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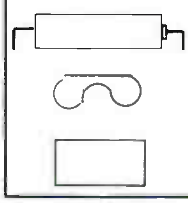

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World Radio History

Electronics Australia with ETI '92

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

Bose improves its Acoustimass 5 system

Louis Challis has been putting the new version of Bose's very compact Acoustimass 5 loudspeaker system through its paces, and the results are very impressive. His review begins on page 12.

Scanning our violent universe

Orbiting the Earth at 450km, NASA's new 16-tonne Compton Observatory is at last providing the world's astronomers with accurate data on the gamma radiation from supernovae, pulsars and quasars. Already the results are forcing them to revise their theories, as Kate Doolan explains in our feature starting on page 26.

On the cover

Examples of the latest in electronics technology (clockwise from upper right): the HEME 2000P clamp-on AC-DC power meter with scope display (courtesy Fastron Australia); the H-P 34401A bench DMM, with the E3611A power supply and the 54601A DSO (courtesy Hewlett-Packard Australia); Sony's new mini CD recorder, due for release this year (courtesy Sony Australia); and the Comsonics Windowlite, a hand-held RF signal level meter for MATV/CATV and antenna installers (courtesy MMT Australia).

Video and Audio

Features

Projects and Technical

World Radio History

Volume 54, No.1
January 1992

ANNUAL DIGEST

Professional Electronics

Columns and Comments

Departments

Australian development: remote metering interface

Developed and manufactured in Australia, Siemens' new CAMRI system uses both the paging and telephone networks for remote reading of electricity, gas and water meters. *(See News Highlights, page 133)*

Setting a good example

How many US company presidents would make calls from a phone box rather than their car phone, to save the firm's money? Intel's president and CEO Andrew Grove does, as we report in Silicon Valley Newsletter *(see page 136).*

Great projects to build

We have four interesting new designs for you to choose from this month:

- *A surround sound decoder, to get greater impact from stereo TV and video programmes*
- *A low voltage cutout, to avoid flat batteries on cars and boats*
- *A 240V power relay unit for computer and hifi systems*
- *An EPROM emulator for microcomputer development work*

World Radio History

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LETTERS TO THE EDITOR

Compact fluoro's

I enjoyed your *Forum* article on compact fluorescent lamps, the information being helpful, but the part dealing with power factor was badly needed. This is a part of electrical practice on which some electrical service people are almost totally lacking in knowledge.

While this may not be a specifically electronics matter, with one exception, I have never met a person who had a comprehensive knowledge of the full importance of this body of AC theory. The article helped to remedy this deficiency.

Bert Heinemann,
Fairfield, NSW.

Help needed

This 71 year old, ex-service pensioner has filed a patent titled 'Sport Umpire System'. (All 11 pages of it). While the brainstorm was OK, I now need to contact a group of people who would work with me getting the system up and running.

The Compaq computer people, have verbally stated they would trial a system after a viable prototype is available. It is based on laser beams, its own dedicated CPU, linked to a dedicated screen, or maybe a laptop computer.

The umpire sees at close range on the screen where the ball was, and he also has it recorded on the m/c for immediate or later verification.

Arthur Pittard,
36 Hubert Street,
Fairfield, NSW 2165

DC welder?

Up here in the sticks, we rely on our own ingenuity for getting things done, that city folk take for granted.

North of the Daintree River, we all rely on our own individual power systems. But we all have one problem when it comes to using an AC welder. Do you think your magazine could design a DC welder powered from an AC generator.

A. Shields,
Mossman, QLD.

Comment: We're not quite sure what you mean, Mr. Shields. Why do you want a DC welder if your generator produces AC? Presumably you could use a fairly standard AC welder — or have we the missed the point?

Vintage radio

My interest in radio started with crystal sets, bright emitters, basket coils and headphones and led to a career of key thumping, radio communications, radar — and eventually, before I retired some years ago, to installing high tech radio navigation aids for the MoD.

However, modern electronics, in general, leaves me cold and this is why I appreciate your articles by Peter Lankshear and Neville Williams.

My latest interest is in renovating domestic radios (both chassis and cabinet) of the early thirties to late fifties era of which, to date, I have a collection of 16. One of these is an Australian manufactured Airzone console radio circa 1936 which has a circular dial escutcheon missing.

If you publish this letter it might help in my search for this item and enable me to complete what will eventually be a good example of Australian radio manufacturing in the thirties.

J. Riddle,
Glenview Road, Motupipi,
Takaka RD1,
Nelson, N.Z.

Inflation

I was first introduced to *Electronics Australia* way back when the magazine was called *Radio and Hobbies*. The fact that I still peruse your pages each month is testimony to its continued excellence.

Although never before having been moved to put character to disc, I must express my ageing crustiness in the criticism of a standards conversion you constantly make and of which I am in total dispute.

I refer to your conversion of pounds to dollars as shown for example in Neville William's article (*EA* June) 'When I Think Back'. To quote just one example, on page 38, bottom of column two, Mr Williams states that "the cost of the basic kit, preassembled and ready to go was £11/11/10. In today's currency, just under $24."!!

