing! Others had painted patterns to resemble burr graining. Lacquer removal from these surfaces may well end in disaster. The rule is to proceed carefully, if you must strip the surface of a cabinet.

Clearly, there is a limit to the extent of amateur repair work to cabinets. Don't hesitate to seek professional advice. If finance or facilities are not available, it is wiser to leave cabinets 'as is', rather than create further damage by an inexperienced do- it-yourself exercise.

Grille cloth

Another problem area is that of grille cloth. Fading, physical damage, grease and grime are a common outcome of half a century or more of domestic exposure. Sometimes, original cloth in reasonable condition can be salvaged by softening the glue with hot water and very carefully washing in warm water and detergent. Fraying and shrinkage can however be a real problem.

Even if laundering is successful, fading is almost certain to have left a shadow of the grille on the cloth. One remedy, if this is the case, is to reverse the cloth, although the pattern may then be different.

In many cases, renewal is necessary. But unfortunately grille cloth fabrics were specially made, and suitable substitutes are often not readily available. So as not to be opaque to sound, a cloth should not be dense, and very important is a degree of elasticity so that it remains taut. Generally if there was a pattern, it was small and geometric, sometimes in two or more shades. If monocoloured, there was usually a pattern in the weave.

A skilled panelbeater, a spray painter and an artist all contributed to the restoration of this Clarltone speaker. Originally, the flare had a hole in it from being nailed to a beam, and much of the paint was missing. After the metal repairs, the horn was resprayed in black cellulose lacquer and the logo was repainted from a photograph. Not a project for the novice!

Lately there has been sufficient demand for at least one manufacturer to make a range of genuine grille cloths, although naturally it is somewhat expensive. NZ Vintage Radio Society members have been able to order cloth through the Society, and it is also available from the Antique Electronic Supply, PO Box 27468, Tempe, Arizona 85285-7468, USA. This well established and efficient firm publishes a comprehensive catalog, with coloured illustrations of the grille cloths available.

The same firm carries a wide range of vintage radio components, ranging from a huge inventory of valves including European, to decal transfers and books to catswhiskers. They accept credit card orders and delivery is by return airmail.

Care is needed when renewing grille cloths. Originally, most were secured with the traditional gelatine glue which is now hard to find — as are double boiler glue pots to melt it in. The practical glue to use today is PVA, sold in handy squeeze bottles.

The trick is to hold the cloth under tension and with the pattern lines straight, while the glue sets. Easiest to fit are cloths fastened to wooden or cardboard baffles.

Place the cloth, which should be cut slightly larger than the baffle, front side down on top of a flat surface and stretch it evenly — holding it in position with masking tape, pins or staples. Now LIGHTLY and evenly coat the face of the baffle with glue, lay it on the cloth and after positioning it carefully, put a weight on it for an hour or so. If the glue is too thickly applied, it will bleed through to the cloth. Finally, trim the edges of the cloth back to the baffle.

If there is no baffle, the cloth will be stuck directly to the inside of the cabinet — requiring a lot more care and patience. Again, pins and masking tape can be useful.

Refinishing: last resort

Complete stripping, restaining and recoating a vintage cabinet should only be undertaken as a last resort. In many cases, the original finish can be rejuvenated adequately, and in so doing the risk of devaluing the cabinet minimised.

Back in December 1988 we described the refinishing of a somewhat beaten up cabinet, dating from the mid 1940's, with polyurethane lacquer. It is generally agreed that this treatment is acceptable for newer cabinets; but prewar sets should, if at all possible, have their original type of polish.

First try and identify the finish. The great majority of cabinets were finished in nitrocellulose lacquer, which is still in use today. Nitrocellulose has the merits of transparency, a high gloss, durability and drying almost instantaneously. Its disadvantages are that it must be sprayed on, and in time it discolours.

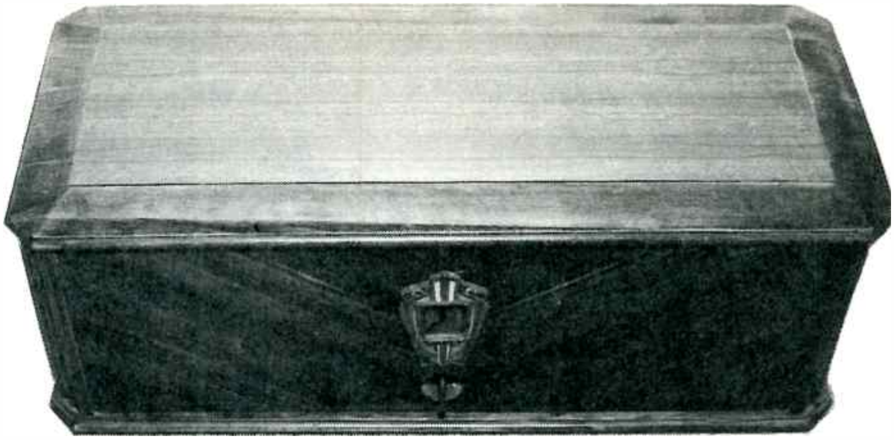
There are several methods of restoring nitrocellulose finishes. First and often all that is necessary is a good scrub with a non- abrasive household cleaner. It is amazing how much old furniture polish and general grime can accumulate. If the surface is crazed, there are preparations available that can be used to reliquefy and blend the surface, often with excellent results.

If respraying has been unavoidable, the new finish is likely to have what appears to be an unnaturally high gloss. If this is the case, wait for a few days for the lacquer to fully harden and rub down the surface with a soft cloth and 'Brasso' — which contains sharp particles of

finely ground pumice. This removes the hard glitter but still leaves the surface with a rich shine.

A few expensive and custom made cabinets were French polished. This can be identified by the rich colouring of the wood and the ease with which methylated spirit will soften the polish. Water can mark French polish, leaving a white discolouration.

French polish has the advantage of being readily retouched, but requires some skill and experience to handle. Varnish, waxing and oiling, which are softer and duller than lacquer, were rarely used on early radio cabinets.



Although at first glance this 1929 RCA model 44 looks to be in reasonable condition, there are serious problems. The veneer on the lid has been replaced with Formica laminate, which will be very difficult to remove, and the wood has warped. A new lid will probably be necessary. The original nitrocellulose finish has also been coated with polyurethane lacquer, and will to have to be removed.

About stains

Most cabinets had at least some staining, which will be ruined by any stripping and should be restained after sanding — but before any lacquer or polish is applied. There are two main kinds with quite different characteristics.

Oil-based stain is more of a thin paint which is rubbed into the wood to provide a seal and hides grain. This was used especially for bases and plinths.

Water- and spirit-based stains modify the wood colouring, but do not conceal the grain. Spirit stain dries almost immediately and unlike water-based, does not raise the grain of sanded wood. Some authorities maintain that water-based stains have the best colour stability.

Sanding of old cabinets should be by hand only. Veneers are very thin, and power sanding can cut through to the base wood in a few moments.

Do not rely on memory for restaining, but take a photograph before any stripping of the cabinet. Be warned: it is very easy to overdo staining, which once applied is hard to reverse. Some unfinished woods can be deceptive, as polish or liquid will alter their colour considerably. Walnut is especially so. The raw timber is a greyish brown, but finishing will turn the darker portions of the grain almost black.

Vintage receivers can present the unwary with some nasty traps.

Often dial scales were made of translucent plastic, illuminated from the rear. Dial lamps can cause scorching and discolouration, but the major problem occurs when attempts are made to clean the dial — because in many cases the markings were made with water soluble ink! Even a damp cloth will smudge them. Why on earth soluble ink was used is one of radio's minor mysteries...

Finally, some cabinets featured fancy carvings or mouldings. They were mouldings — literally — made of wood dust and a matrix that is not resistant to paint stripper, lacquer solvent or alcohol. About the best way to spruce them up is a gentle scrubbing with a nail brush and soapy water.

To sum up then, be *very* careful what you do to an old cabinet. Unless you know exactly what you are doing, give serious consideration to seeking professional help.

Needless to say, a valuable cabinet should never be the object of your first effort at restoration. ❖

New Feature:

Collector's Corner

As a result of the very warm response to Peter Lankshear's monthly Vintage Radio column, and his book *Discovering Vintage Radio*, we've decided to try out a new feature: Collector's Corner. The idea of this is to provide an opportunity for readers to display prized items from their collections of radios and other equipment — or to seek help from other collectors in obtaining information on rare models, or hard to get parts.

So if you're a collector of vintage gear, with a piece of equipment that you'd like to brag about, or you'd like help in either identifying or restoring a set, how about writing in and sending us whatever information you can — including a photo, if possible. We'll try to publish as many as we can. Send them in to Collector's Corner, c/- EA, PO Box 199, Alexandria 2015.

Experimenting with Electronics

by PETER MURTAGH

Simple loudness display

Have you ever thought of building a 'loudness display' — one of those bar graphs where the louder the sound gets, the more the bar lights up? This month's circuit uses several LEDs to achieve this result. And in later projects we hope to adapt this circuit to display other changes, e.g. temperature.

In the March 1992 issue of *EA* we published the circuit for a 'Sound switch'. This circuit picked up the sound with an electret microphone, and the signal was then amplified and used to switch on a relay for a specified time.

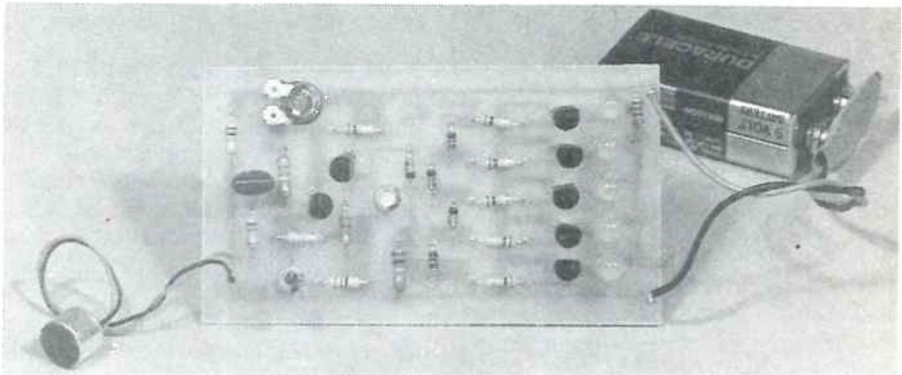
This month we will use this same mic and amplifier, but this time we will use the output to light up from one to five LEDs, to indicate the loudness of the original sound.

So, if you already have our sound switch, you will not need to build any of the circuit shown to the left of diode D1 on this month's schematic diagram. However, you will need to modify the bias on the base of transistor Q1 — the value of R2 has been increased from 100k (in the original circuit) to 330k, and a 100k trimpot has also been added. More about the reason for this modification later...

On our schematic we have shown five LED indicators. Five seemed to us to be the minimum number needed to give a good indication of changing sound levels. But to save money, you could reduce the number to three — or to make an even larger 'bar', the number could be larger. One of the reasons for including trimpot RV1 is to allow the number of LEDs to be increased beyond our five. (Explanation later.)

You will notice that we have used a lower-than-usual value for the common current-limiting resistor (R14) for the LEDs — 560 ohms. This gives a current of about 12mA, which makes the LEDs glow quite brightly to make a more impressive indicator. This looks better, but of course drains your battery faster. (A circuit like this month's, if used for any length of time, would be better run from our power supply as featured in the April 1992 *EA*.)

But why use a shared R14 — why not a separate current-limiting resistor for each LED? See the section of 'How it works' for the explanation — and it's not just to reduce the current!



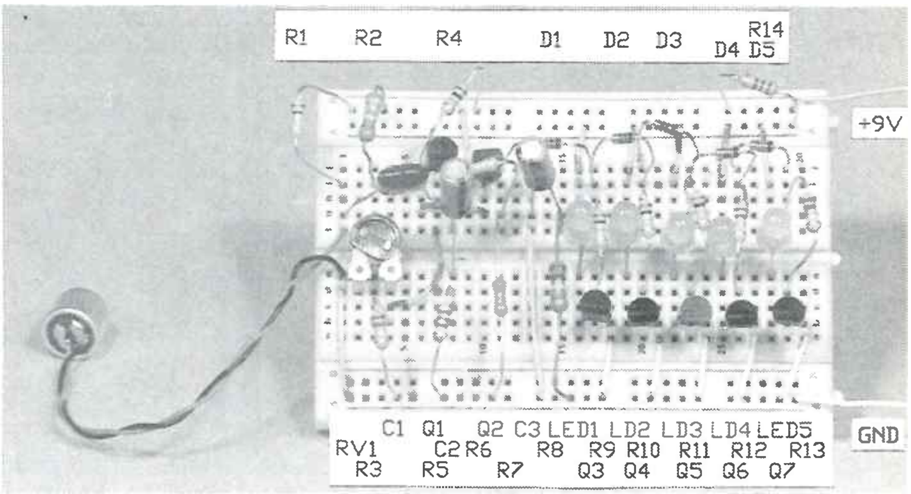
Construction

Start your construction by soldering the components in the usual order, with the more rugged components first: resistors, capacitor, diodes (including the LEDs) and finally transistors. If you have to build the original sound amplifier as well as the new LED display (the schematic and parts list assume this), then solder the mic leads last. This minimises the possibility of damaging the mic, with the constant turning over of the PCB to insert and solder the other components.

Take care with the polarised components. Refer to Fig.3 to identify which lead is which for the electrolytic capacitors (C2 and C3), the LEDs, diodes and transistors. Note that Q2 is the only PNP (BC558) transistor — the rest are NPNs (BC548). Remember too that the electret mic must be inserted correctly — its red lead is the positive one (+).

Changes

The values of capacitor C3 (10uF) and resistor R8 (560k) determine how long the LEDs light up with each sound pulse. They can be increased in value if you want



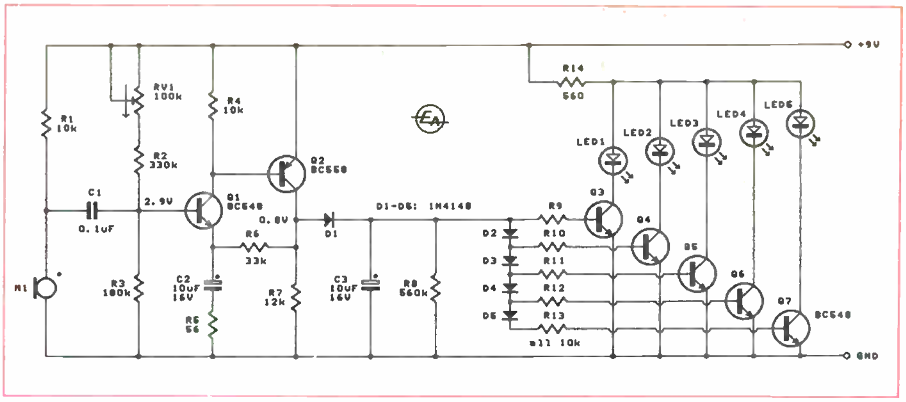
If you can't see all the connections on this breadboard layout for the circuit, refer to the schematic diagram for more details.

[illegible]

the LEDs to stay on longer, but the display will then be a little slower to react to the changing pulses. Of course you can also decrease the values if a more flashing response is required. So experiment with these two values to see what effect they have.

Also, if you want the circuit to be more sensitive, then you can change the gain of the amplifier — this is determined by the ratio of the resistor values of R6:R5. However, this circuit already has a fairly high gain, and the larger the gain, the smaller the negative feedback available for stabilising the circuit. (For more details on how all this works, refer back to the 'Sound Switch' project in the March 1992 *EA*).

Could you increase the number of LEDs beyond five? To answer this question, you must know the voltage drop across a typical diode, as well as the maximum positive voltage swing at the collector of transistor Q2. (Note that the NPN transistors Q3-Q7 can only react to the positive half cycles of the AC signals.) The answer is given later, but why not try to work it out first yourself?



The schematic diagram shows the 'amplifier' circuit built around transistors Q1 and Q2, while transistors Q3-Q7 drive the five LEDs. The arrow on RV1 shows how the resistance varies as the trimpot is rotated clockwise. In this circuit, the resistance across RV1 decreases.

How it works

When sound variations arrive at mic M1, the DC current flowing through it via resistor R1 fluctuates. These AC variations pass across capacitor C1 and are applied to the base of transistor Q1. Resistors RV1+R2/R3 bias this transistor on to allow signal amplification for both positive and negative variations.

Transistors Q2 and Q3 form a complementary 'Darlington pair' amplifier, with negative feedback for stability. Resistor R6 gives 100% DC feedback, so its DC gain is 1. But the AC gain is far higher (roughly the ratio of R6:R5) — about 600.

The reason for this (which is explained in far more detail in the March 1992 article) is the presence of capacitor C2. This provides different pathways for the DC and AC signals — it blocks the DC but provides a low impedance path for the AC. So there is 100% DC feedback across resistor R6, but the fraction of AC feedback is determined by the potential divider action of R5+C2 and R6.

The output signal from the collector of transistor Q2 is then fed to the bases of the various LED-driver transistors (Q3-Q7), across the delay circuit of components C3 and R8. As well as resistor R8 discharging capacitor C3, it also acts as a pulldown resistor for the transistors which drive the LEDs. In the absence of any sound signal, R8 ensures that the NPN transistors are turned fully off.

Now, let's look at the reason for inserting diodes D1-D5 in the circuit. Diode D1 has been included so that only the positive half of the AC signal is used to charge up capacitor C3 — the NPN transistors Q3-Q7 can respond only to such positive signals.

You will remember that there is a voltage drop across such signal diodes of about 0.6V. So the level of our input signal becomes progressively 0.6V less, after it crosses each extra diode. An output signal voltage (at the collector of Q2) of 0.6V will light LED1 only, while an approximately 3.0V pulse is needed to light all five LEDs. In-between voltages will light from one to five of the LEDs. So the louder the sound, the more LEDs will light.

Of course, with such a simple circuit, the LEDs will not light in perfectly linear 0.6V increments, because the various transistors and their LEDs will interact with each other. Also, because the diodes are only supplying very small base currents to the transistors, the voltage drop across them will be less than their normal 0.6V.

This lower-than-usual voltage drop means that you can increase the number of LEDs even further.

For a normal AC amplifier, the bias at the base of transistor Q1 is adjusted to give a DC voltage at the collector of transistor Q2 of 4.5V (half the 9V supply). This allows the amplified AC signal to swing a full 4.5V in either direction. On our 'Sound switch' circuit, this DC output voltage was reduced to about 3.5V to give a larger positive voltage swing which

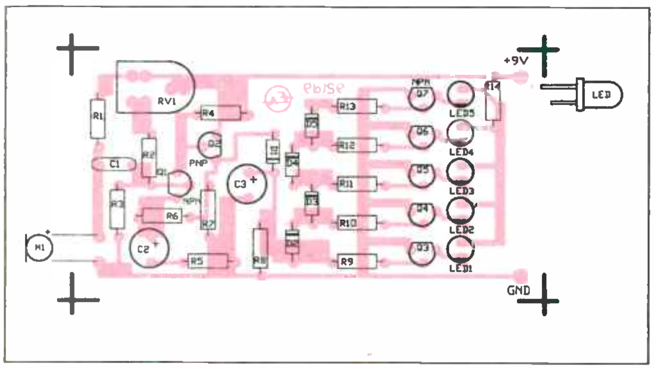


Fig.1: The component layout on the printed circuit board. The LEDs are arranged so that the bottom LED1 is the most sensitive, and so is the first to light. Note that Q2 is the only PNP transistor — all the rest are NPNs.

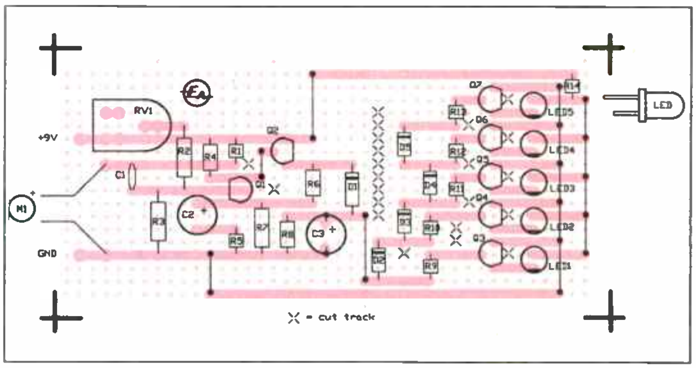


Fig.2: The stripboard layout. There are quite a few 'cut tracks' to make, as the emitters of the five transistors Q3-Q7 all connect to earth, and the anodes of all LEDs connect to the common resistor R14.

[illegible]

would charge up the timing capacitor even more.

This month's circuit takes this idea even further. When we positioned our trimpot RV1 in its centre position, the bias at the base of Q1 (see the schematic diagram) was 2.9V, and the output voltage at Q2 was 0.8V. By doing this, not only are we giving ourselves the opportunity for a far larger positive voltage swing, but we can also adjust the sensitivity of our display. With this setting, the bottom LED of our display was right on the verge of turning on.

And finally, why have we used a shared resistor R14 to limit the current in the LEDs — why doesn't each LED have its own 560 ohm resistor? The main reason is that the 'Sound display' responds with far greater sensitivity with this arrangement, with the added bonus that the battery has to supply less current.

You will notice that capacitor C3, charged up via diode D1, has to supply the base current to all five transistors Q3-Q7 during the negative halves of the sound signal. If less base current is needed, then the capacitor can supply it more readily.

The net result is that resistor R14 supplies approximately a 12mA current, irrespective of how many LEDs are on. For example, when LED2 turns on, LED1 is dimmed as it now has to share the 12mA current. But interestingly, LED2 doesn't seem to be dull — the eye seems to notice more that this LED has now turned on, rather than it is not as bright as LED 1 used to be.

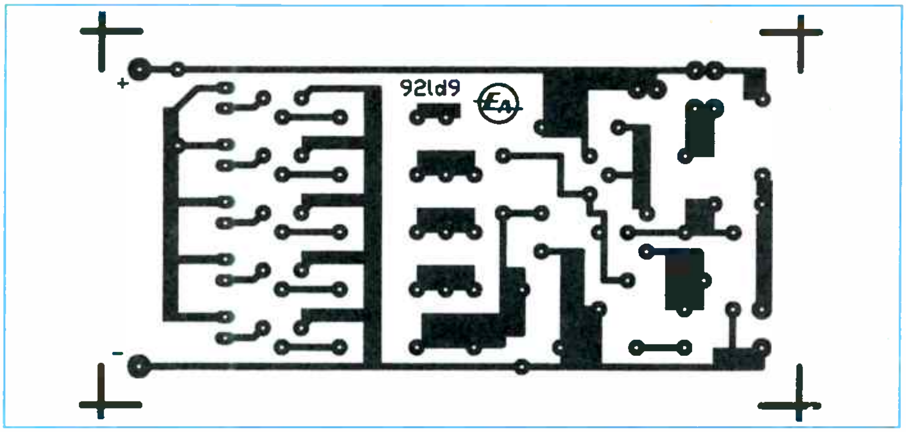
And this same effect continues as even more of the LEDs turn on. With the shared resistor, the sound volume doesn't have to be as loud for all five LEDs to light, and the LEDs react more quickly to any change in volume.

Sensitivity

Once you have completed your circuit, use RV1 to adjust the sensitivity of the circuit. Start with the trimpot turned fully anticlockwise. As you turn it clockwise, Q2's output voltage will increase (since RV1's resistance decreases), and LED1 will eventually first flicker, then come on fully.

Next turn the trimpot slightly back (anticlockwise) until LED1 just goes fully off. Of course, do all this in a quiet room, so that there aren't any sound signals to interrupt your setting! Now your most sensitive LED will react to the slightest sound, and you are ready to try out your display.

Place the mic near a transistor radio. At a low radio volume only one LED should be on. Then slowly make the sound louder, and one by one the other four LEDs should also light up. We found that the volume to turn on all five LEDs was reasonably loud. But then your ideas of 'loud' might be different to ours!



The PCB pattern is shown actual size to enable you to etch your own board, if you so desire.

Should you wish to make the circuit less sensitive, then that's easy — just move the mic further away from the sound source (or turn your RV1 setting more anticlockwise). But if you want to make it more sensitive, then you will have to increase the AC gain of the amplifier by making the value of R5 smaller and/or R6 larger.

But remember that an increased gain means there is less feedback to stabilise the amplifier — with too little feedback, the circuit could oscillate. But experiment — try it and see.

More LEDs?

Here's the (theoretical) answer to the question we asked earlier. If our amplifier is biased at the usual DC output of 4.5V, and each diode needs an additional 0.6V increase in signal, *seven* stages should be possible — there's not quite enough voltage to drive the 8th LED (4.5/0.6 = 7.5).

With our DC output voltage of 0.8V, 13 stages should be possible! But in practice, even though our diodes actually drop even less than 0.6V each, our amplifier doesn't have enough gain to give this large positive swing of 8.2V (9V-0.8V).

And also, capacitor C3 would be struggling to provide enough base current for all the extra transistors. But why take my word for it — try it and see! What is the maximum number of LEDs in practice?

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.

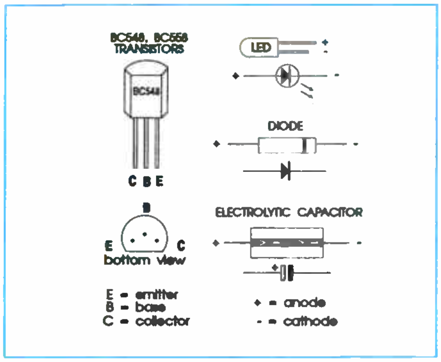


Fig.3: The component leads identification diagram for the polarised components used in the circuit.

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. ❖

PARTS LIST

Miscellaneous

PCB 93x50mm, coded 92ld9
9V battery
electret microphone insert
5 LEDs, any colour
hookup wire, solder, etc.

Resistors

All 1/4W, 5%

7 10k R1,R4,R9-R13 brown-black-orange
1 330k R2 orange-orange-yellow
1 180k R3 brown-grey-yellow
1 56 ohm R5 green-blue-black
1 33k R6 orange-orange-orange
1 12k R7 brown-red-orange
1 560k R8 green-blue-yellow
1 560 ohm R14 green-blue-brown
1 100k trimpot RV1 horiz. mount

Capacitors, polyester (greencap)

1 0.1uF C1

Capacitor, PC-mount electrolytic

2 10uF,16V C2-C3

Semiconductors

5 1N4148 signal diodes D1-D5
6 BC548 NPN transistor Q1,Q3-Q7
1 BC558 PNP transistor Q2

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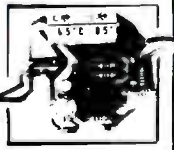
240V Power Relay Kit

(EA Jan '92)

Here's a simple project that monitors the power drawn from a 'master' socket and automatically switches on a 'slave' socket. It will monitor one or several appliances plugged into the 'master' and switch on one or several devices plugged into the 'slave'. Ideal for Hi-Fi's or computers with peripheral hardware.