Now this price was listed in 1926 as (say) £12. Your conversion implies that this figure equals twenty four 1991 dollars. Surely we should equate early values with present values not in LDS to dollars, but as Dick Smith puts it, "hours worked to purchase".

World Radio History

The early radios were incredibly expensive at that time. Even in the 40's, I saved for weeks to buy a Stromberg three-gang tuning 'condenser', and to assemble a *Radio and Hobbies* project, still a formidable outlay, although substantially cheaper than buying off-the-shelf, new AWA Radiola.

John Twycross,
Denmark, WA.

Comment: Thanks for taking the time to make this point. In future, we'll try to be more careful in our wording in this regard.

When I think back

The article 'From sparks to arcs...' by Neville Williams in your 1990 magazines, were very interesting.

Describing the problems of wireless transmissions in those days, and how pioneers tackled those problems was very interesting reading.

Has radio valve research and development ever been written about, in a similar manner? Technologists in that business must have had prickly problems at times, problems quite unknown to the radio constructor, or broadcaster.

Thanks again, for all the articles on vintage radio.

E. Marbrooke,
Parau, Auckland, N.Z.

Fair go, folks...

The TETIA Television Tips printed with the Serviceman each month are supplied for the information of readers, and to promote the image of the Institute. Unfortunately, many readers take the feature as an invitation to submit their own problems for solution.

The time involved to research and answer many of the questions takes just as long as does a problem on my own bench.

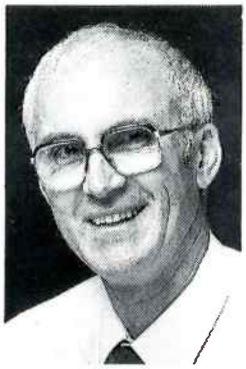
But I have a living to earn, and readers' questions don't buy the bread and butter that I need to keep going. Even worse, the writers never think to enclose a stamp for the reply — so I am doubly bereft.

I regret to tell readers that I cannot afford the time needed to properly answer all the questions put to me. Nor can I reasonably expect any of my colleagues to accept the responsibility.

This is not an outright refusal to help, but it is putting 'On Notice' that only questions with a reasonably simple answer will be considered. And none will be answered without a stamped, addressed envelope for the reply.

Jim Lawler, Hon.Sec.,
TETIA Tasmanian Division,
Geilston Bay, TAS.

EDITORIAL VIEWPOINT



Want to keep reading EA? We need your help — please!

As we enter this new year, with Australia and many other countries still in the grip of a serious recession, I guess most of us have become almost numbed by reports of firms closing and people being thrown out of work. But at risk of numbing or at least depressing you still further, I'd like to tell you about a new and additional threat that is now looming for special-interest magazines like *Electronics Australia* — one that could easily prove crucial to our whole economic viability.

Publishing special-interest magazines has never been easy in Australia, because of the country's relatively small population, and the way that small publication is spread over a very large land mass. Unlike the situations in many other countries, this saddles Australia's special-interest publishers with either low (and therefore relatively uneconomic) print runs, relatively high delivery/distribution costs — or generally, *both*.

Inevitably these factors have meant that for many of these publications (including *EA*) the only way to survive has been by relying heavily on subscriptions. Those that were *not* able to attract and maintain a reasonable 'support base' of subscribers simply aren't here any more...

Recognising these problems, and no doubt motivated by a desire to help all Australians gain the easiest possible access to information, many years ago Australia Post introduced a special system whereby such publications (if they were printed in Australia, and met various other requirements) were eligible for a specially low 'Registered Publication' mailing rate. And there's no doubt that this system has played a significant role in the survival of many of Australia's special-interest magazines — despite the fact that in the last two years or so, Australia Post has increased the Registered Publication mailing rates by a factor roughly *double* the CPI.

But now Australia Post has announced that it is replacing the Registered Publications system with a new scheme called Print Post, which looks like jacking up our subscription mailing costs by a *further* factor of around 70% — despite the fact that we already have the subscription copies sorted into postcode order, wrapped into bundles for distribution and delivered directly to their central distribution point.

Frankly, this kind of *massive* increase in our costs is crippling — especially coming at a time when, like most other media, our advertising revenues have been significantly weakened by the recession. We are going to find it very difficult, if not impossible, to pass on the increases to our poor subscribers; yet by the same token we simply can't afford to absorb it ourselves.

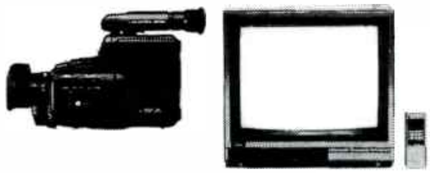
Our only hope seems to be to find an alternative way to have the subscription copies delivered, at a more reasonable cost. But if this can't be found, a lot of special-interest publications like *Electronics Australia* are likely to go to the wall — and possibly as soon as THIS YEAR.

If you want to continue reading *EA*, and see it survive in this our 70th year of publication, I sincerely ask you to write to your local MP and express your concern at what's happening. We need all the support and help we can get — it looks as if we're going to be fighting for our very survival.

Jim Rowe

World Radio History

What's New in VIDEO and AUDIO



Portable dual cassette system

Sanyo has released a portable sound system that is within the reach of most budgets. The MW740F has modern styling and performance to match, with 18 watts (PMPO) power output and an FM stereo/AM radio.

High speed and synchronised tape dubbing can be done with the unit's dual tape deck. Auto-reverse is included on one of the tape decks.

'BassXpander' circuitry adds to the unit's bass performance, and a five-band graphic equaliser lets you adjust sound quality to suit your music.

Line-in terminals enable other equipment, such as a record turntable or an external CD player to be connected. The unit will run from an AC power source or battery power.

The MW740F from Sanyo has a recommended retail price of $199 and is available now from selected electrical retailers throughout Australia.

Affordable mini system

Philips latest mini audio system, the AZ8900, completes the evolution from record turntable to digital compact disc player, by integrating a top loading CD player with an AM/FM stereo digital tuner and auto reverse dual cassette deck.

Advanced operational features on the AZ8900 include programmable memory, introscan and shuffle play. In addition, it features a four band graphic equaliser, 100 watts peak music power, a 'Turbo Bass' generator, detachable two-way speaker boxes, plus an infra-red remote control that operates all functions, including a motorised volume control.

It retails at the affordable price of around $599.

Tapeless, 'no damage' VCR head cleaner

The new Trackmate TM271 VHS maintenance cassette — winner of a British 'Video Innovation of the Year' award — solves the problem of cleaning fragile and inaccessible VCR parts by using a system of three brushes rather than tape.

The three washable brushes are 175% wider than a video tape, to clean not only the areas of normal tape contact but other regions where dirt can accumulate, such as the drum cooling grooves. They are housed in a standard VHS cassette shell, and contain more than 80,000 flexible absorbent filaments, which absorb dirt six times more effectively than conventional cotton buds. Pure isopropyl alcohol is marked onto the brushes from a special pen, to ensure no mess or risk of overdosing.

The TM271 is easy to use. The user simply sets the cleaning cycle by twisting a 'timer' switch, then inserts the cassette in the VCR and presses the 'play' button.

The first brush automatically extends to gently touch the video drum and clean the air grooves which are essential buffers for video tape, as well as the video head pocket and gap which are inaccessible to tape cleaners.

A second brush sweeps the VCR's tensioning arm and adjusts to closely fit the pinch-roller, to clean above and below the tape path. The third brush cleans the capstan. In Aust-ralia the TM271 sells for a recommended $39.95.

For further information circle 181 on the reader service coupon or contact Trackmate Australia, PO Box 652, Avalon 2107; phone (02) 973 1807.

Powered subwoofer uses active servo

Yamaha has incorporated its Active Servo Technology into a new powered subwoofer speaker system, offering the advantages of excellent low bass reproduction and a compact enclosure. Designated YST-SW50, the new subwoofer is a complete system consisting of an Active Servo Technology amplifier and matching loudspeaker system in one cabinet.

The YST-SW50 measures 210 x 475 x 334mm, can be oriented either vertically or horizontally and is magnetically shielded to permit placement near a

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video monitor. The built-in YST amplifier can produce 50 watts of power and the system delivers a frequency range down to 25Hz.

The high end is controlled by a continuously variable high frequency cut-off adjustment from 50 to 200Hz, 18dB/octave. The system incorporates an 18cm (7") multi-range driver and 6cm air woofer.

Since the subwoofer system is self-contained and self-powered, efficiency presents no overall audio system problems, as the YST-SW50 is rated at 103dB/m maximum SPL. Other features include power switch with LED indicator, volume control and phase switch. Yamaha's YST-SW50 subwoofer system has a suggested retail price of $499.

Carousel CD player from Philips

The new CD Carousel Changer range of compact disc players from Philips have a five-disc, touch-loading tray that can be opened and up to four discs changed at once, without interrupting the music.

There are three new models in the range: the CDC552 changer player; the CDC250, a CD changer that integrates with Philips CD series 200 Hi-Fi systems; and the AK701, which incorporated into the Philips Home Audio System range, to deliver a fully featured CD system package for well under $1000. All three units are fully programmable, and provide easy access to any disc or track, as well as easy 'next' and 'previous' track selection and audible up/down search.

In use, all operational and programming functions can be selected directly from the comprehensive front panel controls, or remotely via a convenient, compact full-function 15-key infra-red remote control.

Sonic excellence is naturally assured on all models, with the application of Philips' latest digital decoding IC's and tracking servo circuitry, and the use of 16-bit D/A converters operating with four times oversampling

The CDC522 has a recommended retail price of $399 and is available from jaor retail and audio outlets.