K 6070 **$59.95**

Solar Generator Kit



(ETI Dec '87)

Charge Your Batteries Free From The Sun. The Solar Generator charges and maintains your standard 12V lead acid car battery via the sun. Ideal for boats, caravans and remote data acquisition stations etc. Must be used in conjunction with a suitable solar panel.

K 1680 **$13.95**

Baby Room Monitor & FM Transmitter Kit

(SC Jan '91)

This Baby Room Monitor allows you to listen to your baby from a remote location using a conventional FM receiver. It runs from a single 1.5V AA battery and includes a muting facility so that it only transmits sounds above a certain level.

K 1180 **$24.95**

Ni-cad Battery Discharger Kit

Designed to rid your ni-cad batteries of the 'memory effect' and regain full re-charge potential. It discharges your ni-cad batteries correctly to enable a full and proper re-charge. Suits most battery packs. Great for mobile phones, rechargeable drills, remote controlled toys etc.

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2 Sector Alarm System Kit

(EA March/April '89)

Features: • Includes 12V 1.2 Amp hour inbuilt sealed lead-acid backup battery • Easy to build, assembles on a single PCB • Two sectors - delayed and instant inputs • Entry and exit delay • Panic alarm input • Line monitoring • Soft pre-alarm • Lamp tell-tale output • Auxilliary relay for external siren etc • Key switch operation • Operates on virtually any type of sensor

K 1910 **$89.00**

4 Channel Guitar Mixer & Preamp Kit

(SC Jan 1992)

This project takes advantage of the new low noise, low cost op amps available. This unit features separate bass, midrange and trebel controls, very low noise and distortion, separate input level controls plus an output level control. Ideal for use with most musical instruments from keyboards to guitars to tape decks. In fact, you can feed it with just about any audio signal — it's not just limited to guitar outputs.

K 5535 **$49.95**

Transistor Tester Kit

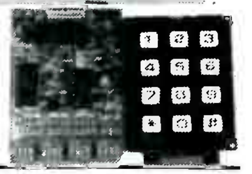
(EA Aug '83)

Checks transistor in circuit. "No need to unsolder suspect transistors". Have you ever de-soldered a suspect transistor, only to find that it checks out OK?

Features: • Tests both NPN and PNP transistors in circuit at the touch of a switch • Tests Diodes and SCRs as well • No need to switch between NPN and PNP — it's automatic • LED indication to show condition of device.

K 2530 **$17.50**

Four Digit Combination Lock Kit



(SC Dec '90) K 1925 **$44.50**

This 4 Digit Combination Lock is bound to prove useful in many applications. Such as accessing alarm systems, electronic doors, ignition killers or just about anything that comes to mind. Momentry or latched relay output.

New 4-Channel Lighting Desk

(SC June/July '91)

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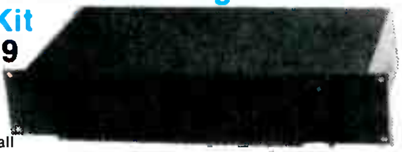
This 4-channel lighting desk is intended for theatre, disco and music group applications. It has heavy duty circuitry and is able to cope with spotlights rated up to 1000 watts or more. It has been designed and built for the rigours of commercial use. You can flash each channel up to any brightness as set by the 'Flash Master' fader. Similarly, the 'Channel Master' control fades all lights up or down, to or from their individual fade settings. Two chaser faders control the rate and lamp brilliance when the unit is operated in chaser mode. The lights can be flashed to full brilliance or to an intermediate setting as set by the 'Chaser Master' fader.

K 5815 Normally $320.00 This Month **$299.00**

Playmaster "Pro Series One" High Power Mosfet Amplifier Kit



(EA Dec '89/Jan '90) K 5070 **$599**

This design has been carefully developed to produce a high definition audio output with reliability, ease of construction and low cost. Kit comes complete with all components, toroidal transformers and case. **Features:** • Individual toroidal transformers for each channel for low residual hum • Mosfet technology for ultra-high performance • Power Output of 140W RMS into 8 Ohms.

Studio 200 Stereo Control Unit Kit

(SC June/July '88)

K 5015

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K 9550 PCB Format **$129.95** K 9555 With Instrument Case **$149.95**

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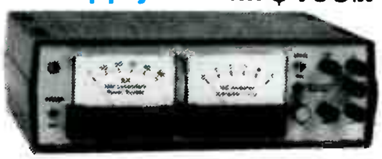
(EA May '85)



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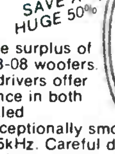

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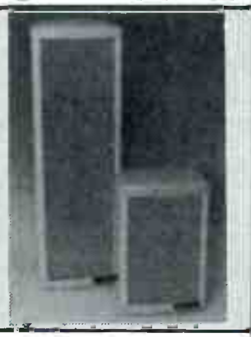

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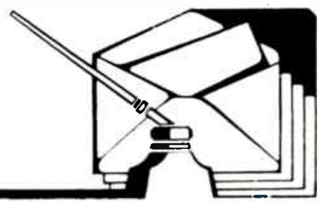
Information centre

Conducted by Peter Phillips



Simple solutions to various reader problems

Most of the letters this month seek an answer to a technical problem. Fortunately, we're able to answer most of them! On the way, we look into the crystal ball about a few projects I have planned.

Most problems in electronics have a simple solution: it's finding it that can be difficult. Still, I suppose that's part of the fascination of electronics. Quite often a solution will seem very obvious when it's found, while in other instances it's a case of 'if it works, don't ask questions'.

All too often, a complex problem experienced by one person will have been solved long ago by someone else. I recall many years ago asking a college lecturer why some types of power amplifiers burn out if operated without a load.

His reply was 'I used to know!' He went on to say that he had researched the issue at the time, solved it to his satisfaction, then remembered only that you don't disconnect the load from a power amplifier if the volume control is turned up.

While none of the replies given this month are in that category, this example illustrates that the 'why' is often less important than the 'fact'.

Our first letter is one I've had in my file for some time, as I really didn't have an answer. The problem is possibly quite common, yet none of my colleagues (except one, as it turns out) could help me. While I had a few theories, as it turns out I was way off the beam. See what you think.

CB Interference

Now this correspondent really has a problem:

I have a problem with my CB transmitter getting into neighbourhood phones. I live in a block of three flats, and being nearest the road, all phone lines run past my unit under the eaves, before connecting to the pole on the roadside.

My antenna is a quarter-wave vertical on the edge of the iron roof, which I use as a ground plane. The antenna is about three metres from the phone lines, with the coaxial cable being one metre from the phone lines at its closest point.

I have tried various filter circuits, fitted inside the phone junction boxes in each flat and was able to reduce the interference by about 80%. This is still annoying, but not enough to interrupt conversations.

The main problem is with the house next door. Their phone line terminates on the same pole, but none of the filters works at all for them. They have to hang up and either wait for me to finish, or ring me to complain.

Telecom have a phone which is fitted with RFI suppression, but this costs $4 extra per month. As there are five phones affected, I'd need to pay $20 per month just to keep the peace.

Can you shed some light on the problem, as I can't be the only person with this dilemma, surely! I'd appreciate my name and address being withheld. (anon).

RFI and its suppression are always a vexing problem, but when the RFI affects other people's phone conversations, it's downright nasty. However, according to a colleague (K.C. Blacktown, NSW), your problem is easily fixed.

The problem is apparently caused by an impedance imbalance in the phone lines, which prevents the interference cancelling itself. While this sounds rather complex, the cure is to wrap both lines around a ferrite rod, such as an AM radio antenna rod, to balance the lines at RF.

This can be done at the phone wall socket, by wrapping a few turns of the phone extension lead around the core. You might need to experiment, but I'm assured it works. Total cost is a few pieces of suitable ferrite, which can also include the core of an old TV line output transformer. Naturally, you'll need to do this with all affected phones. Simple — when you know how!

VCR mixer

In April 1992 I published a letter from G.L. of Ringwood, Victoria, who had some comments about the TV/VCR switch fitted to most VCRs. He argued that this switch was unnecessary, and said 'the real problem is where the VCR's RF output is distributed to a number of TV sets, and a number of different programs (including the VCR output) are to be viewed at the same time'.

I have to admit to being (at the time) confused by this sentence and I took the editor's perogative and deleted it. I had visions of a 'split screen' TV, with all channels occupying small sections on the screen.

Since then G.L. has written and explained that he meant viewing different programs on different TV sets connected to the system. It's obvious now (as it should have been then) and my apologies for being so thick!

However, as well as putting the record straight for G.L., I've received some material from MMT Australia who have, it seems, the answer to G.L's problem. While I don't normally use these columns to promote a product, this one is interesting enough for me to break the rules this once:

I'm writing concerning the problem raised by G.L. in the April edition of EA. The circuit shown by G.L., which uses two two-way splitters does work, but problems can occur with adjacent channels and harmonics produced by the RF modulator in the VCR.

We manufacture a product that solves these problems, called a VCR Mixer. It costs around $60 and takes the VHF and UHF signals from the antenna and notches out the channel used by the VCR as its carrier to the TV set. This also has the advantage of eliminating interference caused by the VCR.

All the remaining channels are fed to the VCR and the output of the VCR is then fed back to the mixer, where it is recombined with the antenna signals. The output of the mixer can then be fed to a splitter connected to several TV sets.

The result is that any TV set in the system can be tuned to any TV station, or the output of the VCR. The mixer is locally made, and doesn't require a power source. It's small and can be located out of sight as required. (J. Bonavia, Sales Director, MMT Australia).

Looking at the specifications supplied with the letter, the VCR Mixer has an insertion loss of -6dB (VHF) and -7dB (UHF). It uses F connectors for minimum RF leakage and is fitted in a diecast aluminium box. If the insertion loss, (plus that of a suitable splitter) causes too much loss in the signal, a TV distribution amplifier might be needed. The system is shown in block diagram form in Fig.1. For further information, contact MMT Australia at 7 Amsted Road, Bayswater, Victoria or phone (03) 720 8000.

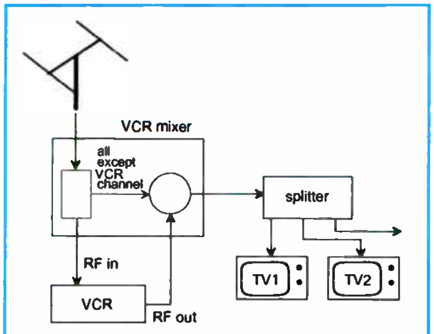


Fig.1

6 metre amplifier

Staying with matters RF, the next letter asks a reasonable question:

I recently read your construction project describing the Miracle TV antenna. I then bought a kit from Oatley Electronics, put it together and tried it out. It works very well, thank you.

For some time I've been looking for a preamp for the six-metre amateur band. Could this masthead amplifier be used for this purpose? Would any changes have to made to this circuit to make it useable on six metres? If not, do you know of any suitable circuit or kit for this purpose? (L.F., Kewarra Beach, Qld).

While I haven't tried it, there is no reason why this amplifier couldn't be used as a six-metre preamp. The low end of the six metre band is at 52MHz, which is around the lower limit of the VHF TV band. Because the amplifier has a very wide bandwidth (it also covers the UHF band), all signals from the antenna will be amplified, so perhaps some sort of bandpass filter before the amplifier might be required. But given the low cost of the amplifier, I'd be very tempted to give it a go, without modification.

Of course if you transmit on six metres as well as receive, with the same antenna, you'll need to protect the preamp from damage due to the transmitter's output.

Logic Pulser

The next letter is about a problem the writer has with the Logic Pulser described in May 1991. However, the writer also appears to be confused about comparators...

Could you please help me with a problem concerning the Dual-Mode Logic Pulser published in May 1991. I don't have a strong understanding of electronics, and I'm trying to determine if my pulser has a fault or if it's a design problem.

The circuit description says 'as U1 is configured as a non-inverting comparator, its output voltage at pin 7 is simply a buffered replica of the state at the pulser's tip.' This suggests to me that if pin 2 is high or low, then pin 7 will be high or low respectively, but if pin 2 is at a high impedance state (neither high or low), then pin 7 should be neither high or low.

The description then states 'R13 provides pull-up current to U1's open-collector output.' Is it this that causes my pulser to read high with no input to pin 2? If so, then if the pulser is applied to a pin with no signal on it the pulser will indicate a high state on that pin and only be able to supply a low pulse to that pin.

This could cause the operator to assume there is a high state at the pin, when this is not the case. If my argument is flawed, then I must have a fault in my pulser. I have replaced U1 without effect. (P.F., Warragul Vic).

The section you're describing is shown in Fig.2. Pin 2 of U1 is the input/output pin of the pulser and the LEDs are D4 and D5. If a voltage higher than that at pin 3 of UI is applied to the probe tip, the output of the comparator will be high, pulled in this direction by R13. An open-collector output (such as the LM311) requires a pull-up resistor, as there is otherwise no connection between the output terminal and the positive supply rail. Without this resistor, the output of the comparator will 'float' and behave as an open-circuit. If the output of the comparator is high, LED D5 will be turned on, indicating a high state at the probe input.

If the probe is connected to a logic 0, the reverse happens. This time, the internal transistor connected to the output terminal of the comparator pulls the output low in response to the input conditions. The two inverters buffer this logic level and LED D4 is turned on to indicate a low.

So what happens if the probe tip is open-circuit? In this circuit, if pin 2 of U1 is open-circuit, the voltage at this pin will be around 0V as there is nothing to pull it high (or at least there shouldn't be). The voltage at the inverting input of the comparator will be positive (about half the supply voltage) and the output of the comparator must therefore be low. The inverters buffer this logic level and LED D4 turns on to indicate a low.

This is the same condition that results when the probe is connected to a logic 0. In other words, the probe doesn't have an indication for the open-circuit condition; a point made in the article describing the project. Hopefully, this should clear up your misunderstanding about the operation of this section of the circuit. The point I'm making here is that a comparator only has two possible output conditions: a high or a low.

So what is wrong with your logic probe? Given that you've replaced U1, I suspect there's a problem in your construction that's causing a voltage to ap-

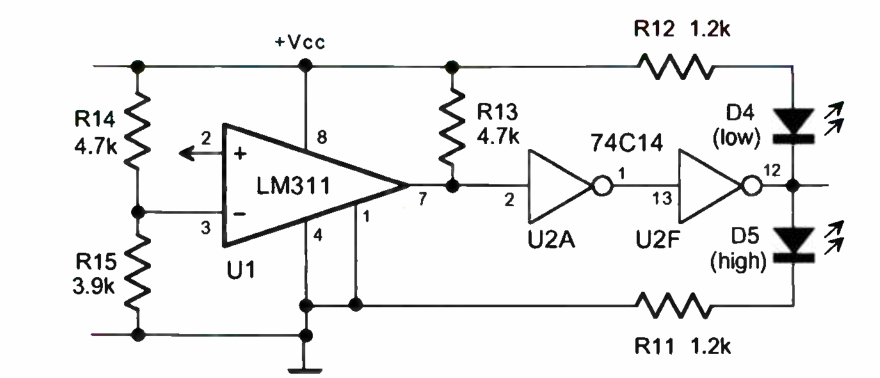


Fig.2

[illegible]

[illegible]

[illegible]

pear at the probe input when it's open-circuit.

The most likely cause is that you've swapped transistors Q1 and Q2. Notice that I'm suggesting the fault lies in your construction, rather than in the design. While design errors are not unknown, they are not as common as you might think. However, it would be quite easy to accidentally swap Q1 and Q2, as they have the same package and are mounted the same way. Incidentally, although not a design error, I have noticed during my research for this answer that the PCB layout and the circuit disagree about the numbering for the LEDs. The circuit is incorrectly labelled, and D4 is really D5 and vice versa.

If the transistors are correctly fitted (and of the correct type), then I suggest checking the rest of the circuit — not for a design problem, but a construction error. The clue to follow is that the probe tip (pin 2 of the U1) has a DC voltage, which in normal operation is incorrect. There are many other reasons that can explain this, including a fault with U3.

Charging dry cells

High on my list of 'things I'm going to do' is a dry cell recharger. This was initially prompted by a writer who sent me information he'd uncovered on this topic. While the information was rather brief, it included a few details on how a conventional carbon-zinc cell could be recharged. Our next correspondent seeks these details...

Apparently some overseas manufacturers produce alkaline cells designed to be recharged. I have also heard that it is possible to recharge locally made alkaline cells a number of times, by using a DC bias superimposed on a low frequency AC signal. Is this true? If so, can you or a reader supply a circuit diagram, or at least the parameters of the recharging waveform? (R.F., Rosny, Tas).

Recharging dry cells is not new, and over the years several design approaches have been published in electronics magazines. You're quite correct, R.F. in saying that a dry cell can be recharged with an AC waveform biased with a DC voltage. As a guide, the forward (charge) current should be about five times higher than the reverse (discharge) current. A frequency of 50Hz is suitable, and there are various ways of achieving this.

Incidentally, I understand that this type of waveform is sometimes used in electro plating. There is apparently an advantage in periodically reversing the current, providing the reverse current is less than the forward current.

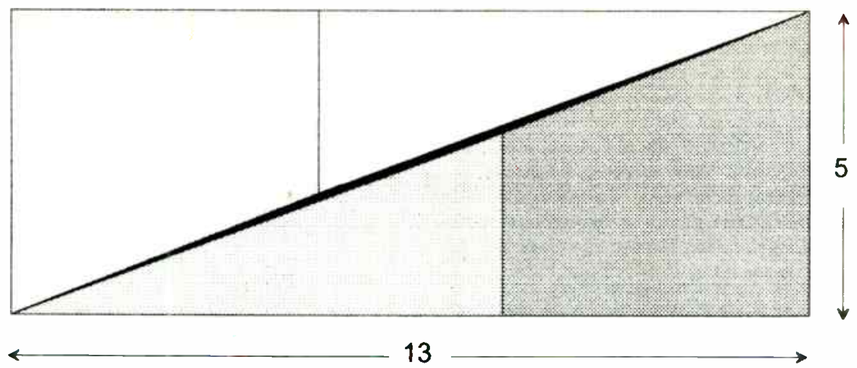


Fig.3:

I am loathe to include a circuit, as there is more to this than space allows me to describe. For example, the peak value of the charge current needs to be limited to prevent overheating (and possible explosion) of the cell being charged. There are other considerations such as how long the cell should be recharged for, the state of the cell and so on. However, it is my intention to develop a dry cell charger and I would rather wait until then to explain things more fully.

Still on the topic of battery charging, the next letter seeks information on the NiCad discharger presented in September 1989.

NiCad Discharger

I am surprised you forgot about video camera enthusiasts when you designed your NiCad discharger. These battery packs have voltages ranging up to 12V, and discharging these at occasional intervals to prolong their life seems a good idea. Would you advise me if your circuit can be modified to make it suitable for higher battery voltages. (J.G., Longreach Qld).

When I designed both the NiCad charger and the recharger units, I confined the designs to 6V battery packs, thinking most people had a similar need to mine: maintenance of single NiCad cells. However, quite a few readers have since pointed out that I should have included facilities for battery voltages up to 12V. So another 'thing I must do' is to redesign both these circuits. The charger circuit will need quite a lot of redesigning, but the discharger shouldn't be such a problem.

There are two considerations in modifying the discharger to cope with higher voltage battery packs: the reference voltage (which determines the battery voltage at which discharging ceases) and the value of the discharge current.

To change the reference voltage to a higher value, the 5.6V zener diode will need to be replaced with one having a higher voltage. This could be achieved by adding another zener in series with the existing zener diode. For a 12V battery pack, a total zener voltage of around 12V is needed. This should allow the existing circuit to give the required adjustment and provide the 11V reference voltage. For a 7.2V battery pack, the reference voltage should be around 6.6V, requiring a zener voltage of 7V or so.

To change the discharge current, the value of the emitter resistor (R) of Q4 has to be a value that gives the required discharge current. The equation to calculate its value is I = 0.6V/R. The discharge current should be about twice the charge current, so you'll need to know the rated charge current of the battery pack.

The only other consideration is to provide suitable heatsinking for Q4. The power dissipation of this transistor equals the battery voltage multiplied by the discharge current. For example, a discharge current of 300mA with a battery voltage of 12V gives nearly 4W of heat dissipation. A BD139 for Q4 will handle this, but a reasonable heatsink should be added.

NOTES & ERRATA

GAUSSBUSTER ELF DETECTOR (July 1992): Due to an error when this article was being prepared, two components were inadvertently left off the schematic diagram on page 105. The components are RV2, a 100k trimpot, and 10k resistor R11. These should be shown connected in series, with RV2 wired as a variable resistor, between pin 11 of 4046 (U2) to the negative rail. RV2 sets the frequency range of the VCO, as explained in the text. Both components are shown correctly on the PCB overlay diagram and in the photographs.

Dolby Decoder

Another query has surfaced about the Dolby Surround Decoder described in January 1992.

I would like some clarification about

the size of the filter capacitors shown as C23 and C24 in the circuit diagram on page 73 for the Dolby Surround Sound Decoder in the January 1992 issue.

The filter capacitor size in the article (top of page 79) is quoted as between 470uF to 1000uF. The circuit diagram specifies 4700uF and the parts list specifies all capacitors as 100uF/25V.

I do not have a great technical background and an explanation with some recommendations would be a great help. What would be a suitable specification for the bridge rectifier? (M.L.)

The power supply for this project is difficult to pin down, as its design will depend on whether a power amplifier is included with the decoder. In the prototype, an 'effects' power amplifier was included, and the values shown for the power supply capacitors in the circuit diagram are correct for this situation. This is because the power supply also powers the amplifier, directly from the main filter capacitors. In this case, a 5A bridge is suitable.

If a power amplifier is not included, the capacitor sizes are as described in the article,as being between 470uF to 1000uF, but in fact, as the parts list states, values as low as 100uF could be used. A 1A bridge will suffice if the power supply is only driving the decoder PCB.

What??

This month's question has been supplied by Gordon Wormald, of Florey in the ACT. He writes: Suppose you have a transistor tester with terminals marked E, B and C and a need to test transistors with unknown pinouts.

Rather than keep swapping the transistor leads, you decide to add some sort of switching between the tester and the transistor, so the three test terminals can be arranged into any of the six possible permutations.

For instance, one setting of the switches might give B, E and C, another setting gives E, C and B.

The question is, how do you connect three double-pole, double-throw (DPDT) switches to achieve this?

Answer to August's What??

The re-arrangement that shows how 64 equals 65 is shown in Fig.3. The mistake is probably not obvious, if you simply cut the pieces out and lay them next to each other.

But a computer drawing shows that there is one unit of area not accounted for. The diagonal line of the rectangle is actually a parallelogram, albeit a rather thin one that encloses the missing area. ❖

NEW KITS FOR EA PROJECTS

Dick Smith Electronics has advised us of the release of a new kit for the following *EA* project:

VHF/UHF SPECTRUM ANALYSER
(September/October 1992):

The Dick Smith kit is complete, with all components as described except that a captive mains cord with three-pin plug, entry grommet and attachment clamp are supplied instead of the captive IEC plug.

The kit also has a silk-screened front panel with all holes prepunched. Listed as catalog number K-7620, the kit is priced at $199.00.

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.

SHORTWAVE LISTENING

by Arthur Cushen, MBE

Radio Australia's future may be uncertain

The future of Australia's external broadcasting service could be uncertain, as the Government may have to fund the ABC's involvement in pay TV, and introduce budget cuts. Despite this, Radio Australia is apparently committed to helping set up a new radio broadcasting service in Cambodia, under UN auspices.

The Australian Government has announced that pay television is to be introduced, and there are pressures to allow involvement by the Australian Broadcasting Corporation. As a result there may well be budget cuts in other areas of ABC operation, including its overseas service via Radio Australia.

Hopefully Radio Australia will emerge from this 'melting pot' period unscathed, and continue to offer the service it has provided since December 1939 — covering the Asia-Pacific region with the Voice of Australia.

Radio Australia moved into its present modern studio complex in a Melbourne suburb in 1982. Having recently visited this very well organised building, I became aware that the staff of Radio Australia has an ideal home from which to broadcast. The building contains many studios, a library, and a cafeteria as well as transcription material, and a cosmopolitan staff who all work together to promote Australia through medium of shortwave broadcasting.

The organisation has undergone many changes over the years and now has its transmitters spread throughout the Commonwealth — in Shepparton, Carnarvon, Darwin and Brandon — with powers ranging from 10kW to 300kW.

English broadcasts are on the air 24 hours a day. The head of the English Section is Roger Broadbent, a New Zealander from Timaru, who will also be remembered by many shortwave listeners as a staff member of Radio Nederland some years ago.

There are many stalwarts still announcing at the station, like Barry Seeber, Dick Paterson and Keith Glover, who retired after broadcasting from the Edinburgh Games in 1986.

Radio Australia is well known to the internal audience within Australia, as its broadcasts are carried throughout the night on the ABC Network. A programme on media interests, 'Communicator', is heard on Tuesday at 0930, 1130, 1530, 1730 and 1930UTC.

Broadcasts from Melbourne are primarily to Asia, and the languages used include Cantonese, Chinese, French, Indonesian, Vietnamese and Thai. There is also a service to Papua New Guinea.

Frequency problems

In common with all international broadcasters, Radio Australia runs into frequency problems, so changes are made from time to time.

The station still observes the seasonal change pattern, unlike most international broadcasters who change at the start and end of Daylight Time in the Northern Hemisphere. Radio Australia has its changes on the first Sunday of March, May, September and November.

A recent frequency change was made when 21,775kHz suffered interference from Moscow, who would not vacate the channel. Radio Australia accordingly moved to 21,740kHz, operating 0000 - 0030 in French, and 0030 - 0200 in English, and 0200 - 0730 with Sports.

In common with all broadcasters, Radio Australia has monitors in various parts of the world who report regularly on reception of its transmissions.

AROUND THE WORLD

CANADA: Radio Canada International, Montreal is broadcasting a special transmission to Yugoslavia for the Canadian Forces, Monday to Friday, 1900 - 1930, and is using the BBC transmitter at Skelton on 5995 and 7235kHz. Transmissions from the RCI Sackville site is carried on 13,650, 15,325, 17,875 and 21,675kHz.

CHINA: Radio Beijing has altered some of its frequencies for English transmission, and the schedule for this area is: 0900 - 1100 on 11,755, 15,440 and 17,710kHz; 1200 - 1300 on two new frequencies, 15,440 and 15,450kHz; and 1300 - 1400 on 15,440kHz.