Compact phone answering machines

Aimed at the home market, Panasonic's new telephone answering machines KX-T2396BA and KX-T1006BA have many features to make two-way communication easier.

A major advantage of the KX-T2396BA is its compactness — the one fully integrated system incorporates a fully featured telephone, automatic telephone answering system and automatic dialler. It can either be used as a desk-top phone or be wall mounted.

The KX-T1006BA answering machines, finished in smart grey and white housing with rounded edges, will visually complement other modern appliances in the home. It is easy to connect to an existing telephone.

Thanks to Auto-Logic operation, the user friendly machines perform a complete sequence of functions at the touch of a button. They automatically rewind, play back messages and reset to take further calls.

The tone remote control system on both units lets the user 'call in' for messages as well as activate other functions such as tape reset. The units can even be switched on from remote locations if the user forgets to turn on the machines when going out.

Lighter 'gyro' camcorder

Following on the success of its palm-sized NV-S1A, Panasonic has released an even lighter gyro movie camera. Weighing only 690 grams, the NV-S5A is ideally suited for travellers and anyone who enjoys recording special events.

The fully-featured NV-S5A gyro movie camera has been designed with the latest technology available yet remains easy to use. Innovative features include 12x digital zoom and a horizontal and vertical digital image stabiliser.

The 12x zoom is the greatest magnification power offered by a compact movie camera. Up to 8x zoom (equivalent to a 350mm still camera telephoto lens) is done digitally, so the major part of the image is automatically selected, digitally analysed and enlarged.

The digital image stabiliser compensates the jittery image associated with lightweight, handheld movie cameras while the digital AI (Artificial Intelligence) focus allows precise, quick focusing at any distance from close up to infinity.

The camera also has a new 170gram DL (aluminium diecast, long reliability) mechanism weighing 100 grams less than previous models. This ensures smooth tape transport and accurate mechanical movement for high quality picture and sound reproduction.

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VIDEO & AUDIO

'Hands free' headset phone

Siemens has launced the StarBase headset telephone from Plantronics. StarBase is a telephone and headset combined, which works on any exchange line or as a PABX (private automatic branch exchange) extension but requires no special adaptive engineering. Plantronics, market leader in lightweight telephone headsets, claims to have a 75% market share of the lightweight headset telephone market.

The company believes tnat StarBase will change the way we use the phone, and bring about working efficiency improvements of 11% for normal usage and up to 43% for telephone users who have to operate a computer keyboard. Designed around a compact console measuring 6" x 4", StarBase is small enough to be used alongside an ordinary telephone and plugs into the existing socket. The StarBase user can make and receive calls, store regularly used numbers, dial the last number automatically and adjust receiver volume control for bad line connections. The StarBase headset telephone can be fitted with different headsets for individual users and retails at between $495 and $590 depending on which headset is chosen.

Further details are available by circling 181 on the reader service coupon or by contacting Siemens, Advanced Information Products, 544 Church Street, Richmond 3121; phone (03) 420 7252.

'Mid drive' VCRs from Sharp

The new range of Sharp 'Mid Drive' VCRs have the tape transport mechanism right in the centre of the video recorder, and are designed so that the more sensitive functions (audio and video circuits) are separated from the power supply and placed closer to the drum.

This redness tape fitter (which is claimed to be down 13% in Standard Play and even 30% in Long Play mode) and thereby significantly improves picture quality, particularly in correcting the performance of rented videos. The machines also feature a newly designed lightweight honeycomb shell, combined with a flexible three-point support structure to improve shock resistance.

The machines incorporate auto tracking and auto picture control to create the best picture quality continuously. All units also have the new enlarged polyurethane auto head cleaning roller, cleaning the video heads each time a cassette is loaded, ejected or every time you press 'play'.

There are six Mid Drive models being offered, to suit all pockets starting with the two head VCA33 and VCA38.

The VCA48 incorporates Long Play, allowing up to eight hours of recording on an E-240 tape. The VCA63 and VCA85 incorporate four head, Long Play technology. Superb Hi-Fi sound is available through the two head VCH83 or the top of the range four head VCH85.

All models also have Digital Program Search System, Child-Lock and Quick-Start mechanism.

Yamaha A-V receiver has DSP, Dolby Pro Logic

The first two models of what the company considers a new generation of audio/video receivers have been introduced by Yamaha. The flagship RX-V1050 and the RX-V850 receivers have been designed for the emerging segment of the market which wants a powerful and sophisticated receiver to control a multi-component audio/video system. The two new models incorporate Yamaha's Digital Sound Field Processing with the company's proprietary Digital Dolby Pro Logic enhanced, and combine those features with a versatile, powerful and high quality AM/FM stereo receiver.

These new receivers make it possible to have complete control of a sophisticated audio/video system. The five channel receivers provide ample audio and video inputs, learning-capable remote control and high power and high quality amplifier sections. The tuner sections feature Yamaha's direct PLL IF count synthesiser tuner circuitry and 40-station AM/FM random access preset tuning. The two models also incorporate a four mode Yamaha Digital Sound Field Processor, which recreates actual concert environments in the home, and Digital Dolby Pro Logic Enhanced, which provides a sound field similar to the best movie theatres.