CONGO: Brazzaville is heard on 4765kHz at 2000 with a 10 minute news broadcast in French, with frequent identification during the news bulletin. At 2010, following a music break, there is an announcement in the local language, which continues to 2030. This station has a long history, as I first heard it broadcasting in 1941 when Free French Radio, established by General de Gaulle, was in operation.

NIGERIA: Lagos broadcasting on 7255kHz has been heard at 0500, and on Sunday has a 'Letterbox' session with world news at 0530. At 0600 there is a programme preview for the week, covering both morning and evening transmissions. I first heard Nigeria in 1949, when it began operating on 6035kHz with a power of 300 watts. Known then as the Posts & Telegraph station, it is now called Radio Nigeria.

PALAU: The Voice of Hope broadcasting from this Island in the Central Pacific is now using its full power of 100kW. Two frequencies are in use, and both have been received. The first is 11,980kHz, with English identification at 0100, after which time Radio Moscow opens on the channel. The second frequency, 9830kHz has been heard with English identification at 1130 and 1200, between programmes in Chinese. Its sign-off has been at 1530, or as late at 1600. The station requests reception reports to Voice of Hope, PO Box 66, Koror, Palau 97920, USA.

SAIPAN: KHBI operated by the Christian Science Monitor is broadcasting in English to this area 0800 - 1000 on 13,615 and 15,665kHz. A transmission, 1005 - 1155 on Sunday and 1105 - 1155 on Saturday, is on 13,625kHz. The other new frequency, 13,840kHz is used 1905 - 1955 daily.

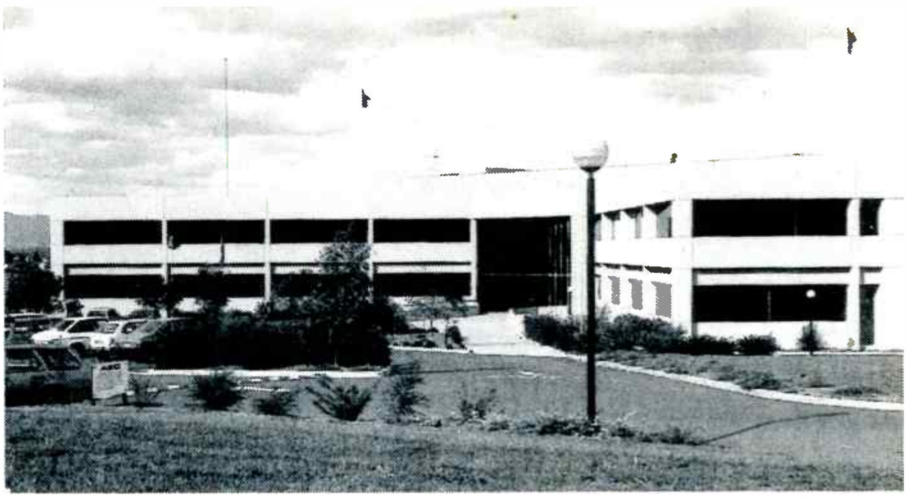
[illegible]

The monitors are located in Samoa, Fiji, Papua New Guinea, Indonesia, India, Mauritius, Japan, Thailand and West Malaysia. Radio Australia is in need of monitors in the Asian area between Malaysia and Japan, particularly in China, so that it can become acquainted on a regular basis with reception in that part of the world.

On the programme side, Radio Australia is moving into pre-recorded programming of two hour blocks, with a gap for the news — this was introduced during June. Instead of live broadcasting, the programmes are held in a digital store and retrieved as required.

Broadcasts from Melbourne are heard on many well established frequencies. The station tries to retain these channels, so that it does not lose its overseas audience who would otherwise have to tune around looking for a broadcast.

So frequencies such as 9580, 11,880, 15,160, 15,240, 15,320 and 17,795kHz have long been used in broadcasts from Australia.



The studios of Radio Australia, Melbourne from which broadcasts in seven languages, including English, originate.

Australia to assist Cambodia

Radio Australia, under United Nations auspices, is to play a part in the technical installation of a new radio service in Cambodia. So that the Cambodians can tune in to their new National Radio station, a Japanese charity plans to collect and donate 250,000 transistor radios, according to a report on 'DX Partyline'.

The station will broadcast nationwide in the Khmere language, and will inform the public of the UN authority's work as it guides Cambodia from the War through to an election next year. The present Cambodian radio stations have lost their listener interest because they continue to broadcast propaganda — the new stations will allow all areas of interest to have access.

The new unit will include studios, transmitters and satellite links. There will be enough transmitters to give coverage over all the country, so that everybody will have access to the media. Although the station will broadcast mainly in Khmere, it will have special French and English services for the 23,000 UN civilians and soldiers stationed in Cambodia who are part of the UN mission.

The Australian Broadcasting Corporation has submitted a proposal to set up the operation, and the ABC bid was around $5 million. The work in Cambodia is the United Nations' most ambitious peacekeeping and reconstruction operation, costing up to $3 billion.

Japan's second shortwave network

Shortwave broadcasting in Japan goes back to the mid 1930's when Radio Tokyo, operated by NHK (The Broadcasting Corporation of Japan), was heard on the shortwave bands. During the war, it figured prominently in propaganda broadcasts towards Australia and New Zealand.

Soon after the war, a second shortwave organisation was formed by Japanese businessmen, who felt that they could cover Japan by shortwave from a central broadcasting operation in Tokyo.

The operation is known as the Nippon Shortwave Broadcasting Company (NSB) to listeners worldwide, but within Japan it is referred to as Radio Tampa. The station, which began broadcasting on August 22nd 1954, employs 160 staff, uses six shortwave frequencies, and estimates that it has a daily audience of 20 million listeners.

Radio Tampa transmits a number of different types of programmes, including news, stock market reports, a variety of subjects from medicine through to science, sports, agriculture, religion, and of course, music.

The transmitters, near Tokyo, carry the station's first programme on 3925, 6055 and 9595kHz, using 50kW. Broadcasts are from 2020 through to 1630 (according to the World Radio & Television Handbook) while on Sunday, the transmission ends at 1530.

Another transmitter is located at Sapporo, using 10kW, and operates on 3925kHz. It carries the same programme, and uses basically the same schedule, except sign off is at 1700. The second programme is broadcast on 3945, 6115 and 9760kHz, from 2300 - 1300.

Programmes are usually in Japanese, but there is an occasional announcement in English. Listeners in the South Pacific should find reception best during our evenings on all frequencies. In particular, those in the 3MHz band are very reliable, and 3945kHz can be heard after Vanuatu leaves that frequency.

Higher Power for Indonesia

The Indonesian Government has recently announced a contract with Marconi of Chelmsford, England, for the installation of nine 250kW shortwave transmitters. The transmitters will be located in two areas, some at Jakarta and the others on Sulawesi. The programme service from the Indonesian capital will be linked to Sulawesi by satellite.

The plan is to cover the entire 13,000 islands of Indonesia (with a population of 175 million), through this new shortwave facility. It will not only be used for direct shortwave reception, but will also be available to the many Radio Republic Indonesian stations to carry the National programme from Jakarta. In most cases, the RRI stations carry the news from Jakarta each hour.

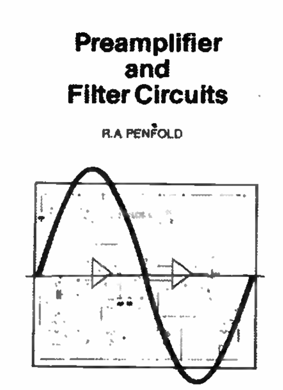
To ensure efficient output from the transmitters, there will be 20 curtain antennas to provide national coverage. The contract with Marconi also covers the installation of the equipment, commissioning, training and logistic support.

The new programme service will back up the present National Programme from Jakarta which is carried on the geostationary satellite 'Palapa' and will operate 24 hours a day. ❖

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.

Electronics Australia

BOOKSHOP



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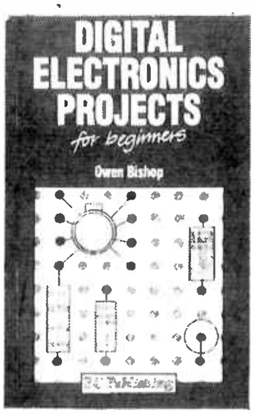
This book explains how to simply set up your own computer music studio. It covers the basics of computing, running applications programs, wiring up a MIDI system plus everything about hardware and the programs.
CODE: PC 1006 PRICE: $23.95

Practical MIDI Handbook
Refers to the powerful capabilities of MIDI ond how to exploit it, with no knowledge of electronics or computing. It reviews the lotest developments in MIDI covering keyboords, drum machines, sequences, mixers, guitors etc.
CODE: PC 1002 PRICE: $21.95



Digital Electronic Projects for beginners
This book provides simple, yet detailed instruction on practicol projects. Covering instrumentotion to home security plus circuit diogroms, this reference book olso offers 'fun' projects for newcomers to electronic construction.
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Synthesizers for Musicians
Written especially for musicians, this book exploins how to get the best from your synthesizer or sampler. If you want to go beyond using the factory presets or the rondom paking of buttons, then this is the book for you.
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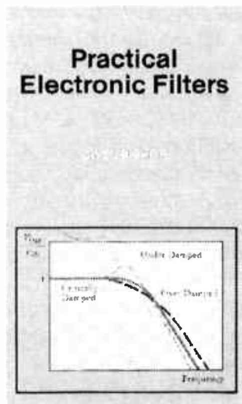

Practical Electronic Filters
Procticol Electronic Filters exploins in o simple form, the understonding of how to work o filter. It presents projects to opply in ond around the home, including diograms that ore suited to the beginner and o more odvanced constructor.
CODE: BP 2990 PRICE: $13.00

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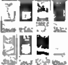
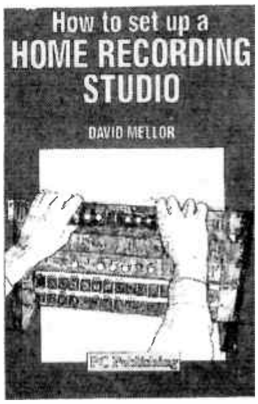
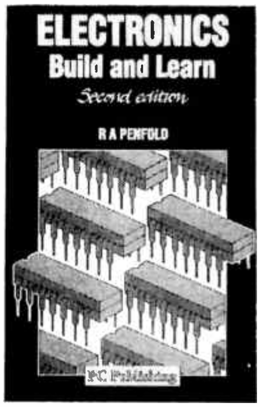
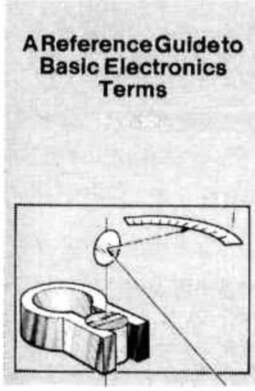




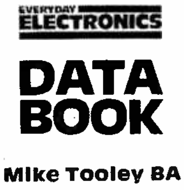
How to set up a home Recording Studio
If you have a studio at home or are about to set one up, this book is for you! It describes the setting up of an 8 to 16 track studio with an outline of the musical and recording gear needed.
CODE: PC 1009 PRICE: $21.95



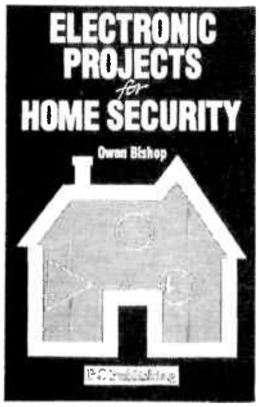
Electronics - Build and Learn
This book is the perfect balance of theory & practice. It introduces common electronic components and how they are built into useful circuits. An essential for the beginner, providing practical tests and experiments.
CODE: PC 1008 PRICE: $18.95



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.
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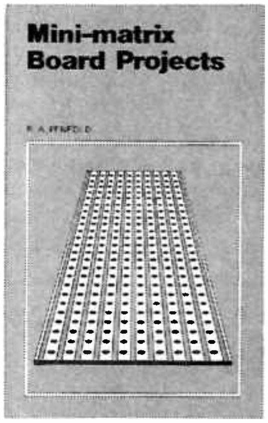
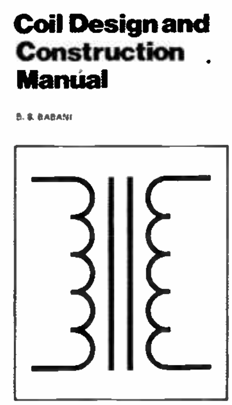
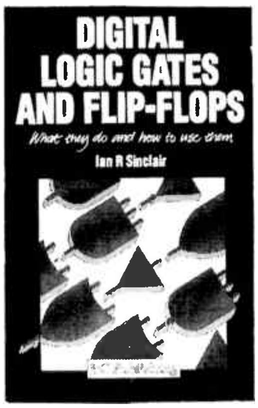
Electronic Power Supply Handbook
This book covers the topic of electronic power supplies, including batteries, simple AC supplies, switch-mode supplies and inverters. Subjects dealt in detail are devices, their operating principles and typical circuits.
CODE: PC 1001 PRICE: $23.95



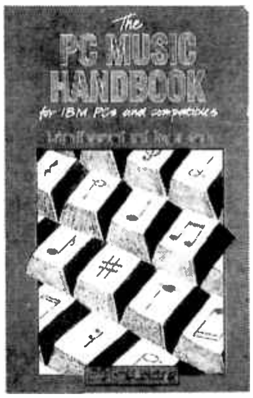
Mini Matrix Board Projects
This book provides you with 20 useful and interesting circuits, all of which can be used on a mini matrix board, which is just 24 holes by 10 copper strips.
CODE: BP 9900 PRICE: $6.50



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

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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.

September 1942

'Educated' torpedo: An 'educated' torpedo sank a medium-sized American merchant ship in the Mexican Gulf, survivors report. Lookouts spotted the torpedo several hundred yards on the starboard and running parallel to the ship's course, but mistook it for a large fish.

Suddenly the torpedo turned at right angles and struck the ship, causing a terrific explosion. Twenty-five people were killed and many injured. No submarine was sighted.

Robot pilot: It is said that when a Jap fighter pilot finds himself at a disadvantage in a dog-fight, he merely engages his robot pilot gear and the control of the plane is taken out of his hands.

For a minute and a half the craft hurtles crazily through the air in all directions, rolling and turning, diving and climbing. During these manoeuvres the pilot probably suffers a 'blackout' until the plane resumes level flight, allowing him sufficient time to recover.

September 1967

Ultra-thin microcircuit insulation: A new group of polymers, made at the General Electric Research Centre, New York, can be produced as films only a few millionths of an inch thick. One of the applications for the new polymers is as a superior electrical insulation for micro-electronic devices.

One of GE's new polymers is formed from hexachlorobutadiene — and is the first known example of a completely chlorinated polymer. Pinhole-free films of this polymer have been deposited successfully upon silicon, aluminium, stainless steel, tin, lead, gold, niobium and many other surfaces. Although these films are only a millionth of an inch thick, they are electrically and mechanically continuous.

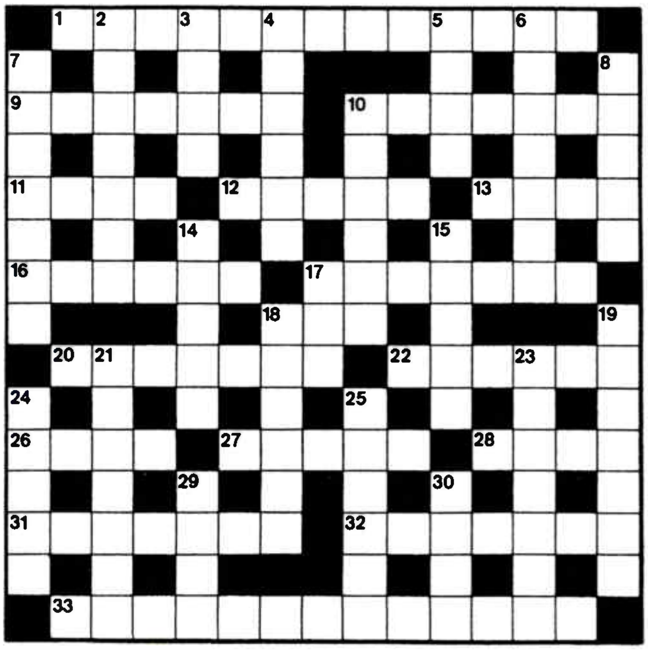
Light problem in space: Studies by Lockheed scientists have shown why dazzling sunlight in outer space causes discomfort to astronauts. The contrast between bright light and the deep black shadows caused by the astronauts is the major cause of the problem; it is not simply the bright light alone.

On earth light is dispersed by the atmosphere, reflected and scattered by every object in our environment. Almost never do we see great contrasts in light intensities, and we are accustomed to our familiar visual cues for working in an abundance of light.

In space most of man's visual habits don't apply to the new conditions of absolutely black shadow contrasted by brilliant light, most of which is coming from a single source.

Decimal currency in ads: Advertisers are advised that from the October issue of *Electronics Australia* all prices mentioned must be in decimal currency only. Copy supplied in £.s.d. will be automatically corrected to the nearest equivalent in decimal currency. ❖

EA CROSSWORD



ACROSS

1. Cutter in the kitchen. (8, 5)
9. Unauthorised intruders into systems. (7)
10. Join conductors. (7)
11. Major manufacturer of electrronic appliances. (4)
12. Condition with respect to phase of matter. (5)
13. Such currents can produce damping. (4)
16. Peaks of waveforms. (6)
17. Pick-up. (4,3)
18. Numerical identifier. (3)
20. Buy-back arrangement for consumer. (5-2)
22. Free from fluctuations. (6)
26. Musical compass! (4)
27. Based on Sun's energy. (5)
28. Elevate status of computer. (4)
31. Study of forces in equilibrium. (7)
32. The --- field theory links e/magnetic and gravitational effects. 7)
33. A coil with a metallic core. (13)

DOWN

2. Electrician's permit. (7)
3. Key symbol. (4)
4. Again puts into position or ready mode, etc. (6)
5. Commonly available battery voltage. (4)
6. Non-batting player with potential? (7)
7. Major branch of science. (7)
8. Two-carbon radical. (5)
10. Natural fibre and insulation material. (6)
14. Prepare for examination. (5)
15. SI prefix indicating 10^{-15}. (5)
17. Metal in solder. (3)
18. Introductory TV shows. (6)
19. Thermionic valve with five electrodes. (7)
21. Type of file. (3-4)
24. VCR control. (5)
25. Empty space. (6)
29. Recording medium, the laser disc ----. (4)
30. Sonar sound. (4)

SOLUTION FOR AUGUST

[illegible]

EA with ETI marketplace

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WEATHER FAX PROGRAMS: For IBM XT/AT's *** "RADFAX2" $35, is a high resolution, shortwave weather fax, morse & RTTY receiving program. Suitable for CGA, EGA, VGA & Hercules cards (state which). Needs SSBhf radio & RADFAX decoder. *** "SATFAX" $45, is a NOAA, Meteor & GMS weather satellite picture receiving program. Needs EGA or VGA, & "WEATHER FAX" PC card. *** "MAXISAT" $75 is similar to SATFAX but needs 2mb of expanded memory (EMS 3.6 or 4.0) & 1024 x 768 SVGA card. All programs are on 5.25" or 3.5" disks (state which) + documentation, add $3 postage. ONLY from M. Delahunty, 42 Villiers St, New Farm 4005, Qld.
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PS2 SCSI CONTROLLER: Procom MCE-16 with diskette. never been used. $550 ono (09) 294 2192

MS-DOS PC PRINTER PORT: Driven Z80 development system includes Fast Z80 Cross Assembler, Z8TBasic, & lots of source code. Once only initial outlay for the short form kit $76. Additional CPU blank boards $35. For more info. Send a 45¢ stamp to Don McKenzie 29 Ellesmere Cres. Tullamarine 3043.

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Amateur Radio News

IPS one-day training course

A recent weekly broadcast by the WIA's NSW Division advised that IPS Radio and Space Services will be presenting a one-day User Training Course in Sydney on Wednesday September 16, at 9am. The course is designed to explain the way IPS predictions and warnings are prepared and best used, describe HF propagation report formats and give an understanding of the way the Sun can produce short-term disturbances to radio propagation.

Following the course proper there will be a demonstration of ACAPS, the IPS Advanced Stand-Alone Prediction System, which runs on IBM PCs and clones.

The course is designed to be of particular interest and value to HF communicators, but can be tailored to the particular interests of those attending. Each person attending the course will also receive a copy of the IPS User Training Manual.

Further details of the course are available by phoning IPS Radio and Space Services on (02) 414 8000, or faxing them on (02) 414 8331.

Boona Mountain gets digipeater

Norm McMillan VK2XCI, of Mount Hope, who also describes himself as 'the Voice of the Edge of the Outback', sends news that the Albert Amateur Radio Group (AARG) has at last got its VK2RRT ('Radio Rabbit Trap') digipeater up and running, at Boona Mountain in Central NSW (about 100km North of Condobolin).

Norm says that getting the digipeater going was really a major achievement, as AARG has only eight members spread over an area of 2000 square kilometres — and most members had a negative income in the last year. Getting more than one member together at any one time is anything but easy, but finally it all came together!

ROSE access is through VK2RAO-3, 636500. At the time of writing there are apparently still a couple of small problems with receiver desensing, but AARG is confident they would be sorted out in short order.

Norm credits Peter VK2BXQ for doing the important groundwork and also for assembling and debugging the system, and Trevor VK2XAQ for getting the radio on air and on channel. The group of five hardy souls who braved Boona Mountain to install everything were Noel VK2EMA, Kerry VK2GQR, Robert VK2ERB, Peter VK2BXQ and Norm VK2XCI himself — who also claims to have 'started the whole show', with his 'townie ideas'.

Norm says that another even smaller club further North is trying to get a voice repeater going. Anyone who can help is asked to contact Ed VK4KAA @VK4ABP, or by phoning Ed on (076) 58 3062 (h) or (076) 58 1783 (w).

Do you QSL?

The WIA's Federal Awards Manager has apparently received many complaints from overseas about the low rate of QSL'ing by Australian amateurs. (A letter from an English SWL on this subject was published in the April 1992 issue of *Amateur Radio* magazine).

Historically, it was traditional that all first contacts were confirmed by the exchange of QSL cards, but this custom seems to be declining. This should not be due to the costs of postage when the QSL bureaux are functioning, but it may be because of the current high costs of getting cards printed.

The WIA has advised its members that for confirmation for award purposes, a received card can be endorsed 'Confirmed', signed and returned through the Bureau for practically no cost. Amateurs who do not intend to QSL should really advise their contacts of this at the time as a matter of courtesy, rather than simply not replying to cards received.

WIA index extended

The WIA's '20 year' index is now a 24-year index. It includes all articles published in *Amateur Radio* magazine since 1968, listed in over 25 categories. Members who wish to trace articles without having to go through annual indices for several years may obtain copies of the index either on IBM format computer disk (in ASCII or .DBF formats), or as a hard copy printout. Disks cost $10.00 each and the printout $5.00, including postage. ❖

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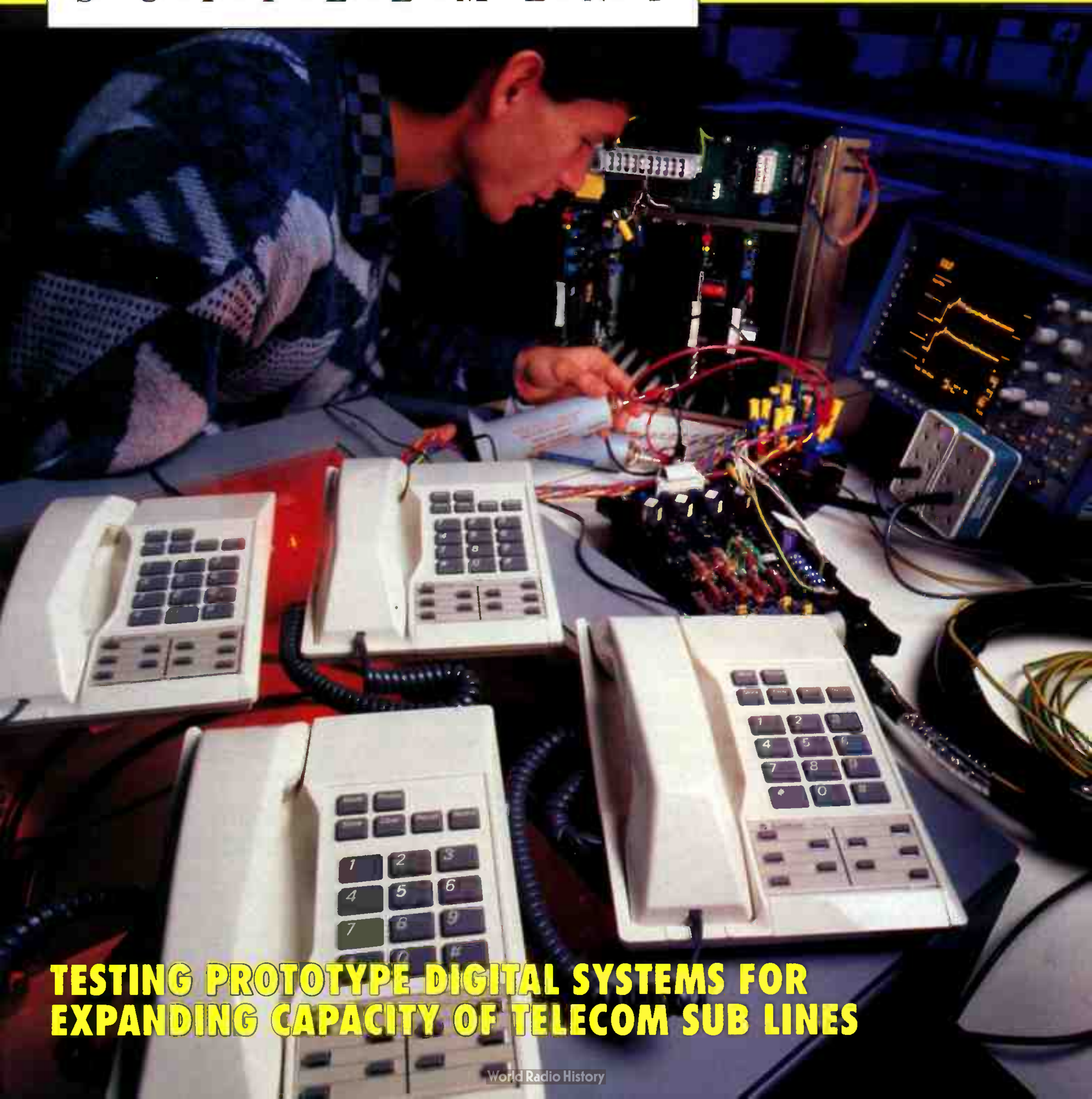

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Professional Electronics

NEWS HIGHLIGHTS

AMERICAN CTIA ENDORSES CDMA

The US Cellular Telecommunications Industry Association (CTIA) has effectively endorsed QualComm's Code Division Multiple Access (CDMA) digital cellular phone system, with a decision by its Board of Directors requesting 'expeditious development of a CDMA digital cellular standard for North America'.

The decision is a direct result of the final report submitted to the Board, encompassing the findings of extensive studies made by the CTIA's CDMA subcommittee and its Wideband Spread Spectrum (WBSS) subcommittee, over the last two and a half years.

CDMA uses wideband spread-spectrum technology, and promises cellular system capacity increases of between 10 and 20 times that of analog systems.

QualComm's CEO and chairman Dr Irwin Jacobs commented that "This decision is important in that it provides a further impetus to complete a second digital cellular standard. Service providers can then select the best technology for the market."

Dr Jacobs also noted that the decision opens up the possibility for the introduction of a wide range of new personal communications services, in the cellular frequency band.

San Diego-based Qualcomm has recently been awarded a US patent (No.5101501) for its method of providing a 'soft' hand-off in the CDMA system. This feature significantly enhances communications quality for users, and reduces the chance of a dropped call, when moving between cells.

Bell Atlantic Mobile Systems, one of the largest US cellular mobile carriers, has begun conducting field trials of CDMA technology in its Washington DC cellular system. Successful demonstrations of the technology have also been carried out in New York, San Diego and the Federal Republic of Germany.

John Dougall, AWA managing director (left) and David Soo, Chrontel president (centre), celebrating delivery of the 5-millionth silicon chip at the presentation organised by the Australian Consul-General, David Charles (right) at the Australian Consulate-General in San Francisco.

5M AUST CHIPS FOR SILICON VALLEY

AWA MicroElectronics delivered its five millionth silicon chip to high technology firm Chrontel Inc, in a recent presentation at the Australian Consulate-General in San Francisco.

Chrontel specialises in supplying frequency synthesis chips that simplify the manufacture of high resolution graphic displays for personal computers (PC). The AWA chips are used by PC manufacturers to drive display electronics in the Super VGA Display.

AWA MicroElectronics won Chrontel's contract over a year ago because of its ability to produce product prototypes for various customers 50% faster than their Japanese competitors.

ALCATEL HANDS OVER GSM NETWORK TO AOTC

In a landmark ceremony in Sydney, Alcatel Australia has handed over to the Australian and Overseas Telecommunications Corporation (AOTC) its trial digital cellular mobile telephone network, based on the new and now widely accepted European GSM standard.

The handover of the new GSM network comes a little more than five years after AOTC's commissioning of Australia's first, and only, analog mobile phone system, MobileNet — and with over 400,000 MobileNet subscribers under its belt, AOTC has made Australia one of the fastest growing cellular markets worldwide.

The move by AOTC into the new generation GSM digital cellular technology is a logical step from its base of what is generally regarded as one of the best analog mobile systems in the world.

The new GSM trial network comprises eight Base Stations, a Mobile Switching Centre and other associated equipment. Already subjected to extensive testing and trials by Alcatel, AOTC will now put this equipment through its paces, running banks of acceptance testing and fine tuning of the system in preparation for a planned commercial introduction of the new network in April 1993.

AUST HOSTING VLSI CONFERENCE

In December, Sydney is to host the Asia-Pacific Conference on Circuits and Systems (APCCAS), whose theme is to be VLSI Architecture, Design, Theory and Applications. The Conference is being organised jointly between Australia

NEWS HIGHLIGHTS

and Japan, with Professor Graham Hellestrand of UNSW as the General Chair and Professor Isao Shirakawa of Osaka University as Technical Chair.

Technical papers have been selected from the USA, Europe, Japan, Australia, Taiwan, Korea, Singapore and China. The presentations will explore HDTV, VLSI theory, application architectures, pattern processing, integrated information networks and design engineering methodology.

Six world renowned researchers and technologists have accepted invitations to be keynote speakers. These are Professor Richard Newton, recently head of EE at UC Berkeley; Professor John Mavor, from the University of Edinburgh; Dr Louis Monier, from DEC's Western Research Lab in California; Professor Ernest Kuh, from UC Berkeley; Dr Masatoshi Shima, designer of Intel's first microprocessor the 4004; and Dr Lance Wu, DSP and HDTV specialist, currently deputy director of the Information and Telecommunications Research Institute in Taiwan.

Further information on the Conference is available from Cherie Morris at the IREE, on (02) 327 4822.

SANYO DEVELOPS PORTABLE FUEL CELL

Sanyo claims to have developed the world's first high performance portable power supply using phosphoric acid fuel cells, in Japan.

Fuel cells represent an environmentally friendly, clean, and in this case, portable power source which generates energy through electrochemical reaction between hydrogen and oxides.

The hydrogen in the new phosphoric acid fuel cell is supplied from hydrogen absorption alloys, producing only harmless water vapour while operating.

A Sanyo spokesman said applications for the portable power supply include lighting sources for outdoor video filming and for recreational use.

Mr Max Sato, managing director of Sanyo Australia, said the unit's output is 250 watts and weighs 28kg.

He said, "Other companies are focusing on large scale fuel cells (over 50 kilowatts). However, Sanyo is concentrating its research and development on portable, small-sized fuel cells."

Fifteen Japanese and four overseas patents are currently pending.

HUBBLE CHECKING HUBBLE'S CONSTANT

Using NASA's Hubble Space Telescope (HST), an international team of astronomers has taken a major first step in redetermining the expansion rate of the universe. This rate, known as the Hubble Constant, is one of two critical numbers needed for making a precise determination of the size and age of the universe.

These results were reported by Drs F. Duccio Macchetto, Nino Panagia and Abhijit Saha of the Space Telescope Science Institute, Baltimore Md; Allan Sandage of the Carnegie Institute of Washington; and Gustav Tanmann of the University of Basel, Switzerland; at the international workshop 'Science with the Hubble Space Telescope,' held in Sardinia, Italy, in July.

Using HST's Wide Field and Planetary Camera (WF/PC) in the wide field mode, the team found 27 Cepheid variable stars in a faint spiral galaxy. The galaxy, called IC 4182, is located 16-million light years away in the northern sky constellation Canes Venatici.

The Hubble Constant is an estimate of the rate at which the universe is expanding and is expressed in kilometres per second per megaparsec (3.26 million light years).

The Hubble Constant is one of two critical numbers needed to determine the intrinsic curvature of space and the rate of the expansion.

Using the absolute calibration of this single type of supernova in IC 4182, the researchers yield a range for the Hubble Constant of between 30 and 60km/sec/mpc. The most probable value is in the middle of this range, yielding a value for the Hubble Constant of 45km/sec/Mpc, which implies a minimum age for the universe of 15 billion years.

The astronomers plan to narrow this range for the Hubble Constant by detecting Cepheid variable stars in other galaxies that have had recent type Ia supernovae as well. These observations will be made next year with HST.

MFB USING AUST ALARM INTERFACE

A computerised Alarm Interface Unit developed and manufactured by Australian communications company Datacraft is said to be playing an integral part in substantially reducing response and despatch times for Melbourne's Metro-politan Fire Brigade (MFB).

The Alarm Interface Unit (AIU) is a small,sophisticated communiations product that is connected to the various sprinkler and fire protection alarms. It also interfaces to a computer system at the local fire station, via a dedicated telephone line.

The local fire station system is online to a large database computer system network at the MFB's Communication Centre, located in East Melbourne, Victoria. When sprinkler or fire detection alarms are activated at a client location, the AIU provides the necessary signalling and communication to the local fire station, which in turn, relays the appropriate message to the MFB's Communications Centre. At the Centre, all the necessary details and information on the location, premises, people, flammable or dangerous goods located within a complex, along with fire fighting equipment and facilities, is immediately displayed on a screen.

The Metropolitan Fire Brigade has already installed about 6500 Alarm Interface Units, at premises located within the metropolitan area and surrounding suburbs.

Interstate and overseas fire and protection service providers have already shown strong interest in Melbourne's MFB system, and the Alarm Interface Unit in particular.

NEW NATIONAL TRANSMISSION AGENCY

The responsibility for management of the Commonwealth's extensive transmission network has been assumed by a new organisation, the National Transmission Agency (NTA).

The Agency will provide and manage the facilities which broadcast Australian Broadcasting Corporation (ABC) and Special Broadcasting Service (SBS) television and radio programs.

Senator Bob Collins, Minister for Transport and Communications, said "The NTA was formed — to operate as a

separate cost-centre attached to the Department — to introduce competitive tendering for the design, construction and maintenance of the network's infrastructure, while still maintaining the network's high standards."

The major contractor for servicing the transmission facilities has been the Australian and Overseas Telecommunications Corporation (AOTC), formerly Telecom.

"AOTC and its staff have done an excellent job over the years in helping to build one of the world's largest broadcasting transmission networks," Senator Collins said. "But the Government is determined to ensure that development and maintenance of the transmission network is both cost-effective and efficient."

"The NTA will introduce competitive tendering for the services it requires to ensure they are provided at market rates", the Minister said.

SIEMENS SPONSORS SCIENCE SCHOOLS

Minister for Industry, Technology and Commerce Senator John Button recently launched the Siemens Science Schools at the Scienceworks Museum in the Melbourne suburb of Spotswood.

Siemens Science Schools will be held over three days each summer at various universities and tertiary institutions throughout Australia. The first of the Schools will be held at 20 universities and tertiary institutions in January 1993.

Siemens has committed itself to the sponsorship for the first three years, and hopes to support it for at least 10 years. This would amount to a total sponsorship of over $1 million.

Senator Button congratulated Siemens for its vision in supporting the Science Schools. "Initiatives such as this, which capture the imagination and stimulate an interest in science and technology, especially by those still in their formative years, are vital to promoting a positive future for Australia," he said.

The concept of the Science Schools was initiated by the Australian Scientific Industry Association (ASIA) and the Rotary Clubs of Australia, which have promoted and run them since January 1990. By January 1992, the program had 2000 students, participating at 16 venues.

The Managing Director of Siemens, Mr Klaus Lahr, said Siemens decided to sponsor the Science Schools firstly, to seize a community leadership role by changing the agenda in public affairs towards technology and manufacturing.

"Siemens will do well in Australia, only if Australia does well in science, engineering and manufacture for both local and export markets," he said. "Australia must do well in these high-technology fields, because, to put it bluntly, there is no other choice."

"It will be impossible to sustain even our present middle-ranking standard of living if we continue importing too much, and exporting unprocessed agricultural, mining and forestry products. We must add value by processing, which needs engineering know-how."

The new Neve Capricorn digital mixing console features a totally digital signal path and full dynamic automation, with instant recall of all parameters. The console has 48 multitrack mix buses and connects to digital multitracks via Madi.

PIRELLI MAKES FIRST 144-FIBRE CABLE

Pirelli Cables has successfully developed the first Australian-made 144-fibre optic communications cable.

As a result of this new development, the company recently won a major contract to supply the loose-tube fibre optic cable required for the inland spur to Sydney, which is being installed by AOTC as part of the cable network connecting Melbourne and Brisbane. Without the new 144-fibre cable it would have been necessary to install two cables instead of one.

The 144-fibre cable specified by AOTC's contractor was supplied within a minimal six weeks from data of order, thereby further reinforcing Pirelli's excellent reputation for fast turn-around in manufacture and delivery.

The newly developed fibre optic cable now makes the future-proofing of cable networks a reality. With a capacity of more than 8000 telephone lines per pair of fibres, the new cable is capable of carrying nearly 600,000 lines. It is also suitable for upgrading to four times its current capacity once the associated electronics, already developed to transmit at 2.4Gbps, becomes commercially available.

OPTUS BEGINS MOBILE SERVICES

Competition in the Australian telecommunications market became a reality on 15th June 1992, when Optus Communications launched its first fully competitive service since its acquisition of AUSSAT.

Optus' initial service is based upon the use of the existing analog cellular telephone service that is currently in operation through Australia.

Users can become an Optus customer by completing a simple application form obtainable from Optus outlets or Optus Authorised Dealers. There is no need to purchase a new phone, nor will there be any need for existing users to change their phone number.

NEWS BRIEFS

- Mr Tom Bianchi has been appointed as Field Application Engineer at the ***ZATEK*** Sydney office. He was previously Senior Design Engineer at AWA Defence and Aerospace.
- ***Alcatel Australia*** has achieved international ISO 9001 quality certification across all its operating divisions. The first divisions to be accredited were Transmission, Power Systems and the Alcatel 1190 Metropolitan Area Network. All other divisions have since received certification.
- ***Scientific Devices Australia*** has obtained NATA accreditation, improving its calibration facility which for many years has offered customers Traceable Calibration.
- ***Technical Imports Australia*** has moved to new premises at Suite 16, 10-12 Old Castle Hill Road, (PO Box 1120), Castle Hill 2154; phone (02) 894 6377.
- ***Electromark*** now offers its entire range of ILP toroidal transformers with a higher insulation standard, at no extra cost. Manufacture will now be in accordance with BS415 and IEC65, and be covered by AUSTEL CCL No. RA 87/139. This triple insulation (to IEC742) meets the primary to secondary insulation requirements of AS3108.
- Defence electronics manufacturer ***Stanilite*** has joined the elite group of Australian firms to win the highest quality assurance rating in the world, known as ISO 9001. This globally recognised standard has been adopted in Australia as AS3901.
- UPS maker ***Upsonic International Electronics*** has moved to Scoresby in Victoria. Its new mailing address is Private Box 6, Scoresby 3179; phone (03) 764 0074.
- The personal computer manufacturer ***Total Peripherals*** has expanded its operation to South Australia, with the opening of its new office at 30 King William Street, Kent Town 5067; phone (08) 362 6599.
- ***Digital Communications*** has also moved to a new address: Unit 2, 13-15 Townsville Street, Fyshwick 2609; phone (06) 239 2369.

Optus Chief Executive Officer, Bob Mansfield, said that the majority of mobile phone users would save up to 10% on current costs.

The mobile service will be followed by Christmas with Optus' dial '1' long distance services from Sydney, Melbourne and Canberra to anywhere in Australia or overseas. The dial '1' services will be introduced progressively throughout the rest of Australia during 1993.

MARINE STUDIES BY SATELLITE

The difficulties faced by maritime students continuing their studies while at sea are being addressed in a world-first pilot scheme conducted by the Australian Maritime College.

The distance education trial, which began on 1 August 1992 and continues until 31 January 1993, enables Diploma of Applied Science (Nautical Science) students aboard 10 selected vessels to submit their assignments to the College in Launceston, Tasmania, from anywhere in the Pacific and Indian oceans.

The students, aboard vessels of the Australian National Line, Broken Hill Pty Ltd, Associated Steamships Pty Ltd and Howard Smith Industries, are able to continue their studies using Inmarsat-C satellite-based mobile communications services provided by OTC Maritime.

Marketed by OTC as Satcom-C, Inmarsat-C is the world's least expensive and most compact global satellite communications system. OTC Satcom-C enables the two-way transmission of text or data messages between fixed telecommunications networks and mobile terminals anywhere in the world.

The Principal of the College, Mr Rod Short said that one of the major functions of the college was to provide maritime education and training to shipping industry deck officer trainees. The pilot scheme is exploring opportunities offered by new technology in distance education.

Melbourne firm Resource Industry Associates is using the Sony range of compact GPS satellite tracking equipment, like those shown above, to develop computer based tracking systems for a variety of applications. The firm can be contacted on (03) 482 4945.

ELENEX 92 EXHIBITION NEARS

ELENEX AUSTRALIA, the Fourth Australian Electrical and Electronic Industries Exhibition to be staged by Australian Exhibition Services (AES), will be held at the Royal Exhibition Building, Melbourne from 29 September until 2 October.

ELENEX AUSTRALIA alternates annually between Melbourne and Sydney and attracts exhibitors from Australia and the rest of the world. AES expects more than 10,000 industry buyers to attend this year, and more than 150 exhibitors to participate from Australia, New Zealand, Korea and the United Kingdom.

"The importance of the exhibition is reflected in the decision by the Surface Mount and Circuit Board Association to move its national conference to September/October, to coincide with ELENEX AUSTRALIA", said Exhibition Director Mr Noel Gray.

A highlight of ELENEX AUSTRALIA will be the Best New product Awards, presented to the winners at a cocktail party on Thursday 1 October. AES is expecting to see the release of a number of high quality Australian products, encouraged by the awards. The Best New Australian product awards are organised in conjunction with The Australian Electrical and Electronic Manufacturers' Association Limited (AEEMA). The Most Innovative New Product Award is supported by the Surface Mount and Circuit Board Association. ❖

Cellular radio technology update:

AOTC'S NEW CELLULAR MOBILE NETWORK - 1

Although Australia's current cellular mobile telephone system was only introduced in 1986, it is technically obsolete. This year AOTC is in fact carrying out trials of one of the 'next generation' cellular mobile technologies, the European GSM system. Here's the first of two articles explaining basic cellular radio concepts, and how GSM differs from the existing analog AMPS technology.

by ROBERT OWEN

The success world wide of cellular mobile telephone systems and the limited range of radio frequencies available has led to considerable congestion in cellular mobile phone networks. As a consequence, cellular mobile radio operators such as Australia's AOTC are continually looking for ways to improve the radio frequency spectrum efficiency of their networks.

During 1992, AOTC will trial a new technology in the Australian cellular mobile network, called the *Global System for Mobile Communications*, or GSM.

GSM is the European standard for the 'next generation' of cellular mobile telephone systems, and uses a digital radio link between the mobile phones (called *mobile stations*), and the cellular network's radio transmitters and receivers — called *base stations*.

This is different from the FM radio transmissions used in the current AOTC cellular system, called the Advanced Mobile Phone System, or AMPS for short. Developed in the USA, AMPS has been used in Australia by AOTC since 1986.

The use of a digital radio link to communicate with mobile stations will allow a three-fold increase in the number of telephone calls that can be handled by a given frequency bandwidth, compared to AOTC's current AMPS cellular system.

But GSM is more than just a digital radio link; it involves a complete upgrade of the entire cellular technology, and offers many other advantages to a subscriber apart from better frequency spectrum usage.

The traditional approach to radio and TV broadcasting involved setting up a single high power transmitter that covered a large geographic area, such as a city. If this technique were to be used in mobile radio, the small number of available radio channels could be used by only a small number of subscribers, spread over a large area.

Although this technique is simple to implement and gives good radio cover, the small number of channels available makes this technique unsuitable for a mobile phone service with a large number of subscribers.

Both the AMPS and the GSM cellular radio systems approach the radio coverage aspect very differently. Instead of using a single high power transmitter to blanket, say, a city, the city is divided into several smaller areas called *cells*. Each cell may have a radius of perhaps only 10 or 20km, and each cell will also have its own base station. In diagrams, cells are usually drawn as hexagons; see Fig.1.

One of the big advantages of cellular radio, though is that by making cells small, and by simultaneously reducing the power of the radio transmitters, we can re-use the available radio frequency channels over and over again, in different cells. Thus, the total number of channels that are available is under the control of the systems engineer.

Experience has shown that for the cellular technique to work, the same frequencies cannot be used in adjacent cells because of interference. In practice there is usually a two-cell gap before the same frequencies are reused.

Suppose we use cells that have a radius of 10km. If we use a separation factor of two cells before we re-use the same frequencies, then the same frequencies can be reused every forty kms.

If now we decrease the cell radius to 5km by reducing the power of the transmitters and by increasing the number of cells, the same frequencies can be reused every 20km instead of every 40km. Hence, decreasing the cell radius by 50% has allowed us to increase the total

number of available channels per square kilometre by a factor of four.

A cell radius of 1km would increase the total number of available channels per square kilometre by a factor of 100.

This increase in the number of available channels comes about with no increase in the available radio spectrum. When cellular radio systems engineers first thought of cell splitting, they realised that they had discovered a 'gold mine'.

From the graph showing Speech Quality vs. Distance from Base Station (Fig.2), it can be seen that for an analog AMPS system the quality of the received speech begins to decline fairly quickly with increasing distance from the base station.

With the digital GSM signal, however, speech quality remains constant for some distance from the base station before declining sharply. Because of this it is possible to have fairly sharp boundaries between GSM cells, and network planners are thus able to pack base stations and mobile stations much more closely without causing interfering with each other.

It is this ability of digital cellular radio to be able to re-use frequencies at much closer distances that allows GSM to have a three-fold capacity increase over AMPS, in the number of simultaneous calls that can be handled by a given frequency bandwidth.

One of the big advantages of the cellular system is that when the initial cell layout is being planned — when there are not many subscribers using the network — cell size can be quite large; say

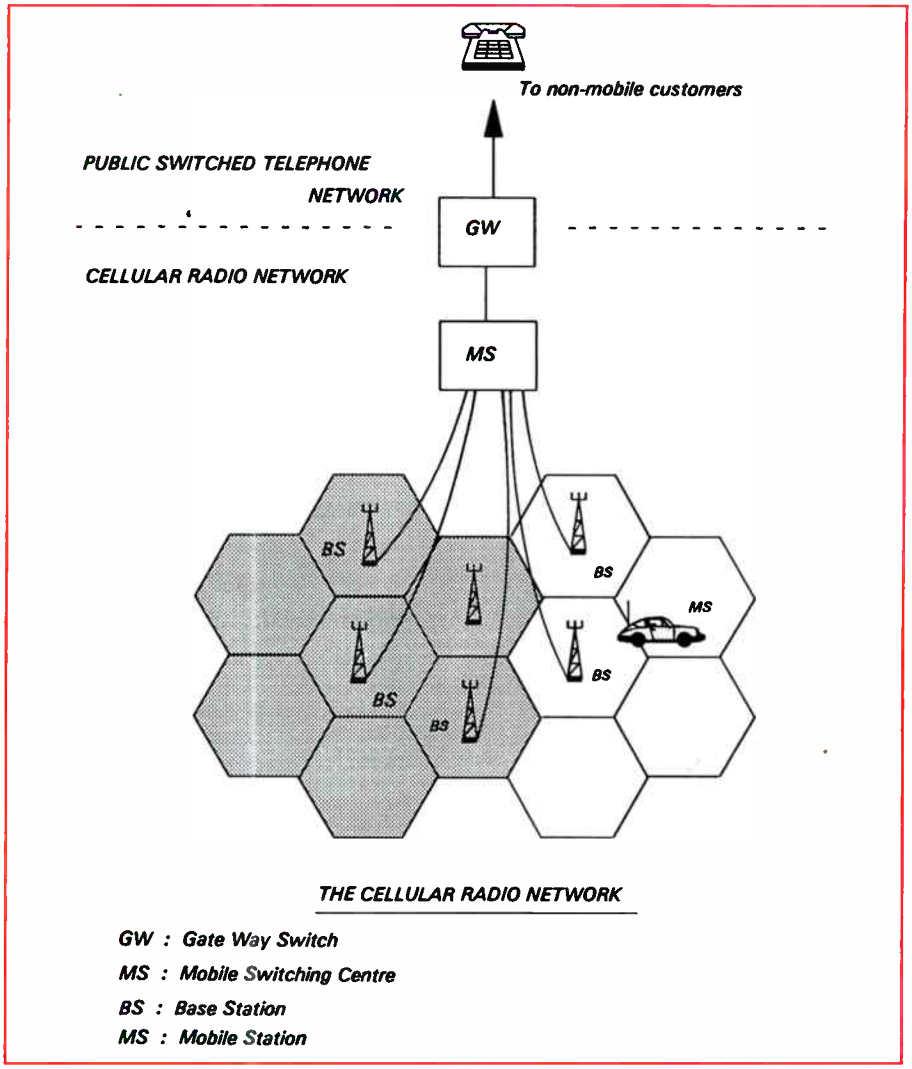
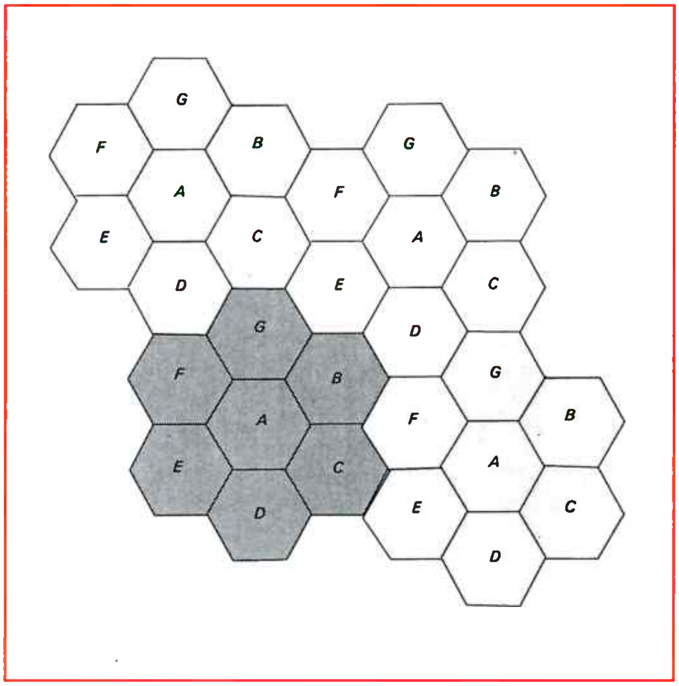


Fig.3: As a mobile subscriber can move from cell to cell during a call, provision must be made for 'handing off' the call from one base station to another. The mobile switching centre (MS) is used to manage this operation.



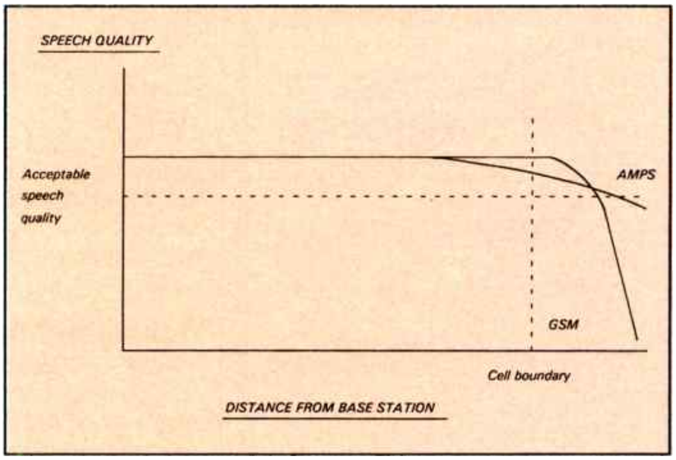


Fig.1 (left): With Cellular Radio, an area is covered by groups of, say, seven cells. All the B cells would use the same frequencies and so on. A frequency used in B would not be used in cells A or C to G.