The RX-V1050 deliverees 110 watts per channel, RMS, to 8-ohm speakers for the main stereo channels and the centre. An additional stereo amplifier section provides 30W per channel to the rear, surround, speakers, so that even the most dramatic surround effects can be cleanly reproduced. Suggested retail price is $1799. The RX-V850 delivers 80W per channel to the main stereo speakers and centre speaker and 25W each to the rear effects speakers. Suggested retail price is $1399. ■

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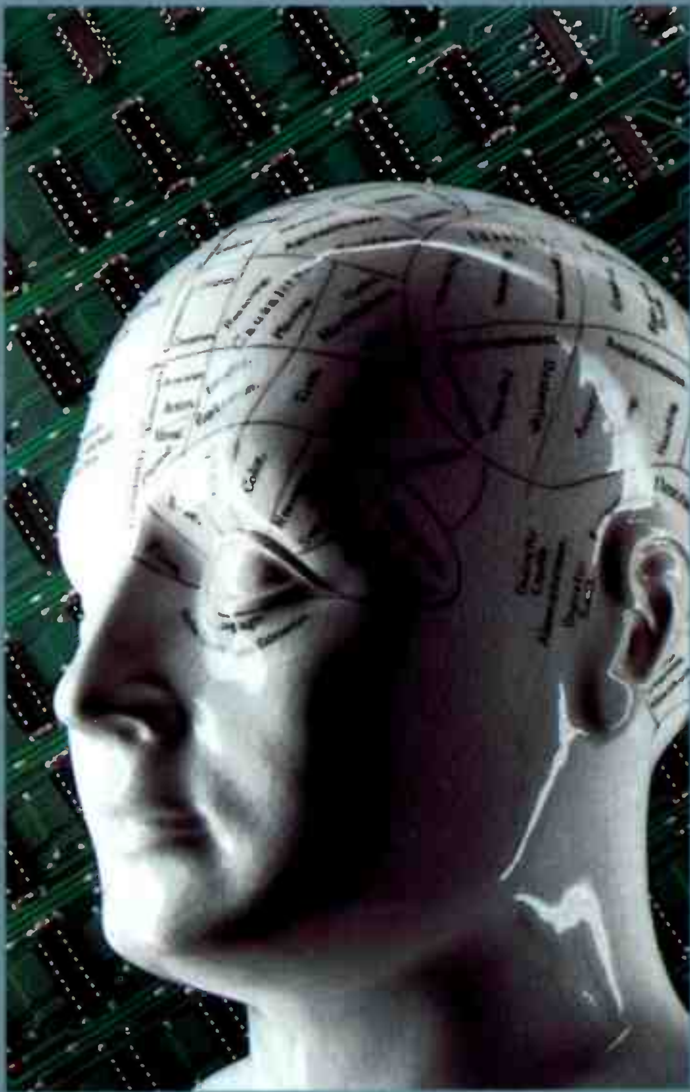

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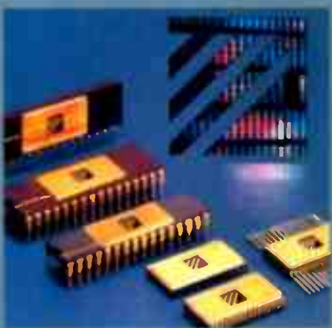

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BOSE ACOUSTIMASS 5 SERIES 2 SPEAKER SYSTEM

Bose was one of the first firms to produce a 'three piece' stereo loudspeaker system, with two small 'satellites' handling the directional midrange and treble components and a single subwoofer unit to handle the non-directional bass. This month Louis Challis has been testing the firm's new 'Series II' version of its very popular Acoustimass 5 system.

A couple of months ago I received a fax from Ray, (one of my friends), containing a copy of a proposal from a well-respected hi-fi retailer, outlining a proposed system for my friend's new home. With the letter came the suggestion from Ray that I might like to come over, share a drink and discuss the proposal with him and his wife.

I'd almost forgotten the letter, when a week later my social secretary (and better half) advised me that we would be stopping by at Ray's new house that night, and gently suggested that I should take his fax with me.

When I finally entered Ray's living room and compared the list of equipment with the room's unusual characteristics (by way of built-in furniture and its lack of space for conventional speakers), I had to agree with the retailer's proposal of a Bose Acoustimass 5 system — on purely functional grounds.

Notwithstanding, I was not really enthusiastic about giving my full blessings to the system. My reluctance stems back to my last subjective evaluation of the Acoustimass 5, when I compared them with another set of conventional Bose speakers; frankly the Acoustimass 5 only came out 'runner up'.

Ray's initial request for a little support put me in a most perplexing situation, because as hard as I racked my memory, I just couldn't think of any

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The largest component in the Acoustimass 5 system is the bass enclosure, but this can be positioned unobtrusively behind a screen — or even behind the sofa. The two visible satellite units are very much smaller.

other suitable speaker system which could satisfy his unusual space and the demanding visual requirements of his living room. I quietly left the house, suggesting that I would carefully review the issue and try to identify an alternative speaker system with which he and I would both be happy.