Fig.2: (above): With the analog AMPS system, the quality of the received speech begins to deteriorate fairly quickly with increasing distance from the base station. In contrast, the digital GSM system remains constant much longer.

AOTC's new Cellular Mobile Network - 1

Each GSM subscriber will be given a smart card containing subscriber information which can be inserted into any GSM mobile station. Here the smart card is inserted into the back of the Mobile Station's handset.

35km in radius. Later, as the cellular network becomes congested (when more customers subscribe to the service), network planners can increase the capacity of the network by splitting large cells into smaller cells.

Also, it is usual for there to be more system congestion in city centres than in suburban areas. In this case small cells, say 5km in radius, can be used in a central business district, while 20km radius cells can be used in suburban areas and 35km radius cells can be used in rural areas.

Cells need not be circular in shape. In dense metropolitan areas, antennas can be placed on buildings below roof-top level, to create cell shapes that are a single street wide and a few hundred metres long.

Subscriber handoff

With small cell size comes a problem. A mobile subscriber in a car travelling at highway speeds may pass through several cells during a single call. To cope with this, the idea of *handoff* was developed.

This involves the mobile subscriber being 'passed' from one cell to the next, as they travel along the road.

As the vehicle moves into a new cell, the cellular network must not only identify which cell he is moving into and connect the mobile subscriber to a spare radio circuit in the new cell, but also ensure that the circuit used in the previous cell becomes available for other users.

To co-ordinate this, groups of base stations are connected to a Mobile Switching Centre (MS), which must transfer the mobile station from one base station to another (Fig.3). Thus, handoff requires some fast work on the part of the mobile switching centre and base stations, if it is to be carried out efficiently with the minimum of disturbance to the subscribers call.

The Mobile Switching Centre can be thought of as 'managing' the cellular call. It is responsible for routing of calls from the originator to their destination, for co-ordinating base stations and for connecting a cellular call to the Public Switched Telephone Network (PSTN).

Within a cellular network there would be many mobile switching centres — say in Melbourne, Sydney, Perth and so on, with the switching centre connected to each other. The mobile switching centres would also be connected to the PSTN, to allow mobile subscribers to make phone calls to non-mobile telephones.

In the second of these articles, we will look at the GSM digital cellular system in greater detail.

(To be continued). ❖

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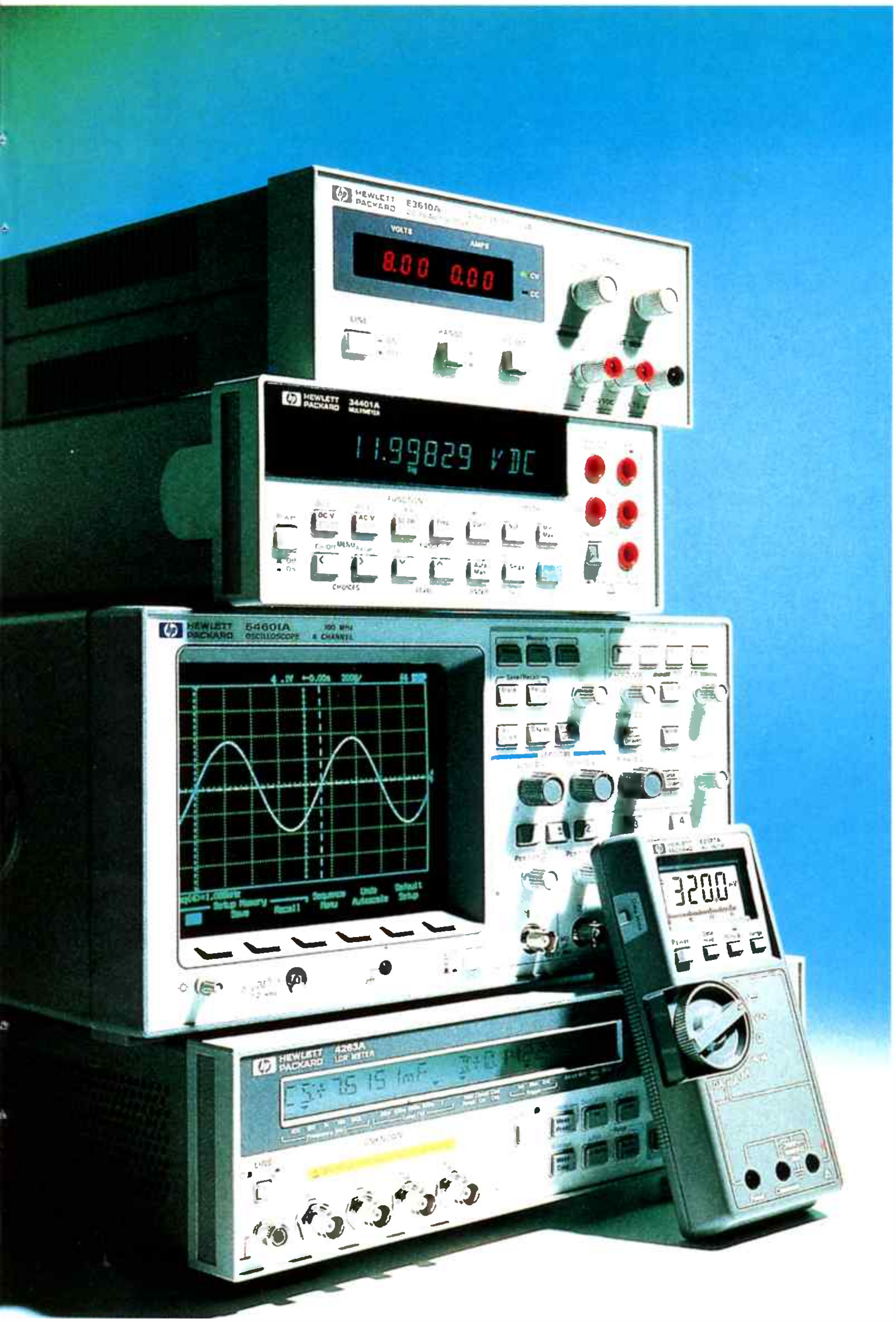

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Modern RF Signal Generators & their use - 1

Here is the first of a short series of articles on the design, operation and use of modern RF signal generators, adapted from a seminar given by engineers at Marconi Instruments in the UK. In this first article the evolution of the modern wide range, digitally controlled and frequency synthesised generator is described.

In order to achieve the best design for a communications system, the areas over which we have some control must be optimised to increase the error free detection of the transmitted signal. This requires independent testing of both the receiver and the transmitter. Ideally, for receiver testing, we should use an instrument which directly simulates the transmitter, allowing the designer to vary a range of parameters to observe the effect on the design.

A signal generator is the test instrument which most closely matches the designer's requirements, and in its most basic form consists of an RF oscillator which is capable of being modulated and which is connected to an output socket via a calibrated attenuator unit, as illustrated in Fig.1.

Although all signal generators conform to this general arrangement, there are many detail differences between instrument designs which affect both the performance and the cost.

Generator types

There are two broad categories of signal generator — the traditional analog unit and the more modern digitally controlled device — although hybrid designs combining features of both types are also available. The traditional analog design is characterised by its dependence on mechanically tuned oscillators, and is easily identified by the proliferation of rotary controls. In digitally controlled designs, the operator control will usually be via a numeric keypad and digital displays are used to indicate the values of the settings.

The earliest forms of signal generator offered only a limited frequency coverage, with the output signal being derived from a single RF oscillator. Later designs extended the frequency range by providing switchable tuned circuits or switchable oscillators.

The simplified schematic diagram in Fig.2 shows how amplitude modulation is obtained, by applying the modulation drive signal to a point which also controls the RF level. No attempt is made in this simple design to control the

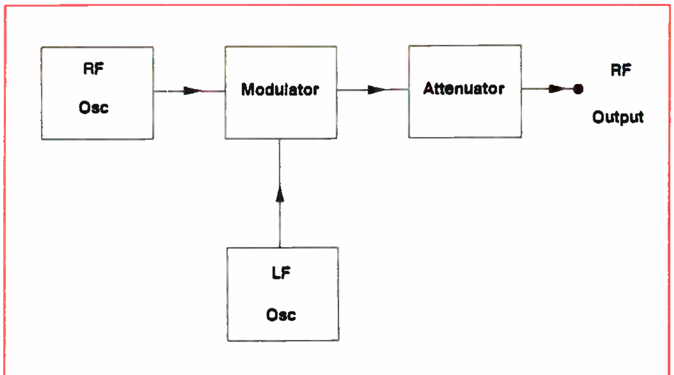

Fig.1

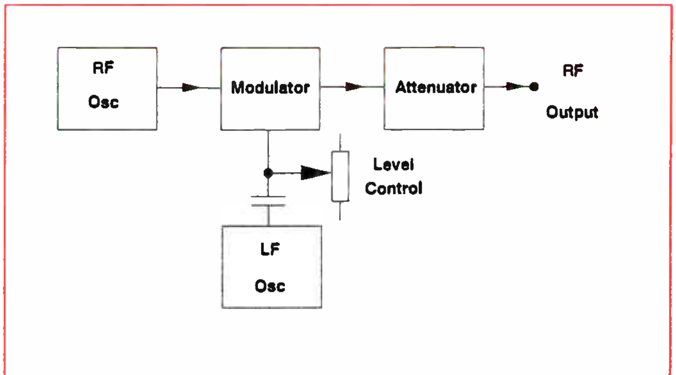

Fig.2

output level automatically and the operator has to readjust the RF level control each time the frequency is changed — and also to compensate for any variations due to time or temperature related drift effects.

The main advantage of this form of implementation is that the output signal is free of unwanted spurious frequencies, as the active circuits are only working at a single frequency.

However, the large number of stages required to provide the frequency coverage required for modern applications means that the fundamental oscillator design is now rarely used for general purpose instruments.

One way of avoiding the bandswitching problems associated with the fundamental oscillator design is to mix the outputs of two high frequency oscillators and to extract the difference signal (see Fig.3). After filtering and amplification, this difference signal can then be used to provide an output which covers many octaves in a single tuneable range.

But mixing of signals is not without its problems, and the heterodyne design is not generally favoured in analog signal generators. High rates of drift and poor noise performance are its main disadvantages, and although these can be partially reduced by careful oscillator design, they can only really be solved by employing some form of frequency control loop. Spurious signal created by the higher order mixing products ($2f_1$+/-f_2, $2f_2$+/-f_1, etc.) are also generated, and may find their way into the output if they lie within the passband of the filter.

With care the wide range capabilities of the heterodyne design can be harnessed within a general coverage instrument, and most modern signal generators include at least one heterodyne (or beat frequency oscillator) stage to reduce the overall cost and complexity of the equipment.

It is usually easier to design oscillators to give good performance at low frequencies. By adding frequency multiplier stages (Fig.4), the qualities of such an oscillator can be extended to higher frequencies. Naturally any noise produced by the basic oscillator is also multiplied, but sometimes it is possible to achieve a level of performance which could not be obtained by a more direct method.

Modern signal generators often use one or two multiplier stages, and these usually take the form of doublers. A fundamental oscillator provides the drive signal needed by the doubler and filters reduce the levels of unwanted harmonically related signals.

With the advent of high speed digital divider circuits, it became possible to effectively use the multiplier principle in reverse. In the divided oscillator design (Fig.5), the output of the RF oscillator is fed to a series of divide by two stages, which in turn are followed by filters. These filters reduce unwanted harmonic signal levels and provide a sinusoidal waveform for processing by the remaining RF stages.

This technique is widely used in modern instruments and provides good performance at a modest cost, particularly where the basic RF oscillator is a synthesised unit.

Modulation is added either directly to the RF oscillator (to provide FM), or as part of the RF levelling system (to produce AM).

The only obvious disadvantages of the divider system are that a high number of stages are required to cover the desired frequency range and that the amount of FM deviation that is obtained at low output frequencies is very small. To overcome these problems, a combination of RF signal processing techniques is usually used.

Traditional signal sources relied heavily on mechanical precision to provide smooth and accurate tuning, but such designs are totally unable to provide the levels of accuracy and stability required for testing more receivers. Synthesised oscillators offer an all-electronic solution to the oscillator problem and completely eliminate the need for moving parts. Whilst *direct syn-*

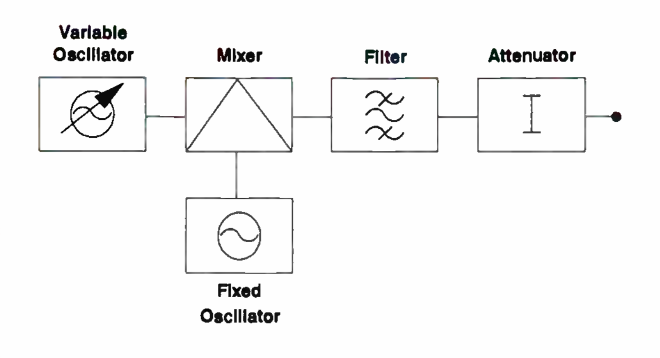

Fig.3

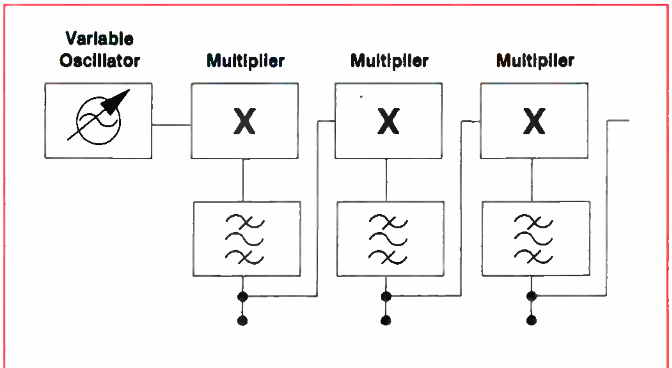

Fig.4

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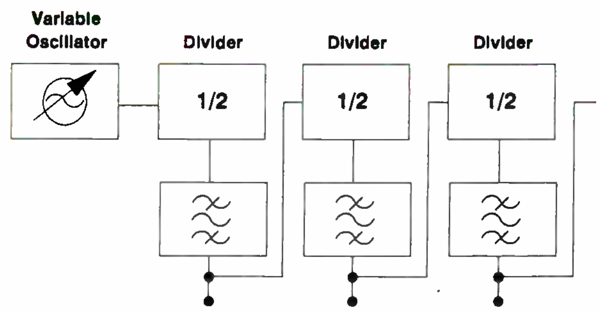

Fig.5

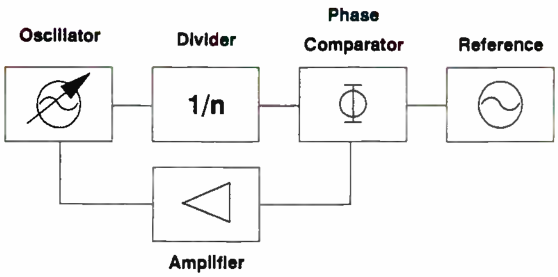

Fig.6

thesis (where the output frequency is derived by processing a series of fixed frequencies) is used in a few specialised generators, most current designs use the *indirect synthesis* approach.

In this system, the frequency of a voltage-controlled oscillator (VCO) is controlled by a feedback loop. This feedback technique forms a phase-locked loop (PLL) and any drift in any of the circuits that would normally produce a variation in the output frequency is compensated for automatically.

In its simplest form, the phase-locked loop consists of a phase sensitive detector which compares a signal derived from the VCO with a signal produced by a stable reference (usually a crystal oscillator) — see Fig.6.

Any error causes a signal to be produced by the detector which, after amplification and filtering, is used to control the VCO. By altering the division ratio between the oscillator output and the phase detector input, a range of frequencies can be obtained. The minimum frequency step size provided by this simple loop system is equal to the value of the reference frequency used. Since a high reference frequency is needed to obtain fast operation, the simple implementation shown here is rarely able to be used in practice.

Practical design

By combining the advantages of a number of RF processing techniques, a wide range signal generator can be produced with good performance and at a realistic price. The typical block diagram (Fig.7), uses a fundamental oscillator technique to cover the range from 250 to 500MHz, a multiplier to extend the frequency up to 1GHz, dividers to provide coverage down to 62.5MHz and a heterodyne stage to complete the coverage down to 10kHz.

Similar schemes to the one illustrated are used in many successful signal generators, and provide a balance of performance which is ideally suited to a wide range of applications.

Of course, the heart of any good signal generator is the RF oscillator system, and a great deal of design expertise has gone into developing circuits which combine the required noise performance with a wide range of other features (wide tuning range, high stability, FM capability, etc.).

Traditional signal generators used variable capacitors to alter the resonant frequency of the tuned circuit, and these capacitors were carefully engineered to provide a smooth control coupled with good stability. Extended coverage was often obtained by switching different values of fixed inductance into the tuned circuit, resulting in some very complex mechanical switching systems. Indeed, these switches were often the weakest part in the whole design and needed careful maintenance to ensure good performance.

Some later designs used a variable inductor to tune the circuit and this was usually implemented by having a moveable core which could slide in and out of a coil. The different frequency bands on the generator were each covered by a separate oscillator system, as it is impractical to switch different values of fixed capacitance into a common inductive circuit. The complex switching associated with capacitively tuned designs is thereby eliminated and a more reliable design is obtained.

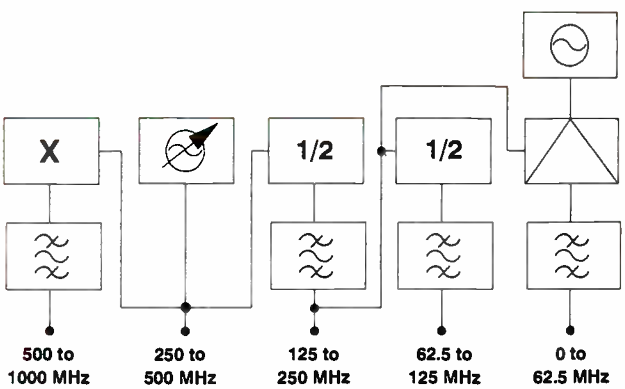

Fig.7

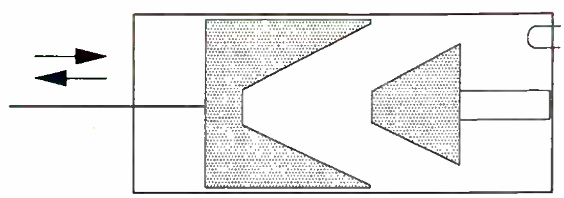
Fig.8

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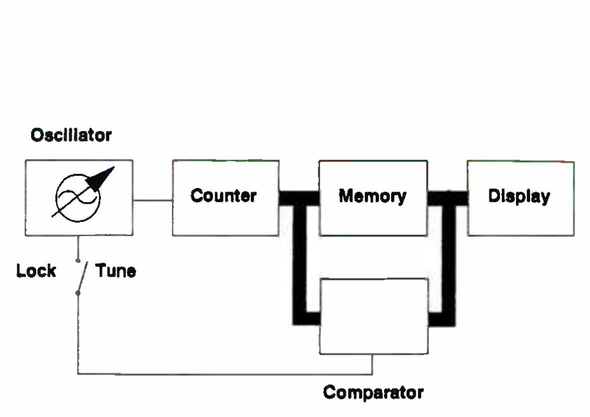


Fig.9

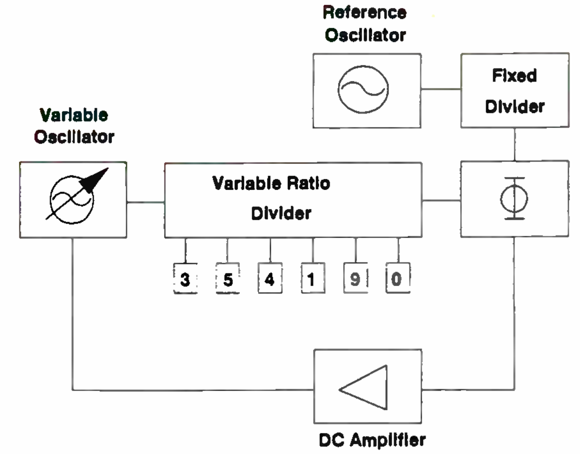


Fig.10

Although it is possible to vary the inductance of a coil by altering the static magnetic field in its core, few practical designs use this principle.

The most common implementation of a voltage-controlled oscillator uses instead a voltage dependent capacitance (usually a *varactor diode*), which operates in conjunction with a fixed inductance to produce the tuned circuit for an oscillator. Varying the DC bias voltage applied to the device alters its capacitance this in turn, affects the resonant frequency.

Voltage-controlled oscillators at VHF and UHF are easily and cheaply fabricated and give reasonable performance, especially when used as part of a phase-locked loop.

Their extreme sensitivity to small noise voltages requires that they must be rigorously screened to ensure that no unwanted sidebands are produced.

It is generally recognised that the Q-factor of the tuned circuit has a significant effect on the level of noise produced by an oscillator and this explains why crystal oscillators are able to achieve such high levels of performance. Normal tuned circuits implemented with capacitors and inductors rarely achieve very high Q values, due to limitations of the components, and one technique which can significantly improve the Q of a circuit is to substitute a 'cavity tuned capacitor' in place of the traditional variable capacitor.

Although such components are commonly referred to as cavities, they are not used in a resonant mode but instead act as a parallel combination of capacitance and inductance. The cross section illustrated in Fig.8 shows a movable piston, which is concentrically mounted in a cylinder surrounding a short central line. The fixed line acts as an inductance and is tuned by the capacitance between the piston and the line. Moving the piston alters the capacitance and hence the frequency of the oscillator circuit. A small coupling loop couples the resonant circuit to the oscillator.

Frequency stabilisation

Without some form of feedback, most RF oscillators are useless in modern narrowband applications and many forms of frequency control have been tried in the past. In the earliest designs, the control was simply provided by the operator, who had to make continuous fine adjustments to the signal source to keep it in tune with the receiver being tested.

Novel techniques included a feedback system where a voltage derived from the FM discriminator was applied to the FM input of a generator and gave a simple form of closed loop, although this method would only work when the tuning was already very close to the required setting.

From these early attempts at stabilisation, two practical techniques emerged — one based on a frequency counter and the other on a simple form of phase-locked loop.

In the frequency counter system, shown in Fig.9, the counter circuits are normally used to provide a digital display of the signal generator output frequency. When the required value is reached the operator sets the switch to its 'lock' position and a circuit then compares subsequent counter readings with the value held in a digital memory. Any drift gives rise to an error, which is converted to a correction voltage to be fed back to the oscillator.

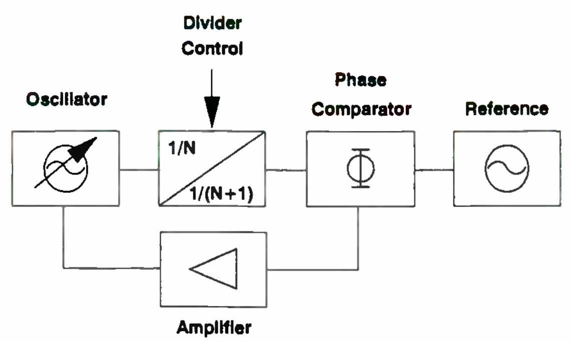


Fig.11

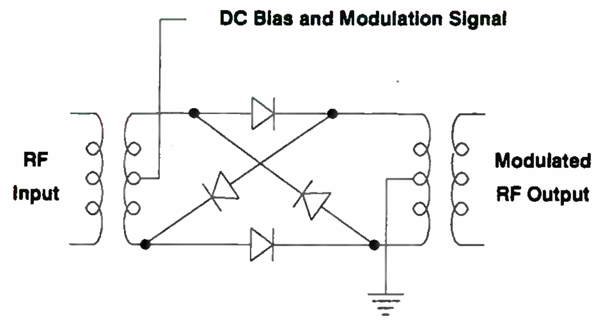


Fig.12

Modern RF Signal Generators and their use - 1

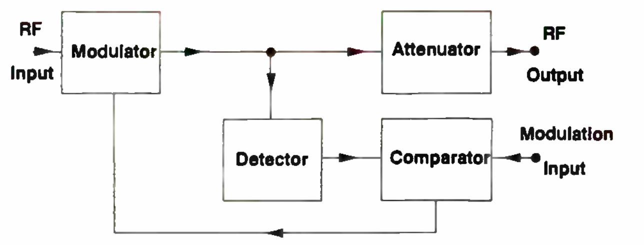


Fig.13

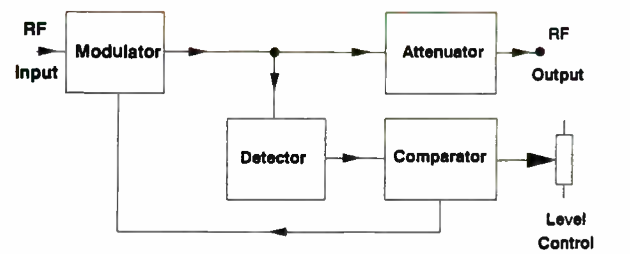


Fig.14

Retuning the generator requires that the switch is set back to its 'tune' position, so that the operator can use the normal tuning controls to move to the next frequency.

An alternative, the counter technique, uses a variable ratio divider in a simple phase-locked loop (Fig.10). The operator sets the division ratio of the variable ratio divider using a series of front panel switches, tunes the generator to within about 1% of the required frequency and the locking loop then takes over and completes the final tuning.

Once locked, small changes in frequency are easily accomplished by simply resetting the divider dials.

Synthesised tuning

The modern synthesiser combines the qualities of the voltage-controlled oscillator with digital divider circuits, to create a wide variety of designs capable of producing high levels of performance. Current designs are usually based on multi-loop architectures or fractional-n schemes, which have been devised to provide better frequency resolution without the need for excessively low comparison frequencies.

Of the modern designs, it is the fractional-n implementation which has attracted the most interest and which has seen the greatest level of innovation. In its simplest form (Fig.11), the fractional-n system is almost identical with the traditional phase-locked loop, but with the important difference that the division ratio can be switched between two integer values.

By varying the amount of time the divider spends set to the different values, the effective overall division ratio can be adjusted to by anywhere between the two integer values. This allows a finer resolution to be obtained, with a higher comparator frequency than would have been possible with the traditional phase-locked loop.

One major problem with the fractional-n system is that the switching of the divider ratio introduces jitter in the output frequency, and elaborate techniques for eliminating this effect have been devised.

This increase in the complexity of the resulting design does not necessarily add significantly to the cost of manufacture, however, and fractional-n technology has been successfully implemented in low cost signal generators.

Modulation

Modulation facilities are always provided on signal generators, to simulate the signal a receiver would normally be expected to handle. Amplitude modulation (AM) and frequency modulation (FM) are provided on virtually all instruments, while pulse modulation is often offered as an optional feature.

The simplest technique for generating amplitude modulation is to use the modulation signal to vary the supply voltage to the RF oscillator, but this method is only suitable for low modulation depths (up to 50% AM).

The high levels of incidental phase modulation caused by variations of internal capacitance in the active device of the oscillator circuit also limit the general applicability of this simple technique.

A separate modulator circuit mounted between the RF oscillator output and the following RF stages is capable of producing much higher modulation depths, with reasonably low levels of distortion.

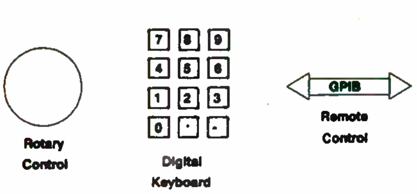


Fig.15

A common system uses a diode bridge (Fig.12), where the RF signal level at the output of the bridge can be varied by changing the bias current flowing through the diodes.

Superimposing the modulation waveform on this bias current causes the output to contain the required modulation, and depths up to a full 100% are possible. The circuit is also suitable for pulse modulation.

To ensure low distortion, careful matching of the diodes is necessary and in some generators a feedback technique, known as envelope feedback, is used (Fig.13). In this system the output signal is detected to obtain the modulation envelope waveform, which is then compared with the modulating signal. Any differences are amplified and the resulting signal is applied to the modulator.

Low distortion outputs are possible at low modulation depths (up to 50% AM), but non-linearities in the diode detector limit the performance at higher depths. Envelope feedback also has a limited modulation frequency range, particularly at low carrier frequencies, and is not suitable for pulse modulation.

Frequency modulation is always applied directly to the oscillator, and the usual method uses a variable capacitance diode in parallel with the main resonant circuit. The capacitance variations are arranged to be very much smaller than the capacitance which determines the oscillator tuning, and these variations are controlled by the modulation signal voltage applied to the diode.

In the majority of oscillator circuits, the tuning is carried out by varying the capacitance. Consequently a given variation in capacitance will have a larger effect at the higher frequency end of the band than at lower frequencies. To compensate for this effect, an FM tracking circuit is used to reduce the voltage variations applied to the variable

[illegible]

capacitance diode as the oscillator frequency is increased.

Good FM linearity (and low modulation distortion) is easily obtained for small FM deviations, but where the deviation exceeds 1% of the carrier frequency it is necessary to deliberately distort the waveform applied to the diode, to compensate for the inherent non-linearities in order to obtain a reasonably linear modulation output.

Phase modulation is usually organised by including a pre-emphasis network in the FM circuits to give the required 6dB/octave rising characteristic.

Output stages

The output from the oscillator (or modulator) may be used directly as the generator output, but an additional amplifier is usually preferred to provide sufficient output level and to isolate the oscillator against changes in load impedance, etc.

To provide the wide range of output control (the output of a signal generator often has to cover a dynamic range of over 140dB) a stepped attenuator will also be needed to allow low level signals to be provided.

Accuracy of output level is an essential requirement of signal generators, and an *automatic level control* (ALC) system to stabilise the output against the inevitable variations caused by changing frequency or variations in the ambient environment is a necessary part of every signal source.

The basic ALC system (Fig.14) monitors the RF level at the amplifier output with a diode detector and compares the resulting DC voltage with a reference voltage. Any errors are amplified and used to vary the gain of the amplifier so that the errors are removed.

This negative feedback system effectively makes the monitoring point a zero impedance point, since the voltage is maintained regardless of load impedance. To obtain the desired output impedance a resistor must be added.

Fine control of the signal generator output is arranged by making the reference voltage in Fig.14 variable, and a range of at least 10dB is often provided on an instrument by this method. Larger variations in output level require a switched attenuator, consisting of carefully screened resistive attenuator pads which are selected by high quality switches.

The quality of this attenuator system is critical to the overall performance of the generator and great care must be taken in its design to ensure that the desired accuracy can be achieved across the full range of the instrument.

The output stages of a signal generator are not designed to handle high power signals, and some form of protection is very desirable to prevent accidental damage to the components when testing transceiver units. External fuse units and power attenuators are sometimes satisfactory, but built-in protective devices have the obvious merit that their connection cannot be forgotten.

The two types of reverse power protection system are the diode clamp, where a diode in parallel with the output prevents the voltage rising above a safe level, and the in-line relay — consisting of a relay in series with the output which opens when a high level signal is detected.

Both systems can provide protection against at least 25W of transmitter power, but the diode system is only applicable where the generator maximum output is less than 200mV. At higher levels, the diode would introduce significant distortion due to clipping of the signal peaks.

Control systems

Traditional signal generator designs were characterised by a relatively large number of rotary controls and usually employed direct mechanical linkages from the front panel controls to the main oscillator. With synthesised designs digital control is possible and panel layout is no longer dictated by mechanical considerations.

Modern microprocessor control increases flexibility and allows the operation of the instrument to be simplified. Direct keyboard entry speeds the tuning process and digital memory facilities allow regularly used settings to be stored for future use.

Calibration factors may also be stored by the memories, to improve overall accuracy. In-built calculation routines can provide the user with a range of alternative output calibrations.

Digital control also permits simple interfacing for remote programming applications and allows the signal generator to be used in automatic test systems under the control of a GPIB controller.

Such ATE systems significantly reduce the time associated with receiver testing in applications where the throughput justifies the development of the system.

In the next article, the parameters used to evaluate RF signal generator performance will be described.

(To be continued) ❖

[illegible]

A selection of recent Opto-electronic products

Optical spectrum analyser

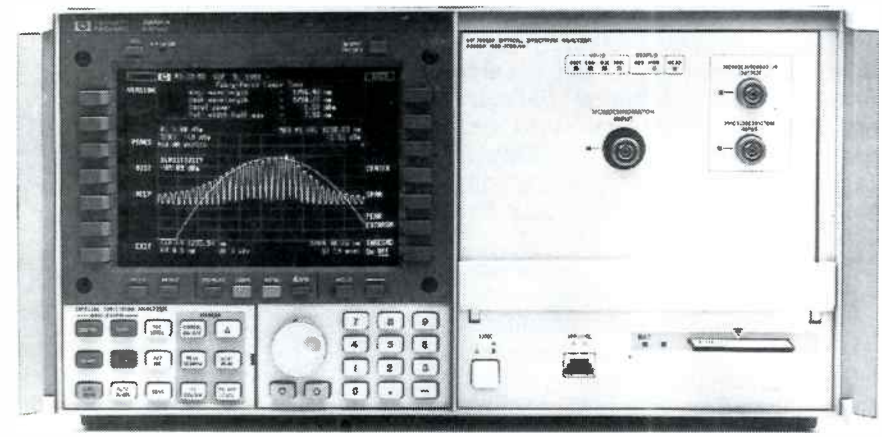
Hewlett-Packard has released the HP 71450A and HP 71451A optical spectrum analysers, which provide a combination of high dynamic range and high sensitivity to optical spectrum measurements.

Designed for use in lightwave, laser and fibre optic research, development and manufacturing, the new optical spectrum analysers perform spectral measurements between 600nm and 1700nm on light emitting diodes (LEDs), Fabry-Perot lasers, distributed feedback (DFB) lasers and Erbium-doped fibre amplifiers. Internal switching in the HP 71451A allows measurement-port access to internal components, providing additional modes of operation.

HP's double-pass monochromator technology gives the HP 71450A and HP 71451A the high dynamic range of double-monochromator instruments (55dB at 0.5nm from the peak) and the sensitivity of single-monochromator instruments (better than -80dBm).

Also both analysers allow users to perform spectral measurements rapidly, either manually or remotely. Both can sweep 50nm in 180 milliseconds and the full frequency range in 500 milliseconds. The instrument architecture reduces dead time between sweeps. The HP 71450A and 71451A can continue to sweep for months at a time without wearing out or requiring costly repairs.

For more information phone Hewlett-Packard Australia on 008 033 821.



Compact CO_2 laser system

Ultra Lasertech has released its Model CL23 compact CO_2 laser system, which is a stable source of infrared laser radiation in a small, inexpensive and ruggedised package.

This is a new concept in high performance, especially designed for a variety of scientific, industrial, medical and military applications.

The laser head incorporates a long life, sealed-off laser tube emitting a stable, polarised TEM_{00} beam at 10.6 microns. Power output is guaranteed at five watts and the laser tube is warranted for one full year, regardless of operating hours.

For further information circle 201 on the reader service coupon or contact Laser Electronics (Operations), PO Box 359, Southport 4215; phone (075) 73 2066.

OTDR for PCs

Continuously expanding its line of fibre-optic test instruments and related products, Exfo has developed a brand new single mode card-level optical time domain reflectometer for PC compatible computers, the FCS-100.

To produce a simple yet powerful OTDR, Exfo has developed two different operating softwares, both providing trace storage, printer interfacing and trace analysis tools.

The first is a fully automated version, for fast 'plug and go' analysis. It is intended for high throughput with minimal user intervention and will be most welcome in telco applications. This software makes OTDR measurements a routine procedure. The other software, designed for in-depth analysjs, is menu driven (mouse or keyboard controllable). It offers the flexibility experienced users need to perform their specific tests.

Three operating wavelengths are offered: 1300, 1550 and 1300/1550mm. Built on a full size AT card for any PC compatible portable or tabletop computer, it has a range of up to 140km and a short 4m event dead zone. Complete averaging is

performed in less than three minutes; the computation speed is independent of the computer type (286, 386, etc). The Exfo FCS-100 permits accurate and complete fibre characterisation in a very short time.

For further information contract EXFO Electro-Optical Engineering, 465, Godin, Vanier, QC, Canada G1M 3G7.

Fibre-optic connector

A new FC-II-compatible lightwave connector, manufactured by Molex, has been released. Specifically designed for Telecom applications, the new connector is fully compatible with existing FC/PC connectors and features a pre-polished physical contact (PC) profile with a convex spherical radius, enabling fast polishing of the fibre to ensure high performance. Typical insertion loss is 0.08dB and typical return loss is 48.0dB in the single mode version.

Known as series 86057, the connector series features a true non-optical disconnect design with fewer components than traditional industry standard designs. The connector meets JISC 5970 Japanese standard and Bell Core TN-NWT-000 326, issue II specification.

For further information circle 202 on the reader service coupon or contact Utilux, Electronics Division, PO Box 68, Kingsgrove 2208; phone (02) 50 0155.

High powered pulsed laser

Laser Diode has released the Model LDP 2000 Laser, for applications where high-peak power with low repetition is required.

The ultra-small LDP 2000 pulsed laser is designed with high-peak power over 10MW that can be varied by simply turning the driver current knob. It features pulse energies of 30 to 200mJ at 1.064um wavelengths.

Applications include: semiconductor processing, medicine, micro-machining, ranging, spectroscopy, optical testing, and research and development.

For further information circle 204 on the reader service coupon or contact Laser Electronics (Operations), PO Box 359, Southport 4215; phone (075) 73 2066.

Singlemode module for OTDR

A new singlemode module is now available from Siemens for its K2300 optical time-domain reflectometer (OTDR). With this new module, the OTDR is suitable for use on singlemode fibre which is used for long distance communication. Wavelengths of 1310nm and 1550nm are available for singlemode application.

The new software for the OTDR, called Compare Traces, provides extensive emulation features. For example, two traces taken at different times can be compared and any changes will be highlighted. This software is available in addition to the existing PC Batch Software. PC Batch is used for analysis on a PC of field measurements stored via the K2300's internal floppy disc drive.

The design, operation, style and result evaluation of the K2300 OTDR are such that it can be used without restriction in laboratories and test departments, and for operation and maintenance services. Special advantages include very small dead zone and very high resolution (less than 5cm).

For further information circle 203 on the reader service coupon or contact Siemens Telecommunications Electronics, 885 Mountain Highway, Bayswater 3153; phone (03) 721 2509.

Measuring colour and light

The J17 LumaColor is a handheld test instrument that operates as a photometer or a colourimeter. The modular design of the J17 accommodates plug-in heads, which offer a set of light and colour measurement functions critical in the manufacture and calibration of displays and lighting.

Provided with the J17 are two plug-in heads — the J1803 Luminance Head and the J1820 Chromaticity Head. They are precalibrated, and can be interchanged with any J17 without precalibration. Both

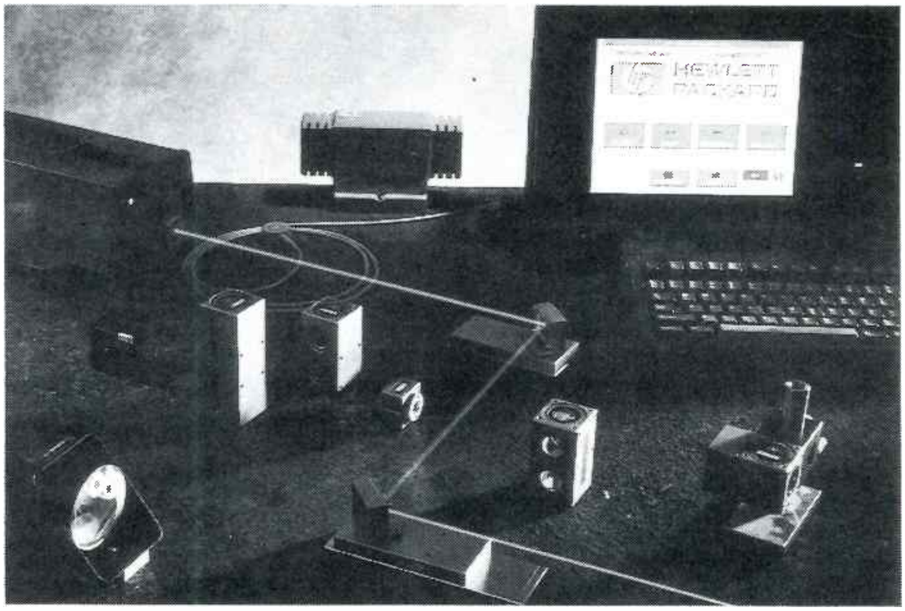
heads incorporate a new photopic filter design (patent pending), silicon photodiodes and laminated multi-element glass filters, which provide exceptional accuracy and stability in spectral correction.

The J1803 measures luminance in candelas/m^2 (NIT), or foot-lamberts where light, scattered or emitted by a surface, must be measured. The acceptance angle is approximately 8°.

The J1802 provides direct colour measurements in the 1931 CIE and 1976 CIE-UCS coordinate systems. Colour coordinates are automatically computed and displayed in either x and y, or u' and v' units. The head can also measure luminance and X, Y, Z tri-stimulus values. It has a suction cap adaptor which easily attaches to a flat surface, greatly simplifying measurements.

Using the RS-232 output, users can download data to a computer for data logging and analysis. This is especially useful in manufacturing quality control, lighting studies, and colour characterisation.

For further information circle 206 on the reader service coupon or contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113; phone (02) 888 7066.



PC-based laser interferometer

Hewlett-Packard has introduced a personal computer (PC)-based laser interferometer system for machine-tool calibration. The HP 5529A dynamic calibrator system provides substantial improvements in performance and functions over its predecessor, the HP 5528A. The HP 5529A makes standard machine-tool measurements: linear distance, velocity, angle, straightness, parallelism and squareness.

It also makes diagonal measurements — a quick way to check machine-tool accuracy — to the new ANSI B5.54 standard. If the diagonal measurements indicate satisfactory machine-tool performance, full calibration and its associated downtime may be avoided.

Maximising machining accuracy is critical for rapid production of quality parts. With the capabilities of a laser measurement system, users can quantify and correct errors with precision.

They minimise costly scrap and rework, make machine tools more productive and increase the profitability of the manufacturing process.

Also the HP 5529A performs dynamic calibration for fast data collection (collecting data while the machine is moving), thus speeding calibration.

Dynamic calibration also allows characterisation of the machine's dynamic performance, including vibration analysis, making the system more useful for trouble-shooting.

To reduce system cost and enhance portability, HP designed the instrument's laser electronics to be PC-compartible. The electronics are installed easily into a PC, eliminating the need for a separate electronics box.

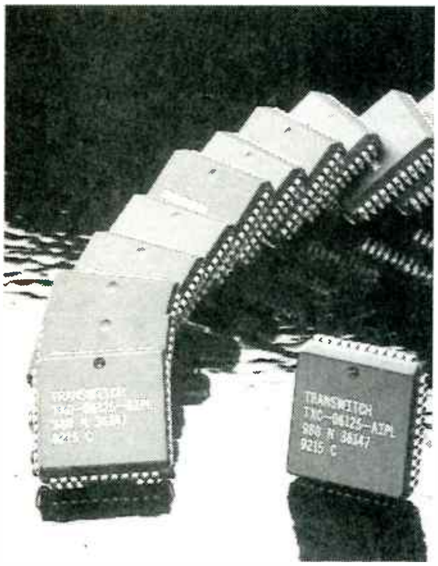
The HP 5529A uses the same rugged, dependable laser head design and optical components used in the HP 5528A. The new system is priced from $25,300 to $93,100 depending on system capability.

For further information phone Hewlett-Packard Australia on 008 033 821. ❖

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Bit error rate tester



TranSwitch Corporation has released a single chip VLSI termed 'XBERT', which can be used for Bit Error Rate testing of communication channels. The chip is a programmable test pattern generator and receiver, capable of analysing pseudorandom patterns, fixed words, or programmable words.

XBERT is used for testing the error rate performance of digital communication circuits up to 51.84Mbps.

The VLSI device includes bit-serial, nibble-parallel or byte-parallel interface capability, and can operate in a burst data mode by using an external clock control.

Under microprocessor control, XBERT's test patterns include four pseudorandom sequences (2E15-1, 2E20-1, 2E20-1 QRSS, 2E23-1); four fixed word sequences (000..., 111..., 1010..., 1100...); and a programmable mode (up to four bytes).

For further information circle 271 on the reader service coupon or contact Alkira Australia, 108/2 Pembroke Street, Epping 2121; phone (02) 876 8000.

Power amp for 2.3GHz

With its CLY5, Siemens is now offering a semiconductor in the medium power range which will still operate without problems in its low cost SMD SOT223 casing, even at supply voltages of between three and six volts.

In addition to the low supply voltage, the GaAs-MESFET exhibits very good linearity, high transmission gain and high efficiency. The device was developed for the mobile communications field (DECT, PCN); however, it still gives notably good performance in the 13cm band (2.3GHz).

The main features of a power MESFET are maximum output power and a high gain. A power FET principally consists of a number of small signal FETs which are connected in parallel to obtain as large a drain current as possible.

In the CLY5, 16 FETs, each with a gate width of 250um are connected in parallel. This corresponds to a total gate width of

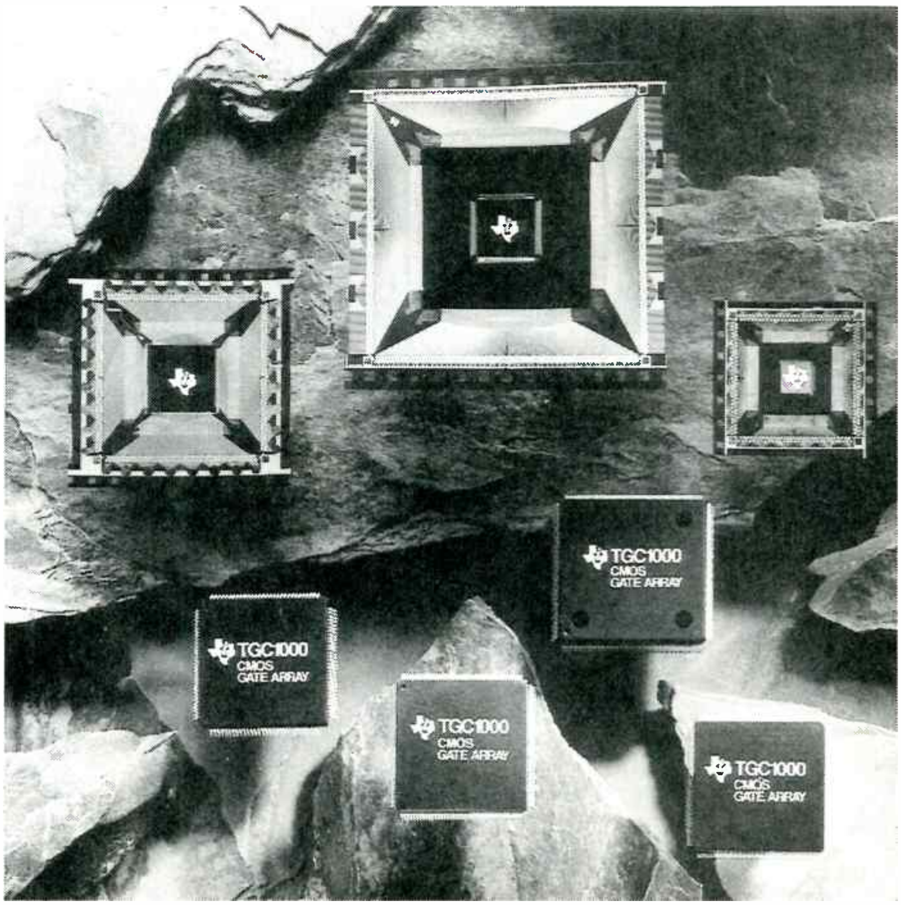
Gate arrays operate at 2.7V

Texas Instruments has released its first optimised low voltage family of gate arrays, designed to meet the needs of telecommunications, portable personal computers and personal communication system manufacturers.

The broad series of 0.8 micron CMOS ASIC products has been designed specifically for low voltage operation and efficient implementation of memory functions. The low voltage TGC1000LV and the TGC1000 gate arrays offer up to 455,000 gates with 70% usage.

The arrays contain new CMOS base cells which provides reliable performance in high speed, high density memory structures and in low power logic gates, when operated from supplies as low as 2.7 volts. The cell is also useful in systems based on the JEDEC regulated voltage standard (3.3V +/-10%), and on the 5V +/-10% supply of standard applications.

The TGC1000LV CMOS gate arrays provide a very low power dissipation of 0.8 microwatts per-megahertz-per-gate, resulting in lower packaging and system costs. It achieves up to three times the battery life for portable and personal communications systems, and a 70% reduction in power dissipation over 5V operations.



4mm. The gate length is 1um. The S parameters give a maximum available gain of 11.27dB at 2.3GHz. Since the small signal parameters vary sharply for large signal operation, an iterative procedure for optimum power matching is recommended.

For further information circle 272 on the reader service coupon or contact Siemens Electronics Components, 544 Church Street, Richmond 3121; phone (03) 420 7345.

Dual op-amp, comparator

National's new LM613 operational amplifiers are a versatile common-mode-to-the-negative-supply (single supply) type, similar to the LM124 series, but with improved slew rate, improved power bandwidth, reduced crossover distortion, and low supply current even when driven beyond output swing limits.

The new dual comparators are also a common-mode-to-the-negative supply type, similar to the LM139 series. The op-amps and comparators have lateral PNP input transistors which enable low input currents for large differential input voltages.

The firm has also released a new voltage reference, a three-terminal shunt-type bandgap similar to the adjustable LM185 series, but with anode committed to the V- terminal and improved voltage accuracy to +/-0.4%. Two resistors program the reference from 1.24V to 6.3V. The reference features operation over a shunt current range of 16uA to mA, low dynamic impedance, and broad capacitive load range.

For further information circle 274 on the reader service coupon or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 748 4066.

24-bit DSP delivers 20MIPS

Motorola's new DSP56002 24-bit general-purpose digital signal processor delivers 20 million instructions per second (MIPS) with a 50ns instruction cycle time, when driven by a 40MHz clock. The 56002 is upwardly compatible with the 56001.

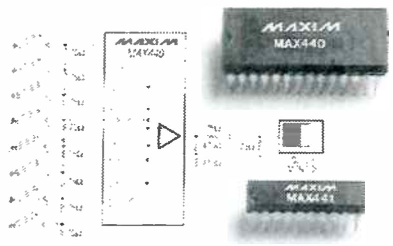
With native performance of 20 million instructions per second, the 56002 can easily address applications traditionally served by low-end floating-point DSP's and embedded processors.

Applications that require more performance than the 56002 delivers can use Motorola's 96002 floating-point processor, which provides more than 50 million floating-point operations per second (MFLOPs) for high-resolution graphics and modelling.

The 56002 includes two 256-word data RAMs and two pre-programmed data ROMs. As in all of Motorola's DSPs, there are three independent execution units that operate in parallel — the data arithmetic logic unit (ALU) for central math and logic processing, a program control unit (PCU) for fetching, decoding and dispatching instructions and an address arithmetic unit (AAU). It is a fully static design.

A phase-locked loop (PLL) has been added to allow the 56002 to use almost any available external system clock for full-speed operation, while also supplying an output clock synchronised to a synthesised internal core clock. In order to achieve its performance levels, the 56002 multiplies up the frequency using the PLL so that the user can obtain a high frequency of operation. The PLL allows the 56002 to run at 40MHz instead of relying on a system's master clock. ❖

160MHz video mux/amp



The MAX440/MAX441 are eight or four channel, 160MHz broadcast quality video multiplexer and amplifier (mux/amp) combination ICs. The multiplexer has a fast channel switch time (15ns) and the amplifier has a wide 160MHz unity-gain stable bandwidth (110MHz at gains ≥ 6dB).

The ICs have an extremely low differential phase and gain error of only 0.03° and 0.04% respectively. This combination of high speed and precision performance, from a single IC, make the MAX440/MAX441 ideal for broadcast quality video applications. In addition, stray circuit capacitance is dramatically reduced, as well as board space and cost over discrete multiplexer and amplifier alternatives.

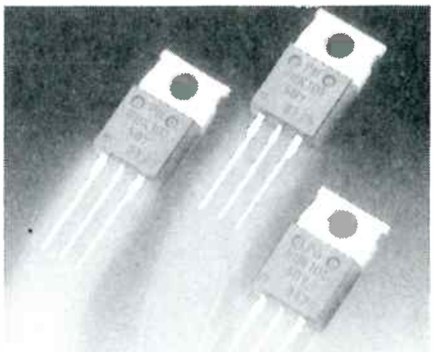
On each chip pin-selectable compensation allows the amplifier's AC response to be optimised, without external components or complex calculations. For closed loop gains of 6dB (2V/V) or greater, bandwidth is 110MHz and slew rate is 370V/us. The MAX440/MAX441 directly drive a 50 ohm load to +/-2.5V or a 150 ohm load to +/-3.5V.