Lo and behold, two months passed. And although my wife reminded me of my promise on a number of occasions, I just couldn't think of any other speaker system which would fill the bill. Now what was the matter with the Bose Acoustimass 5 system, that I couldn't bring myself to recommend them?

Hadn't I already nominated the Acoustimass 5 for a CEASA award, for innovative design? Hadn't I personally nominated the Acoustimass 5 because I believed its double-ported bandpass bass filter design constituted one of the most ingenious developments in the last decade? Well yes, I had, and it does!

So why was I no longer prepared to recommend this speaker system to my friend — after all I had already said in public, and had obviously believed when I said it?

Well, it's true that the Acoustimass 5 is almost revolutionary in concept, with two pairs of fist-sized satellite mid-range/tweeters that are so small that most people look around for the 'real' speakers making all that sound, and are terribly confused when they can't find them. The trouble was of course that the self-same revolutionary aspects of the Acoustimass 5 required some equally basic evolutionary steps — to clean up some inadvertent deficiencies, which the designers seemed to have ignored and I identified only when I had the chance to audition them in a conventional A/B test.

Foremost amongst those deficiencies was an audibly perceptible and regrettably relatively wide notch in the frequency response, at just under 200 Hertz. Next was a higher level of audible distortion and colouration than most people would expect — or even accept, from what was being marketed as a top line speaker system. Whilst Bose Corporation took the 'slings and arrows' fairly gracefully at first, after a while they realised that whilst the Mark I Acoustimass 5 system was good, there was absolutely no reason that they shouldn't make them better. And so we come to the new Acoustimass 5 Series 2.

Improved model

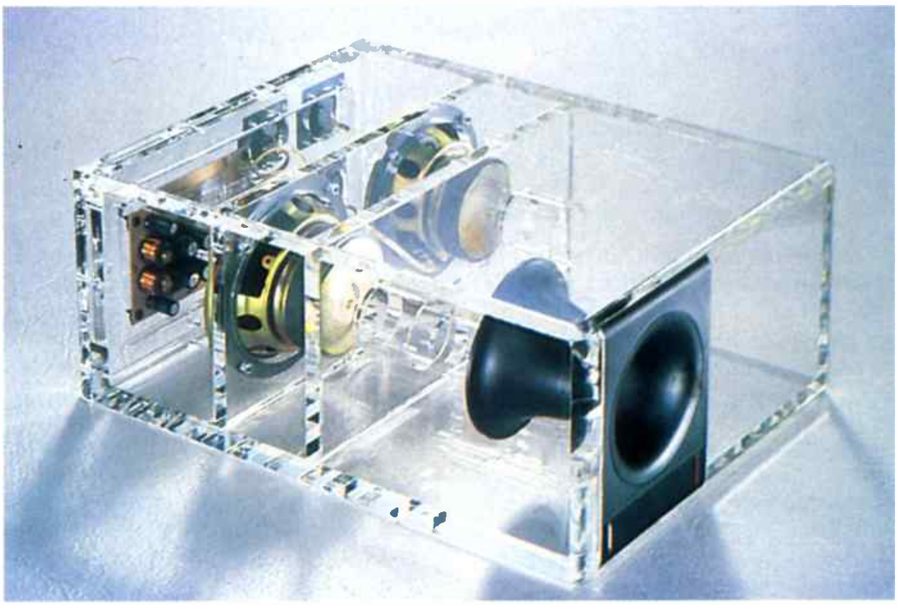
It was with the new model that the Bose innovation has become truly evolutionary — although I didn't really find out just *how* evolutionary, until I asked for a cut-away picture of the bass unit.

Instead of a picture, I was lent a magnificent Plexiglass working model of the bass unit itself, which was the talking point in my living room for more than a week.

As I soon saw from examining the Plexiglass enclosure, the bass module now has *three* separate chambers, with three primary tubular loading ports and one (black) moulded plastic venting port, whose diameter (and beautiful aerodynamic shape) flares smoothly from 60mm at its throat to just under 100mm at the outlets at both ends.

The one long and two short internal porting elements form an unconventional double-vented speaker enclosure, with true bandpass frequency response characteristics. These extend its operating range from below 50Hz to just under 200Hz.

The third chamber, into which the loading ports of the other two cham-



Bose has produced a small number of Acoustimass 5 bass units made from transparent plastic, to show the internal detail. The two drivers have a tuned volume on each side, with twin ports coupling to a third volume.

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The rear of the bass unit and one of the satellites. Both cables from the amplifier run to the bass unit, and then separate cables run from it to the two satellite units.