For further information circle 273 on the reader service coupon or contact Veltex, 18 Harker Street, Burwood 3125; phone (03) 808 7511.

Fully protected power MOSFET

Philips Semiconductors has introduced what is claimed to be the world's first three pin power MOSFET to include integrated short-circuit, over-temperature and over-voltage protection. Encapsulated in a standard TO-220 package, the BUK101-50 TOPFET (Temperature and Overload Protected Field Effect Transistor) requires no additional protection components.

The chip can be driven directly from conventional logic-level FET driver circuitry which allows TOPFETS to be used as fully ruggedised replacement MOSFETs in existing equipment, as well as for new designs. They are particularly suited to the switching of lamps, motors and solenoids in automotive electronics.

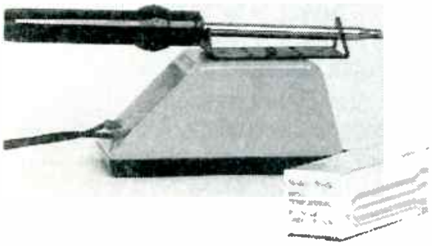


The BUK101-50 is an N-channel, enchancement-mode DMOS FET with an $R_{DS(on)}$ of 60 milliohms and a continuous current rating of 26A (100A peak). Its protection circuitry automatically switches the BUK101-590 into the off state if the junction temperature exceeds a safe value (typically 180°C), as a result of inadequate heat-sinking or short-circuit load currents. The over-temperature and short-circuit protection circuits incorporate a latch which maintains the BUK101-50 in the off-state until its control input is driven low.

In addition, on-chip avalanche diodes, coupled with a controlled turn-on of the BUK101-50's power MOSFET, provide dramatic clamping of V_{DS} voltages which exceed 50V — fully protecting the device from transients caused by the switching of inductive loads. All the active protection circuitry is powered from the control input, allowing the BUK101-50 to achieve a typical 25°C off-state I_{DSS} rating of 1uA for a V_{DS} voltage of 12V.

NEW PRODUCTS

Heavy duty soldering station



Scope Laboratories has released an alternative version of its 100W heavy duty soldering station.

This new model, designated SS-BL:PSU, is designed for end users such as auto electricians and industrial maintenance technicians, who want extreme temperature resistance in the iron hand piece.

When this Australian designed heavy duty station is constantly used for heavy terminations at close to its capacity and in high temperature locations, the extreme temperature tolerance of its moulded black phenolic is appreciated.

For further information circle 242 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566.

Non-intrusive 2.5GHz probe

Hewlett-Packard has introduced a wide-bandwidth, 2.5GHz active probe that allows the high-speed digital hardware designers and scientists to probe a circuit accurately, without changing its characteristics.

In the past, probing often distorted a signal under test. This undesirable effect was especially problematic in high-speed digital technologies such as CMOS and ECL.

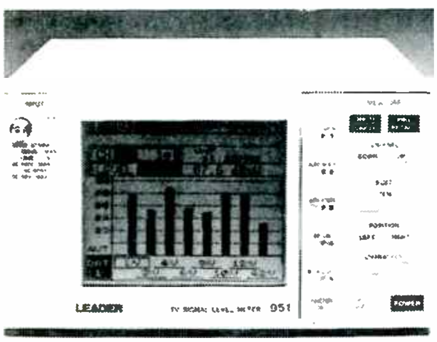
Circuits operating at higher frequencies generally are more sensitive to probe loading because the probe actually becomes part of the circuit under test. The low input capacitance and high-input resistance of the HP 54701A prevent the loading that often results when probing a circuit.

The 0.6pF input capacitance helps ensure the 2.5GHz bandwidth, 140 picosecond rise time and 1% flatness. The probe's high DC input resistance of 100k, 0.5% DC gain accuracy and 10:1 division ratio provide excellent response.

Other specifications of the HP 54701A include 200V AC maximum input voltage and 12kV electrostatic-discharge protection. Its list price is $3600, plus $1900 for the matching HP 1143A power supply.

For further information ring Hewlett-Packard Australia on 008 033 821.

Multi-display TV signal meter



The Model 951 TV signal level meter from Leader is claimed to be the world's first capable of displaying eight channels simultaneously. It can be used for all Australian UHF and VHF channels as well as FM and CATV, and measurement is made with just one touch of a button.

Signal levels in the range 46 - 870MHz are displayed on a large, easy-to-read backlit LCD display, all auto-scaled, and with audio and video carrier levels shown in both bar graph and digital form. Four groups of eight channels can be preset, and the data saved in memory.

Automatic compensation is carried out for variations in signal level that are related to frequency and temperature, so that high measurement accuracy is ensured. Also a peak detector circuit allows the display of signal peak level.

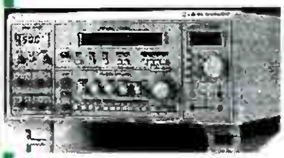
Housed in a compact 213 x 120 x 200mm case, the 951 is powered by eight D-size batteries, with an Auto power-off facility operating about five minutes after the last key activiation.

For further information circle 243 on the reader service coupon or contact AWA Distribution, 112-118 Talavera Road, North Ryde 2113; phone (02) 888 9000.

FOR CHIPS...WOOD FOR CHIPS...WOOD FOR CHIPS...WOOD FOR CHIPS...WOOD FOR CHIPS...WOOD FOR CHIPS...WOOD FOR CHIPS...WOOD FOR CHIPS...

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

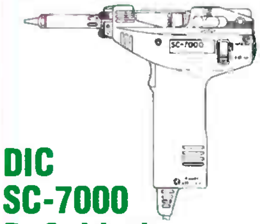
Frequency Counter
- 1Hz to 100MHz
- 15mV sensitivity to 60MHz
- 0.1 to 100Hz resolution
- 10ms to 10s gate
- 10MHz reference, with 5ppm stability
- 8 digit display with annunciators

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

The Best Yet!



DIC SC-7000 DeSoldering Tool – ESD* Protected

- Now with 100W ceramic heater
- Sensor feedback digital temperature control
- Work on up to 12 layer boards
- * Special antistatic housing and zero crossover switching to protect sensitive components
- Suction/Hot air blow switch – suck for desoldering, blow for SMD removal
- Optional surface mount kit

$482.50 ex tax
$579 inc tax

See the review in Electronics Australia March 92 – "Electronics Workbench is certainly the easiest simulator I've ever used" Peter Philips

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 rsion 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**

Run Your TV from a Car Battery with My-Power 200

Yes this hand-sized inverter will run a 33cm TV for up to 6hours from a 12V car battery.
- Gives 240V, 50Hz from 12Vdc
- Rated to 400W surge (200W peak and 140W cont).
- Has overload and undervoltage protection.
- Full 12 month warranty.
- Measures only 50x135x74mm and is great value at $180.00

SerialTest

PC-based Protocol Analyser & Data Line Monitor

The new version of Serialtest turns ANY PC into a full-featured serial data protocol analyzer — even laptop and notebook computers – for both synchronous and async data. Serialtest unleashes the power of your PC for data communications testing with a simple, user-friendly interface and either! The new ComProbe plugs in to your printer port. With Serialtest and your PC, there is no longer any need to buy or rent expensive, dedicated protocol analyzers.

The Serialtest package includes Serialtest software and Frontline's RS-232 ComProbe™ adapter. The ComProbe connects to your computer via the parallel printer port *(no need for plug-in cards)* and allows Serialtest to work with both synchronous and asynchronous devices.

Serialtest's monitor mode shows you exactly what information is flowing between any two serial devices — both data bytes and control signals. Source mode allows you to interactively simulate either the DTE side or DCE side of the communications link.

Serialtest Async is similar to Serialtest, but is limited to async-only testing. The package includes Serialtest Async software and custom cabling which works in conjunction with the serial ports on your PC.

Anyone who works with serial data communication needs Serialtest. Field service engineers and system integrators will appreciate the portability and ease-of-use. Communication specialists and network supervisors will enjoy the power and flexibility. No matter what the industry, Serialtest will prove to be an indispensable tool.

Look at ALL these features –

Protocols: *Async, SDLC, Sync, X.25, HDLC, SNA*

Data Capture: *data bytes, control signals, and error conditions. Capture data to RAM and directly to disk with no file size limit.*

Data Display:
Frame/Packet level: one decoded frame/packet per line.
Byte level: split-line DTE over DCE or mixed using reverse video for DCE.
Characters displayed in hex, ASCII, EBCDIC, or Baudot.
Nonprintable characters displayed using hex, mnemonics, graphics,dots.
Captured data can be searched; search patterns can include wildcard characters.

Control Signal Display:
Live breakout box includes timing diagrams and counters.
Captured control signal transitions can be viewed in relation to captured data bytes using timing diagrams.

Timestamping: *Absolute or relative display of event time. Delta time and effective data rate calculations.*

Triggers: *Character strings, control signals, and error conditions can be used to activate and deactivate data capture. String triggers can include wildcard characters.*

Device Emulation: *Transmit data entered from the keyboard, Serialtest capture files, or any DOS file. Modify control signals. Use hardware and software flow control including user-defined XON/ XOFF characters.*

Configuration Management: *Name and save an unlimited number of configurations.*

User Interfaces: *Pop-up menus and context-sensitive help allow new users to be up and running quickly. Command line options can be used to further simplify operation.*

SerialTest Sync/Async with Comprobe **$2480.00** (ex tax) **$2536.00** (inc tax).Plug Pack **$24.95**. *Allow $15 P&P*
SerialTest Async is still **$480.00**. Demo disk $10.00 refundable on purchase

FEELING BLUE?

Then we have blue LEDs to suit in 3 and 5mm with a water clear case. 14mcd (typ) brightness at 20mA and 3.0V (typ). 5V reverse. 470nm wavelemgth and 30° viewing angle.
Both sizes **$3.95**ea, **$3.55** (10+), **$3.20** (50+), **$3.00** (100+)

NEW Telephone Plug & Socket Adaptors

Its easy to link telephone equipment fitted with American 6 slot 6 pin plugs in to an Australian system with our adaptors.
Four pins are wired. Adaptors are a bit thicker than standard Aussie parts.

American socket to Australian socket	**610M**	**$5.95**
American socket to Australian plug	**605M**	**$5.95**

Looking for Value in Multimeters?

Then take a close look at these APPA multimeters. Look familiar? That's because they're sold under different brand names.

It's called 'Badge Engineering' – Appa makes the multimeter, but it's sold with someone else's name on it. And that means you could pay a lot more than you need to. We've seen the top of the line model selling at around $150 more than our price. So you're paying that much extra just for the brand label!

It's also an indication of how good Appa meters are that other people want to put their names on them!

- ***Extra tough for industrial users***
- ***High energy fuse and PTC protection against overloading***
- ***O-ring sealed case, switch and jacks against dirt and moisture***
- ***Protective holster and tilt stand with lead storage***
- ***Test probes have finger shields and sleeved plugs***
- ***Thick walled ABS case and shock mounted LCD withstands 2m drop on to concrete floor***
- ***Unique rotary switch with berrylium copper contacts and gold plated pcb***

Model 103 & 105
- 4000 count
- Digital update twice/second, analog 20 times/sec
- 8 Functions - Vdc, Vac, Adc, Aac, Ohms, Diode, Continuity, Frequency, Capacitance
- Data hold & Relative functions
- 0.5% dc accuracy

$298.80 $249.00 ex tax

Ranges
Vdc 400mV, 4V, 40V, 400V, 1000V
Vac 4V, 40V, 400V, 750V
Adc 4-400mA, 10A
Aac 4-400mA, 10A
Ohms 400Ω, 4kΩ, 40kΩ, 400kΩ, 4MΩ, 40MΩ
Frequency 100Hz, 1kHz, 10kHz, 100kHz, 1MHz
Capacitance 4nF, 40nF, 400nF, 4μF, 40μF

Model 105 has similar specs but with improved accuracy of 0.1% typ on Vdc and 0.5% at 50Hz
$358.80 $299.00 ex 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. 31 **(inc in N S W)**
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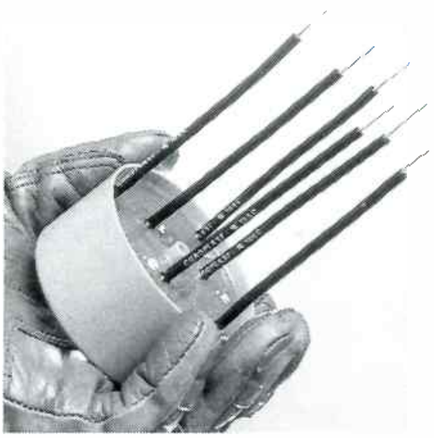
(Corner Beatrice Street)
Mail Orders to – P O Box 671, Lane Cove N S W 2066
Telephone : (02) 428 4111 Fax : (02) 428 5198

Three-phase EMI filter



Siemens has available a new filter — the B84143 — for interference suppression of frequency converters of the kind used to control three-phase motors.

Particular emphasis has been laid on adequate damping, even at low frequencies, of the mainly asymmetric high interference levels that occur in converters.

The B84143 is a mains filter for three-phase systems without a neutral conductor, designed for nominal voltages of 440/250V (50/60Hz). It is available in three versions: 3 x 16A, 3 x 35A and 3 x 75A. Insertion loss is 55dB (measured asymmetrically), in the 16A version, 50dB in the 35A version, and 35dB in the 76A type.

For further information circle 248 on the reader service coupon or contact Siemens Electronics Components, 544 Church Street, Richmond 3121; phone (03) 420 7716.

Clock oscillators

AVX/Kyocera has introduced a complete range of crystal clock oscillators, capable of accommodating all timing application requirements.

The first in the range is the KXO series, which provides a selection of drive outputs for TTL to HCMOS applications. Its frequency coverage is from 1.84 - 75MHz. These devices are in a 4-pin DIL package.

The 386 series of clock oscillators is approved by Intel, and drives the Intel 386 processor without the need of a clock generator or buffer IC. The oscillators have a high load capacitance of 150pF, a duty ratio of 45/55 and disable/enable functions, and are available in standard frequencies of 20, 32, 40 and 50MHz.

For further information circle 249 on the reader service coupon or contact ACD, PO Box 139, Bayswater 3153; phone (03) 762 7644.

40W switchmode power supply

The Computer Products NFS41 switchmode power supply is a cost-effective universal input switching supply that mechanically replaces the industry-standard 40 watt power supply.

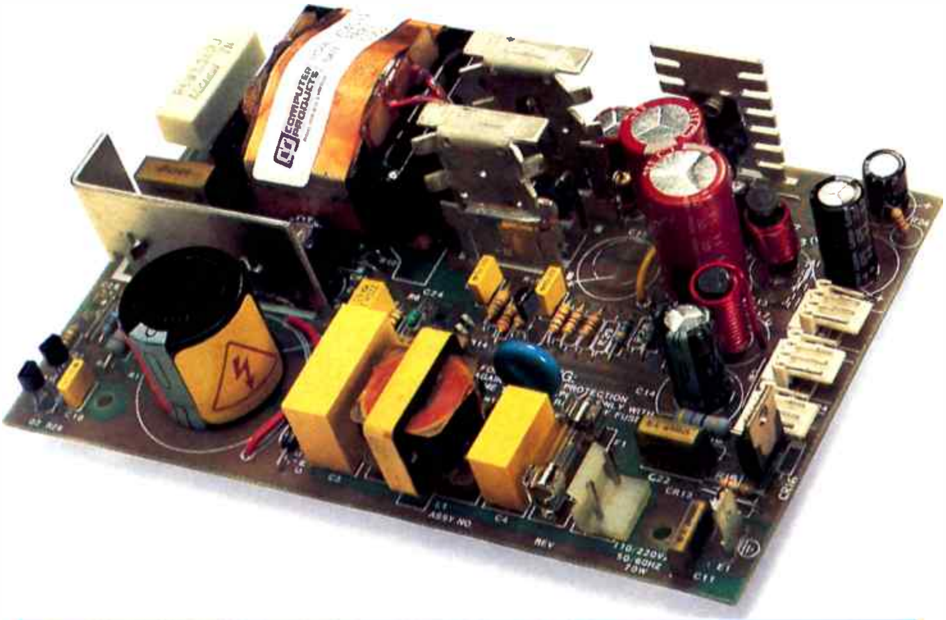
Universal input voltage eliminates the need for an external 115/240V AC system switch and cable assembly, saving cost and assembly time. Failures due to improper input voltage are eliminated, lowering total power supply cost and improving end-customer satisfaction.

The NFS42 is a multiple output unit providing +5.1V and +/-12V, +5.1V and +24V and -12V, and +5.1V and +/-15V, with peak outputs, lasting for 60 seconds. The input voltage is 85 - 264V AC, 47 to 440Hz.

This continuous wide input range allows the power supply to operate to voltage dips down to 85V AC, and with an input of 220V AC can provide a hold-up time of 75ms.

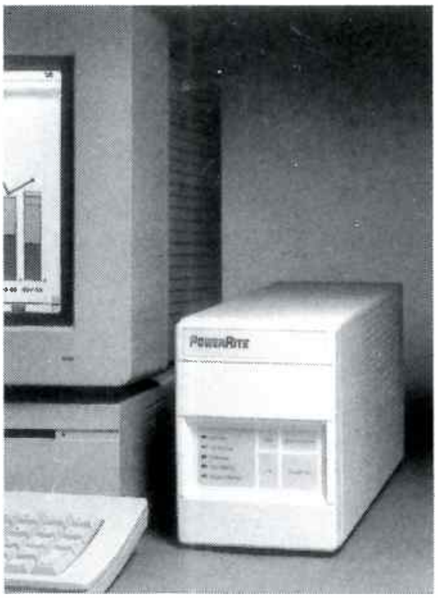
Full output power is available up to an operating temperature of 50°C, and 20 watts up to 70°C. Other features include over-voltage protection on the 5V, line regulation of 0.3% and short circuit protection.

For further information circle 241 on the reader service coupon or contact Amtex Electronics, 13 Avon Road, North Ryde 2113; phone (02) 805 0844.



Improved UPS

Deltec has recently introduced five new UPS's offering protection up to 2000VA for computers, workstations and networks: the Powerite PR400I, PR600I, PR900I, the PR1250I and the PR2000I. These units have two features which help to preserve UPS batteries for the times when they are most needed.



First is the special SmartBoost feature, which preserves batteries from brownout drainage.

In a voltage dip 12% below nominal, SmartBoost will boost the voltage to within normal limits before it reaches the computer, and continue to operate under these conditions without draining the batteries.

The second feature is an adjustable dipswitch for raising the upper voltage limit. This makes an allowance for consistently higher incoming voltage, which would otherwise cause battery power to be triggered on frequently.

For further information circle 245 on the reader service coupon or contact On-line Control, 2/7 Waltham Street, Artarmon 2064; phone (02) 436 1313. ❖

Silicon Valley NEWSLETTER

Japan caves in on US chip trade

With time running out, Japan's electronics industry has caved in to mounting fears of US reprisals for its country's failure to open its domestic chip market to foreign vendors.

In a new emergency agreement, Japan's 10 largest chip consuming companies agreed to dramatically increase the purchase of US and other foreign-made chips by the end of this year.

Under the terms of the agreement between the US semiconductor industry and representatives from Japan's electronics industry, the Japanese companies will purchase an additional US$600 million worth of foreign semiconductors this year in order to help their country meet the terms of the second US-Japanese chip trade agreement.

Currently, Japan appears to be 6% short of the 20% foreign market that must be achieved by the end of this year under the terms of the chip trade agreement.

In addition, the new agreement states that when the Japanese economy recovers, foreign chip suppliers will receive a much larger share of any new chip purchases. Included is a plan that will ask the chief executives of Japan's 80 largest electronics companies to issue formal company policies for encouraging the purchase of foreign made chips.

The agreement was hammered out by the US Semiconductor Industry Association and the Electronics Industry Association of Japan just a week after President Bush announced a thorough government review of the chip trade agreement. That decision indicated that Bush was finally gearing up to put sanctions into place, in retaliation for the lack of progress on the market access issue.

The move apparently sent a shockwave through the Japanese electronics industry. Industry and government agencies in Tokyo tried to blame Japan's recession for the stagnant foreign market share. But a strong undercurrent of concern over sanctions appears to have resulted in a need for drastic action to satisfy the 20% market share demand.

At the EIAJ, chairman-elect S.Itoh, a senior executive with NEC, said the new agreement "gives fresh thought to our efforts in meeting the agreement. Our new agreement is very positive. Our mission is to avoid any potential misunderstandings that might lead to the imposition of sanctions."

SIA representatives said they were as surprised as anyone to have reached the agreement with the EIAJ. When they arrived in Tokyo for a round of discussions, the SIA expected a confrontational climate. Instead, they found Japan had caved in to the mounting pressures to open its protected chip market.

An artist's impression of the new 150,000 sq.ft. facility which Motorola is building in the People's Republic of China. Located in the Tianjin Economic and Technology Development Area (ETDA), the plant will be completed in 1993 and will perform assembly and final test operations for a variety of products.

AMD loses microcode case with Intel

In a major setback for Advanced Micro Devices, a 10-member San Jose jury has concluded that AMD failed to prove it has the right to make use of the Intel microcode under the terms of a 1982 technology licensing agreement with Intel.

At the same time, the jury also ruled that Intel failed to show it disagreed with AMD on the meaning of the language of the agreement, at the time it was signed.

For AMD, the ruling means the company will have to delay introducing its next generation 486 compatible processor until the company has developed a new compatible microcode that won't infringe on Intel's technology and copyrights. Work on such a microcode has reportedly been in progress for some time. It also means Intel may be able to collect tens of millions of dollars in damages from AMD. Intel vowed it would ask the jury to bar AMD from selling any 287 math co-processor chips and to award Intel damages based on AMD's illegal sale of the 287's incorporating the disputed microcode.

AMD's stock, which had already slipped from more than $22 earlier this year to US$14.50, took a $5.50 plunge to US$9 on the day following the jury's announcement. At this time, AMD's lucrative 386 business appears isolated from the jury ruling, even though it incorporates the same microcode.

Earlier this year a state arbitrator granted AMD full rights to the 386, including its microcode after finding Intel guilty of breaching a 10 year technology exchange agreement with AMD.

At AMD, company chairman Jerry Sanders said he was disappointed with the jury's verdict. "We believe the verdict is inconsistent with the evidence presented."

Sanders added that the jury of ordinary citizens was confused about the intricacies of the technologies involved and said AMD would ask presiding judge

William Ingram to overturn the verdict and rule himself on the legal meaning of the wording of the agreement.

While conceding the decision will send AMD engineers back to the drawing board in having to come up with a new microcode, Sanders expressed confidence that his company will continue to play a major role in the X86 market.

Ross Perot regrets not buying Microsoft

Not buying Microsoft is a decision Ross Perot says he has never forgiven himself for. It seems that in 1979, when Perot was still head of Electronic Data Systems, he met on several occasions with Bill Gates to discuss a possible acquisition of Microsoft.

Mind you, that was well before the IBM PC bonanza, when Microsoft was mostly selling M80 cards for the Apple II and related products. Microsoft with 28 employees was doing a brisk US$2 million business, but Gates' asking price of US$40-60 million seemed overpriced.

Today, Perot, who may well end up in the White House this November, remembers the incident well. "Gates gave me an opportunity to buy a ringside seat. He has never kidded me about that, but I think if the shoe was on the other foot, I'd probably needle him."

"I should have just said: 'Now Bill, you set the price and I'll take it. Whatever you think is fair'," Period said.

Gates, for his part, said he was 'bowled over' by EDS's US$1 billion size. He recalled he even got a rare haircut before his first meeting with Perot. Gates was also interested in linking up with EDS to get Microsoft into the corporate software market. "We thought: Hey, these guys can help put micros into these big corporations and proliferate the micro-based idea."

Perot said he was impressed with Microsoft and the people working there. "My satisfaction wouldn't have been in all the money I could have made. It would be in the day-to-day contact with Bill and the people at Microsoft, in watching them do it."

US computers to be more efficient

The US Environmental Protection Agency (EPA), in cooperation with six of America's largest computer makers, has announced a program to make millions of personal computers sold each year more energy efficient.

The so-called 'Energy Star Computer Program' (ESCP) would save businesses and individuals as much as US$1 billion in electric energy expenses.

Starting in 1993, the EPA will grant an ESCP certificate to computer makers who incorporate the so-called 'sleep mode' feature into their desktop system. The sleep mode automatically powers down a system when it is not used for a certain amount of time, while retaining all of the data that may not have been saved to disk yet. Companies will be allowed to attach the ESCP logo onto their computers and use the logo in their advertisements.

The EPA is trying to reduce the vast amount of energy wasted when computers are left on all day and night, even though they may be used only a few hours during the day and not at all at night. In many companies, leaving the system on at night is a mandatory procedure. Other computers are left on in order to receive faxes, E-mail, and other data electronically. "A lot of companies today are interested in being 'green', and we are building on that", commented Eileen Claussen, director of the EPA's Office of Atmospheric Programs.

The EPA program was endorsed by IBM, Apple, Hewlett-Packard, Compaq, Digital Equipment and NCR.

H-P packs 20MB on 1.3" hard drive

If Seagate's new 1.8" 65MB disk drive wasn't impressive enough, Hewlett-Packard is jumping into the minidrive market with a drive that packs 20MB on a disk with a diameter of just 1.3".

The so-called 'Kittyhawk Personal Storage Module' will be marketed by H-P for use in pen and palm-size computers, but also in new generations of machines that never before incorporated disk drives — including fax machines, intelligent copiers, cameras, printers, personal digital assistants (PDAs), medical equipment, and even in cellular phones for voice mail purposes.

The Kittyhawk, which uses a new ultra-small read/write head from Read-Rite in Milpitas, will be manufactured for H-P by Japan's Citizen Watch Co. The drive is so tiny, it is held together by screws too small to be visible to the naked eye.

Industry analysts said the 1.3" drive will be in a class by itself. Its limited storage capacity voids applications in the notebook computer market, where most machines come with 60MB or more in order to handle operating systems such as Windows 3.1.

Instead, the Kittyhawk will be competing with solid-state memories such as the Flash memory cards from Intel and others. Although solid state memories have a definite reliability advantage, the Kittyhawk, at US$250 in volume quantity, costs but a fraction on a per-megabyte basis.

High-tech execs flock to Perot

A new poll taken by the American Electronics Association shows 55% of US high-tech executives now favour Ross Perot as president of the United States.

President Bush came in a distant second, with 39% of the 408 executives favouring the President. Democrat Bill Clinton is well advised not to spend much of his campaign budget on trying to convert the high-tech executive class, where only 4% would vote for him.

In general, Perot now commands a 35-38% preference among voters across the US compared to about 25% for both Bush and Clinton.

"The AEA numbers are pretty amazing. The bottom line is that Bush will lose California. And without California, Bush is dead", said Richard Carlson, president of Spectrum Economics, a Mountain View consulting firm.

Critics of the AEA poll say the numbers are artificially high because a large percentage of the AEA's 4000-company membership is based in California, where Perot has been more popular than on the East Coast.

Supercomputer runs at 34 Gigaflops

Supercomputer vendor NCube, of Foster City in Silicon Valley has announced a new 8200-processor-based massively parallel processing computer that it claims will deliver 34 gigaflops (34 billion floating-point instructions per second) of computing power. The company also announced plans for a computer that will achieve the 'Holy Grail' of computing power: one trillion flops.

Besides 8192 microprocessors, the new 2S computer also has a whopping 512 gigabytes of main memory. At a starting price of just US$360,000, the machine costs less than US$1000 per megaflop.

NCube founder Lawrence Ellison, who is also chairman of Oracle Systems, said NCube is currently working on a third-generation machine that will not only break the teraflop barrier, but will smash it. The machine will reportedly process as many as 6.5 trillion instructions per second, but could cost as much as US$200 million. ❖

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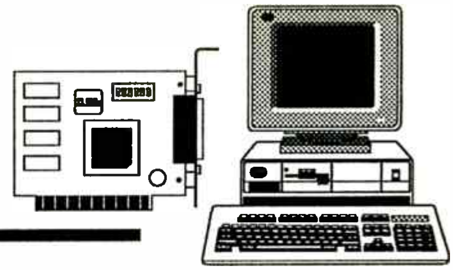
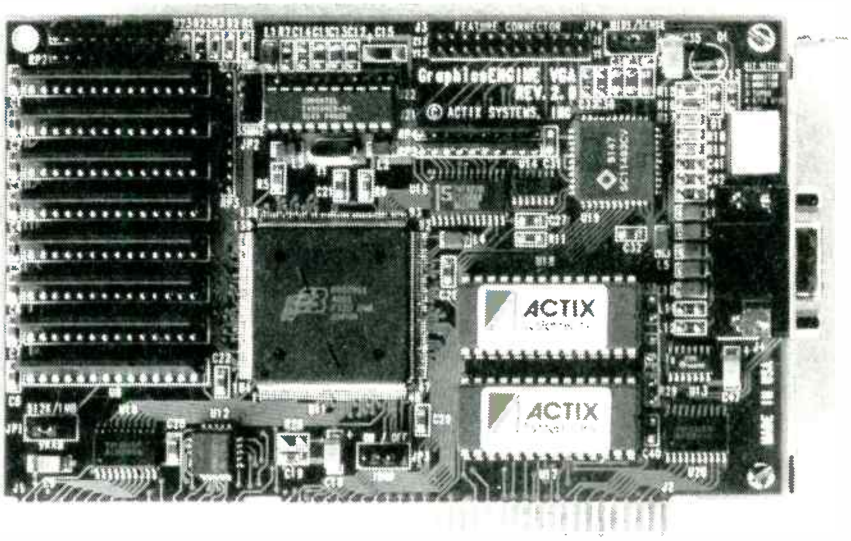
Computer News and New Products



Graphics engine for Windows



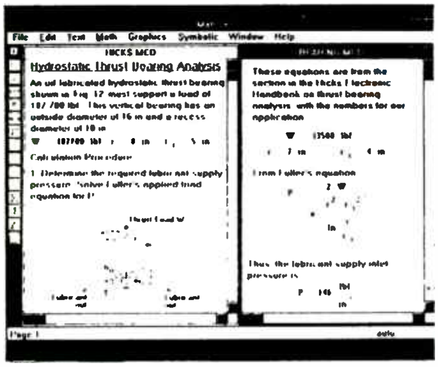
The Actix GraphicsENGINE card, based on S3 Inc's 86C911 70MHz chip, delivers up to 30 times the Windows speed of a standard VGA card, of 12 times the speed of a Tseng Labs ET4000 based card.

Fitted with 1MB of VRAM, it drives VGA, Super VGA and Multi-Sync monitors, such as the new 15" NEC 4FG, at up to 1024 x 768 resolutions with 256 colours and with a flicker-free 72Hz refresh.

The Actix GraphicsENGINE uses the S3 processor to allow graphics processing to be handled on the card, rather than on the computer CPU. This can allow 286 and 386 Windows systems to perform at 486 levels, with significant price savings. Software drivers are included for Windows 3.X, AutoCAD, GEM/Ventura, Cadkey and others. An IBM MCA version is also available.

For further information circle 161 on the reader service coupon or contact Sprinter Products, Level 1, 22 Darley Road, Manly 2095; phone (02) 977 8155.

Mathcad 'handbooks'



Mathcad now has three Electronic Handbooks to give you instant access to the formulae, methods, diagrams and tables which you rely on every day.

You can also modify these formulae for specific calculations. When you change parameters, plots and variables, Mathcad automatically calculates the answers within the Handbook.

By double-clicking on the entry, you can paste the answer into a Mathcad document — along with its correct units!

The Handbooks are: Mathcad Treasury of Methods and Formulas ($180); Machine Design and Analysis from Hicks' Standard Handbook of Engineering Calculations, with 125 practical calculations and procedures ($180); and the CRC Materials Science and Engineering Handbook, with 140 tables of data, bit mapped illustrations and Mathcad plots ($240).

To operate these Electronic Handbooks, you need Mathcad V3.1 for Windows, which retails at $650. For further information circle 162 on the reader service coupon or contact Hearne Marketing Software, 36/458 St Kilda Road, Melbourne 3004; phone (03) 866 1766.

VET 6.9

The new version of the Australian antiviral software, VET is now available. Apart from looking for additional new viruses, including Micro Cops, Pogue, Stonehenger, Squawk, Padded and Mummy 1.2, VET 6.9 has several new features. VET now encrypts itself when you install it, with each version using a different encryption algorithm. This makes it very difficult to write a virus specifically targeted at VET. Also when VET removes a virus from a file, it automatically rechecks the file to ensure it is completely safe.

The price of VET 6.9 is still $90 for a single copy, and educational prices apply for all schools, colleges and universities.

For further information circle 164 on the reader service coupon or contact Cybec, PO Box 205, Hampton 3188; phone (03) 521 0655.

Audio port

The MicroKey Audio Port, manufactured by Video Associates of Austin Texas, is an external digital audio record and play device that plugs into the parallel port of any DOS/Windows based PC. It measures only 60 x 90mm.

Laptop and Notebook users will now have access to Multi Media applications, as there are no cards to insert — the microphone and speakers simply plug into the Audio Port.

Using ADPCM 3:1 compression, Microkey allows you to record high quality audio without using up all your available hard disk space. In fact one minute of narrated voice recorded at 16kHz sampling rate will take up approximately 480KB. The Audio Port has selectable sampling rates ranging from 8 to 44kHz. The Audio Port will play SoundBlaster and Microsoft MPC files, as well as its proprietary MicroKey format. Audio can also be recorded and played back using the Windows 3.1 'Audio Recorder' function, making audio recording even easier.

For further information circle 165 on the reader service coupon or contact Lako Vision, 1/45 Wellington Street, Windsor 3181; phone (03) 525 2788.

'Workstation doubler'

Industrial Computer Source (ICS) has released its keyboard and monitor 'Station Doubler'. This gives you two workstations from one computer, by enabling you to connect a second keyboard, monitor and mouse — the second station being as far as 24m away from the computer.

The Station Doubler can also be hooked up to any automated machinery, robotics, motors, gauges, starters and instruments that have a monitor and keyboard output port, and is compatible with IBM protocols for the video and keyboard signals. It is a hardware system only, with no memory overheads nor software drivers required.

For situations where either an additional workstation is required on a LAN system, or there are only two users on a system, the Station Doubler provides a cheap alternative to the cost of installing a LAN or adding additional adaptor cards, software, and possibly another computer.

For further information circle 166 on the reader service coupon or contact Interworld Electronics & Computer Industries, 1G Eskay Road, Oakleigh South 3167; phone (03) 563 7066.

High speed modems

Telebit Corporation has released two new powerful high-speed modems: the WorldBlazer modem, which delivers transmission speeds in excess of 70,000bps, and the QBlazer, which is a portable V.32 modem.

A high-performance V.32 bis/TurboPEP modem, the WorldBlazer is a powerful standalone modem and networking tool. Telebit's PEP (Packetised Ensemble Protocol) technology enables the modem to take advantage of the entire bandwidth of the telephone line, and maintain connections on lines that

World's smallest fax machine

The Ricoh FAX PF1 measures a tiny 275 x 180 x 54mm and weighs only 2.5kg. This qualifies it as the world's smallest fax machine — and it has an entry in the Guinness Book of Records to prove it!

The PF1 accepts and transmits full A4 size documents, and comes with its own rechargeable Battery Pack which can print 30 A4 pages before requiring a recharge.

It can also be powered from a car battery, with the addition of a Car Adaptor, or from the mains with the optional AC adaptor.

To use the fax, all you need is a normal telephone line, or a cellular phone with the appropriate interface. And to reduce transmission errors, the PF1 is equipped with Ricoh's Error Correction Mode which automatically re-sends any damaged data.

Transmission of an A4 page takes approximately 34 seconds and the PF1 doubles as a mobile photocopier, giving crisp, clear copies of A4 size documents in seconds.

The recommended retail price for the PF1 is $3,850 (including tax), plus $480 for the AC adaptor.

For further information circle 163 on the reader service coupon or contact DBE Australia, 12 Barcoo Street, East Roseville 2069; phone (02) 415 9444.

modems using conventional technologies are unable to sustain.

In addition to its implementation of the V.32bis standard with transmission speeds of 14,400bps uncompressed, the WorldBlazer's TurboPEP mode adds an additional modulation which operates at speeds up to 23,000bps uncompressed. This enables the modem to achieve theoretical throughput rates of up to 92,000bps using built-in V.42bis data compression.

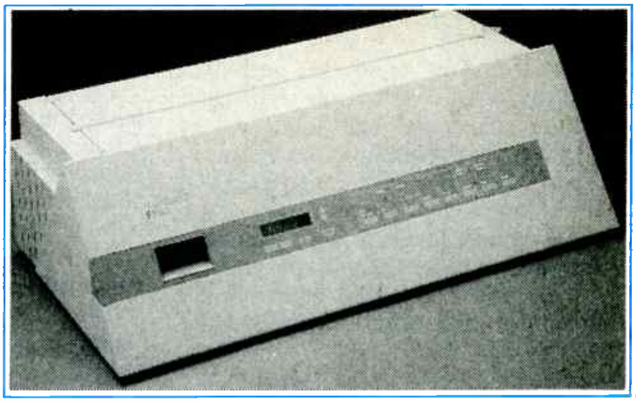
WorldBlazer is designed to accommodate DTE to DLE interface speeds up to 115,200bps, ensuring the highest possible compressed throughput speeds. V.32 bis also offer real-time, interactive communications with non TurboPEP modems.

PEP technology, first implemented with the TrailBlazer product family, divides the voice bandwidth of a telephone line into 511 separate channels, analyses their data-carrying capability and then selects the quantity of data to send on each channel. As line noise increases, TurboPEP modems have the capability to gradually reduce the transmission speed in 10bps decrements, to maximise error-free transmissions.

The other new model is the QBlazer. Measuring just 25 x 25 x 25cm, this is a very small, powerful V.32 modem. Supporting nine-volt battery operation, it is capable of transmission speeds of 9600bps uncompressed, or up to 38,400bps with built-in V.42 bis data compression. The QBlazer is compatible with both PC and Macintosh computers.

Pricing is around $2000 for the WorldBlazer and $1600 for the QBlazer. For more information circle 168 on the reader service coupon or contact NetComm Australia, PO Box 379, North Ryde 2113; phone (02) 888 5533.

Matrix printer runs at 500cps



The new Model E850 Matrix printer from Facit has a character printing speed of around 500 characters per second.

It offers high throughput of more than 400 pages per hour, high print quality and the potential to print original plus up to five copies. Paper handling provisions include paper parking and zero tear-off, with an optional integrated printer stand which makes paper handling even more convenient.

The Facit E850 can be used with a wide range of computer systems, with dual/parallel or serial/parallel interfaces managed by an auto-poll feature that enables simultaneous connection to two computer hosts. Options include IBM Twin-Ax or Co-Ax interfaces and DEC emulation. Target applications include printing of listings, plus single and multipart forms and documents incorporating OCR and colour printing.

For further information circle 167 on the reader service coupon or contact Elmeasco Instruments, PO Box 30, Concord 2137; phone (02) 736 2888.

High-frequency SPICE simulator

Hewlett-Packard has released the HP Impulse, a high-frequency transient simulator that expands the applications of time domain simulation in high-frequency analog, high-speed digital and package-modelling applications.

HP Impulse builds upon the capabilities of the SPICE transient simulator, which it claims compromises accuracy for many applications because it operates only with time domain information. HP Impulse allows the mixing of time and frequency-domain information in the same environment. At the same time it is compatible with most functions of Berkeley SPICE.

By including frequency-domain information, HP Impulse makes available new categories of accurate models and measured data. These include physical models of transmission media and discontinuities such as microstrip, stripline and coplanar waveguide. Previously, users of transient circuit simulators were forced to model equivalent circuit networks to emulate a frequency response.

Models made using this method were limited because they did not include dispersion or skin-effect loss, which are frequency-dependent effects. There are also thousands of transistors and FETs prespecified in S-parameters by their manufacturers.

For high frequency analog circuit designers working in frequencies from megahertz to terahertz, phase-lock-loop analysis, oscillator startup and digital communication circuit analysis are problems that now can be solved with transient simulation. These solutions are now possible because HP Impulse takes

 READER INFO NO. 35

into account transmission-line effects of circuit layout and makes more accurate device models available to the designer.

HP Impulse, integrated with HP Microwave Design System, starts at $48,900. Deliveries are expected to begin in December 1992.

For further information ring Hewlett-Packard on 008 033 821.

Laser printer has inbuilt sharer

Siemens has launched a shared interface version of Mannesman Tally's heavy workload, high performance laser printer, the MT911. The printer allows four users to be connected simultaneously, resulting in higher throughput for lower cost.

The sharer has four built-in serial interfaces, with 256K of buffer space on each port. The machine automatically switches data to the active interface, thus enabling each system to be freed quickly. If the printer is busy, jobs are automatically placed in a queue.

For further information circle 169 on the reader service coupon or contact Siemens Advanced Information Products, 544 Church Street, Richmond 3121; phone 008 032 954.

Real time DSP for Macs

The NB-DSP2305, from National Instruments, is a high performance digital signal processing (DSP) and analysis accelerator board for Macintosh II and Quadra computers.

The board has a 40MHz version of the

TI TMS320C30 32-bit floating-point DSP chip that delivers 40MFLOPS of processing power, 64K words of zero wait state memory, and a NuBus master interface that can directly access Macintosh NuBus boards.

Serial data from the company's dynamic signal acquisition boards can be sent over the Real-Time System Integration (RTSI) bus directly to the NB-DSP2305, while the Macintosh is concurrently using the bus.

The NB-DSP2305 can be programmed with the company's NI-DSP, LabVIEW, and DSP Developer Toolkit software packages.

National Instruments now includes its NI-DSP high-level, ready-to-go digital signal process (DSP) software library at no charge, with its DSP plug-in boards for PC AT and Macintosh NuBus computers. NI-DSP includes 32-bit, single-precision, floating-point analysis functions for Fourier and spectral analysis, digital filtering, waveform generation, statistical analysis, vector and matrix algebra and numerical analysis.

For further information circle 170 on the reader service coupon or contact National Instruments, PO Box 466, Ringwood 3134; phone (03) 879 9422. ❖

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.

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KEY TO CODING:

A Kits and modules
B Tools
C PC boards and supplies
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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) 693 9751.

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.

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ADVERTISING INDEX

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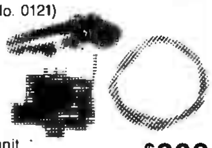
NIGHT VIEWER BARGAINS

A very small telescopic monocular IR viewer. The assembled scope has high quality military grade optics, and employs a prefocussed IR image converter tube. This tube has a useful response from 600-1300 nM, thus also making it useful when working with IR LEDs, and IR laser systems. The scope has provision for a coaxial E.H.T. connection, and is supplied with a power supply kit, that features a ready assembled inverter on a small PCB. The power supply easily fits into a small plastic case, and can be fitted with a belt clip: Also supplied! At a very small fraction of its real value! **$269**
(Item No. 0121)



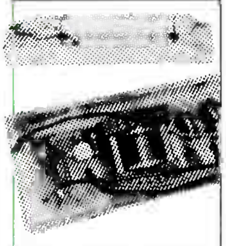
We can also supply the same monocular viewer with its original power supply. Powered by a single 1.5V C type battery. In this case all that is needed is connecting the scope to the power supply unit via a coaxial cable, which is also supplied. **$289**
(Item No. 0122)

LARGE LCD DISPLAY MODULE

Brand new large Hitachi LM215XB display, as used in some laptop computers. Yellow-green LCD reflective type, 480 X 128 dot display, effective display area of 242 X 69 mm, has 14 LSI ICs mounted on the rear of the PCB. Includes four pages of data sheets. Limited stock at a small fraction of their real value. **$39 ea.**

(Item No. 0132)

12V OPERATED LASER WITH A KIT SUPPLY



Save by making your own 12V laser inverter kit. This combination includes a He-Ne visible red laser tube and one 12V universal laser power supply kit — MkII. This inverter features easy construction since the transformer is already assembled and will drive all the 0.2-15mW tubes efficiently. Universal 12V supply plus a used 2-3mW tube or head **$99**

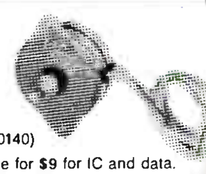
One extra tube or head $30 extra. Only with initial purchase.
(Item No. 0105X)

Universal Supply Kit plus a new 1mW tube **$129**
(Item No. 0105)

Universal Supply Kit plus a new 5mW tube **$189**
(Item No. 0106)

Universal Supply Kit plus a new 10mW tube **$299**
(Item No. 0107)

STEPPER MOTORS



These are brand new units, main body has a diameter of 58mm and a height of 25mm. Will operate from 5V, has 7.5 deg. steps, coil resistance 6.6 ohm and it is a two phase type. Six wires.

ONLY **$12 ea.** (Item No. 0140)

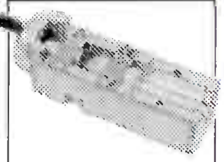
A suitable driver IC is available for **$9** for IC and data.

MUSIC ON HOLD PCB

Small PCB assembly containing two ICs, one of which is a Music generator (7910 CF). The other IC is probably a power amplifier (NEC—CTM701D). Apply 3-12V across two of connector pins to obtain music from one of the IC pins. This information and a circuit diagram is provided.

$4 ea.
Item No. 0146

IR LASERS



This precision collimator assembly was removed from working laser printers, but is supplied with an extra Brand New laser diode to suit. It produces a beam that can be focussed to a fine dot or line. Barely visible, 780 nM/5mW. We also supply a PCB components and instructions kit, for a suitable digital driver circuit that can be used to complete the laser transmitter.
Suitable for communications, data links, perimeter protection, bar code reading, medical, etc. Limited stocks.

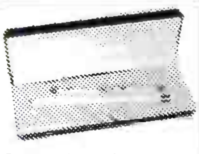
ONLY **$89**
(Item No. 0111)

We can also supply a similar kit which is based on an unmounted collimating lens which will need to be supported in front of the laser diode. This kit includes a brand new 5mW/780nM IR laser diode, a suitable heat sink, a collimating lens, a driver kit (PCB and components) and the instructions.

ONLY **$45**

Note that if either of the above lasers are coupled with a suitable receiver (E.A. April 91) a perimeter protection or data link with a range of a few kilometres should be possible. We tried it over 300 metres, with no problems! We may stock a kit for the receiver which would include the instructions, in July 92. Approximate price **$20** for the PCB, all on-board components, and a suitable relay.

VISIBLE LASER DIODE POINTER-PEN



Suit teachers, doctors, businessmen, and other professionals. Improve and enhance all your presentations. Not a kit, but a complete commercial pen sized laser pointer at an incredible price!

ON SPECIAL AT **$180**

Small pen sized body. Runs on two small AAA battery. Battery life: 2-10 hours. Visible 5mW red (670nM) laser. Projects a visible red spot at more than 50 metres. As used for medical treatment by doctors and acupuncturists.
(Item No. 0101)

SINGLE CHIP MICRO COMPUTER

In the form of a telephone display. Based on an NEC uPD7503G single chip micro computer. Apply power to the unit and the display will show date and time (Xtal controlled oscillator on board) but this is only a small part of the micro computer's features: 4 bit single chip micro computer, 4 bit parallel ALU, 8 bit serial interface, 4096 X 8 bit words of ROM, 224 X 4 bit words of RAM, 23 general purpose I/O lines, 24 line segment outputs and 4 lines common outputs for driving LCDs, instruction set enables direct memory addressing, can be battery operated (3.5-6V), extremely low battery consumption: less than 1mA whilst operating, less than 10uA in standby. Connection to the phone display can be made by simply pushing wires into the socket provided. One complete 15 page set of instructions on the uPD7503G and a circuit diagram of the phone display will be provided with each order for one or more of the phone displays.

ONLY **$15 ea.**
OR 5 for **$60**
(Item No. 0133)

SWITCH COLLECTION

A mixture of no less than 15 switches: 5 off modern 3A panel mounted mains rated switches, 5 off modern 16A panel mounted mains rated switches, and a mixture no less than 5 rotary switches: small and large. That's a total of 15 New switches worth at least five times our total price of **$16**
FOR THE COLLECTION
Item No. 0150

LARGE ROTARY SWITCHES

These large rotary switches have "snap in" action and all are rated at mains voltages, or higher. They have at least three positions and are have currents ratings from 10-35A. Great for high power mains, and antenna switching.

ONLY **$15 ea.**
Item No. 0151

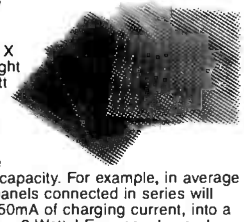
LARGE COMPUTER FANS

Powerful ball bearing mains powered fans. 220V/0.13A, 173mm diameter by 60mm deep. Thermally protected, finger guard included, removed from new equipment. **$9.90**
Item No. 0152

FILTER PCB ASSEMBLY

Contains mainly 8 modern ferrite transformers which are very easy to dissamble and rewind. Ferrite halves are clipped together and no adhesives are used between them or in coil winding. There are four identical small transformers and four identical larger transformers. The transformers can be rewound for use in inverters, inductors, filters, etc. **$5 ea.**
Item No. 0147

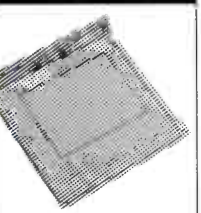
SOLAR PANEL GIVEAWAY



Brand New high quality US made, amorphous glass Solar Panels. Dimensions: 150 X 150 X 2.5mm. In normal sunlight they deliver a full 1 Watt whilst charging 6V-8V batteries! Can be connected in series, in parallel, or series / parallel, to increase the voltage, and/or current capacity. For example, in average sunlight, two of these panels connected in series will deliver approximately 150mA of charging current, into a floating 12V (14V) battery: 2 Watts! Four panels can be connected in series parallel to deliver 300mA into a floating battery: 4 Watts! Compare the prices!
All the panels have a weather protection film on rear, and the terminating clips are provided.

INCREDIBLE PRICING: **$10 ea.**
or 10 for **$85**
(Item No. 0130)

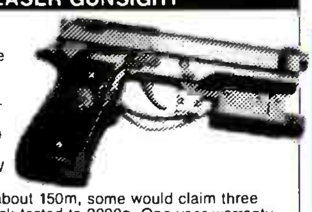
FLUORESCENT BACKLIGHT



These brand units are supplied in their original packing. They are an option for backlighting Citizen LCD colour TVs. The screen glows a brilliant white colour when the unit is powered from a 6V battery. Draws approximately 50 mA. The screen and the inverter PCD can be separated. Could be used as the basis of a solar powered sign, e.g. house number. Effective screen size is 38 X 50 mm. The inverter PCB can be also used for powering backlighting strips on LCD displays. **$12 ea.**

(Item No. 0144)

LASER GUNSIGHT



Small black anodised metal body. Removable pressure switch. Vertical and horizontal adjustments. Battery life more than 10 hours continuous. 5mW 670nM class IIIA laser. Range is about 150m, some would claim three times more. Shock tested to 2000g. One year warranty.

ON SPECIAL AT **$249**

Price includes one rifle or pistol mount (Item No. 0108)

DANGER! LASERS ARE NOT FOR KIDS

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FLUKE **PHILIPS**

Find trouble when you're not there... with the new Fluke 80 Series.

The 80 Series' unique recording functions make it easy to find intermittent faults. Hook it up, walk away, and let the meter do the work.

- MIN MAX AVERAGE recording stores the highest, lowest and true average of all readings.
- Selectable response times let you record such changes as turn-on surges or voltage drift.
- 1 ms PEAK MIN MAX hold on the Fluke 87 lets you capture elusive transients or half-sine surges to 400 Hz.
- Audible MIN MAX Alert™ on all three models signals you for readings above or below previous limits.

The new Fluke 80 Series—with 12 different measurement functions, it's the first multimeter that's truly multi. For a free brochure, contact your local distributor today!

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

Volts, ohms, amps, diode test, audible continuity, frequency and duty cycle, capacitance, Touch Hold®, relative, protective holster with Flex-Stand™.

FLUKE 83	FLUKE 85	FLUKE 87
0.3% basic dc accuracy	0.1% basic dc accuracy	0.1% basic dc accuracy
5 kHz acV	20 kHz acV	20 kHz acV
Analog bargraph & zoom	Analog bargraph & zoom	High resolution analog pointer
Three year warranty	Three year warranty	True rms ac
		1 ms PEAK MIN MAX
		4½ digit mode
		Back lit display
		Three year warranty

READER INFO No. 74

Available from the following Philips Test & Measurement distributors:

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ACT: John Pope Electrical, Aeromotive Maintenance Services.

VIC: Radio Parts Group, Mektronics, Factory Controls, Blackwoods, Emcorp, Technico.
QLD: St. Lucia Electronics, L E Boughen, Colourview Electronics, Auslec, Thomson Instruments, Nortek, Emcorp, Mass Electronics.

SA: AWM.
NT: Blackwoods, Industrial Supplies & Switchgear.
WA: Atkins Carlyle, Leda Electronics.
TAS: George Harvey Electric.
NEW ZEALAND: Communication Instruments, David Reid, Sirius Enterprises, Dick Smith Electronics.