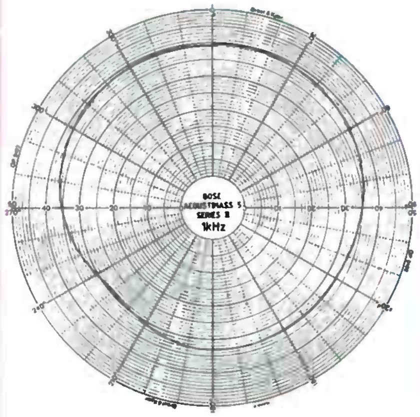
bers terminate, provides an important frequency trimming characteristic, which ensures a smoother transition of the bass module's frequency response — to smooth over most, although not quite all, of the nasty gap evident with the original (Mark I) version.

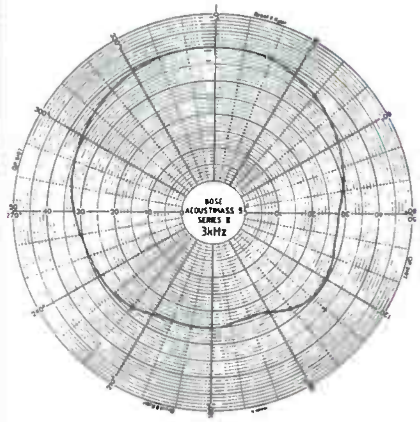
Added to this, the two satellite combined mid-range/tweeters now produce substantially less distortion, and will still handle prodigious levels of power, with only the simplest form of protection elements.

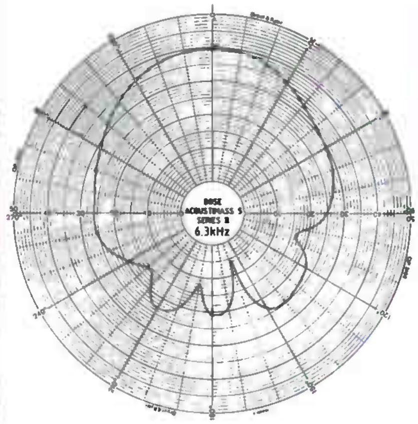
In more detail

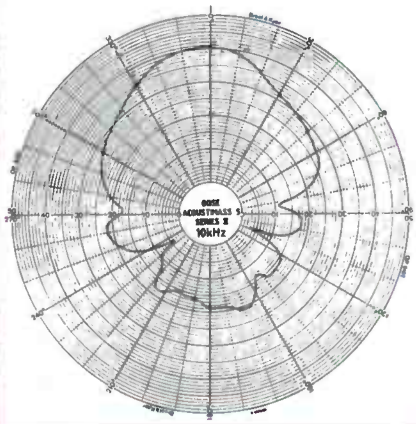
The Acoustimass 5 Series 2 system is remarkably basic and totally disarming in its first impressions. It uses a single innocuous black box as the bass unit, in which the crossover networks are incorporated.

The two output channels of a standard stereo amplifier are simply connected with two separate leads (provided) to the spring loaded terminals on the back panel of the module.

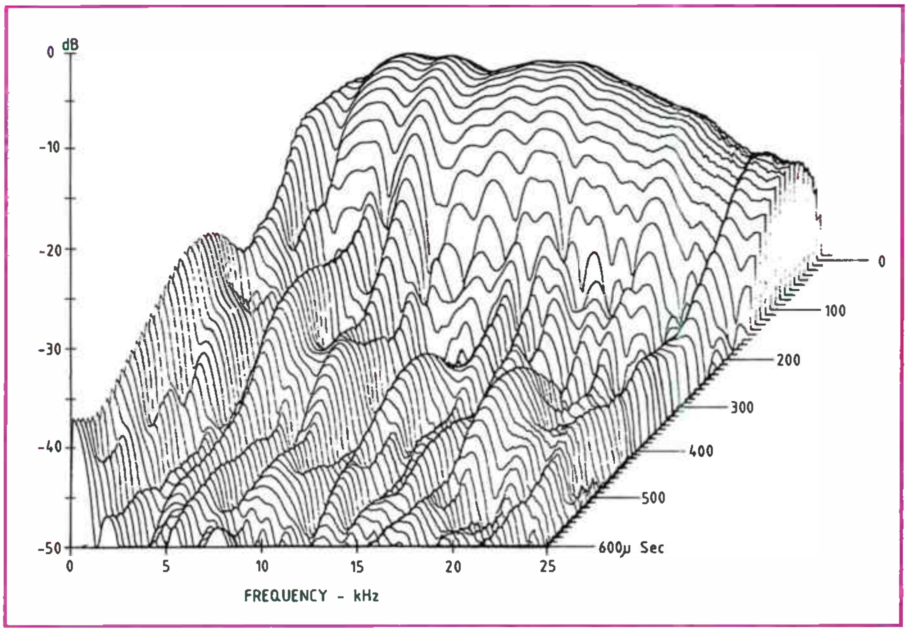








Polar plots for the Acoustimass 5 Series 2 system at 1kHz, 3kHz, 6.3kHz and 10kHz.



The cumulative decay response characteristic for the Acoustimass 5 Series 2 is remarkably smooth — impressive considering the small size of the satellite drivers and enclosures.

The user then connects up the two pairs of satellite speakers to two additional sets of spring-loaded terminals, located above the input terminals on the same otherwise blank rear panel.

The two pairs of satellite speakers are remarkably small. Each satellite incorporates two vertically stacked minuscule 60mm diameter drivers, each in its own miniature cabinet, and with the ability to rotate the upper unit with respect to the lower unit.

A single pair of colour coded spring loaded terminals is located behind the lower of the two speakers, as is a convenient recessed screwed socket to facilitate future mounting options.

Having connected up the satellite system with cables provided, you then have to decide just where you're going to put them, and more importantly on what (or to what) you will attach them. But Bose has already foreseen that problem, and has developed two different sets of brackets (optional extras) to simplify the installation task.

The obvious preference of most users will be to place the satellite speakers high up on the wall. With the speakers mounted in that position they can be used to provide conventional direct radiation patterns, or if you prefer (and most users will) a combination of direct and reflected sound, to achieve superior dispersion. Particularly so if appropriate reflecting walls, or corners, are located at a suitable distance from the selected mounting position.

Objective tests

I was sufficiently impressed by the published Bose claims to carry the Acoustimass Series 2's straight into the anechoic chamber — to find out how good they really are, and if they have overcome my previous concerns.

For the initial series of tests, I set up the two pairs of satellite speakers (i.e., all four drivers) on the top of the bass module, with the mid-range/tweeters all pointing directly forward and towards the microphone.

This of course produces a situation in which the combined satellite speaker outputs are +6dB relative to the bass unit (or to a single unit in isolation). But it does ensure that there are no anomalous loading effects on the cross-overs or the output circuits.

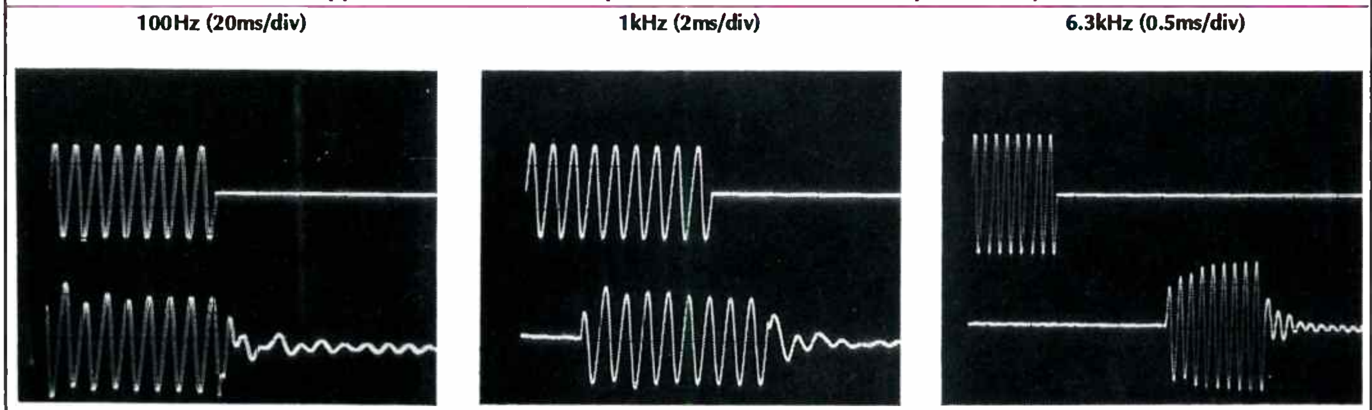
As I soon discovered, the output of the bass unit generates the typical double-peaked bandpass response, which was a trifle more peaky than I would have expected. It extends from 40Hz and 170Hz, with a dominant peak at 50Hz and a modest peak at 130Hz.

Not so surprisingly the output of the satellite speakers extends from 230Hz to 18kHz. These outputs are relatively smooth, with just a modest trace of brightness between 2kHz and 7kHz and a further region of brightness between 10kHz to 14kHz.

Repeated measurements with different configurations reveals that there is still a trace of a notch around 200Hz. But it is not nearly as wide nor as deep as with the original Acoustimass 5, and it looks much more like the conventional crossover notch that many two-way and three-way speakers produce.

You shouldn't be fooled by the frequency response curves, all of which are subject to the additive +6dB factor

Tone Burst Response of Bose Acoustimass Series 2 Loudspeakers
(For 90dB Steady State SPL at 2m on Axis)
Upper trace is electrical input and lower trace is loudspeaker output



The results of tone burst tests at 100Hz, 1kHz and 6.3kHz show that the system has no obvious vices.

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which results from the combined outputs of the four satellite speakers. When those results are equated to the output of one satellite speaker, and allowance made for the expected different pointing angles for each of those speakers, the frequency response is relatively smooth. More importantly, the measured distortion levels of the Series 2 satellite speakers have dropped quite dramatically, particularly when compared with the Series I parameters.

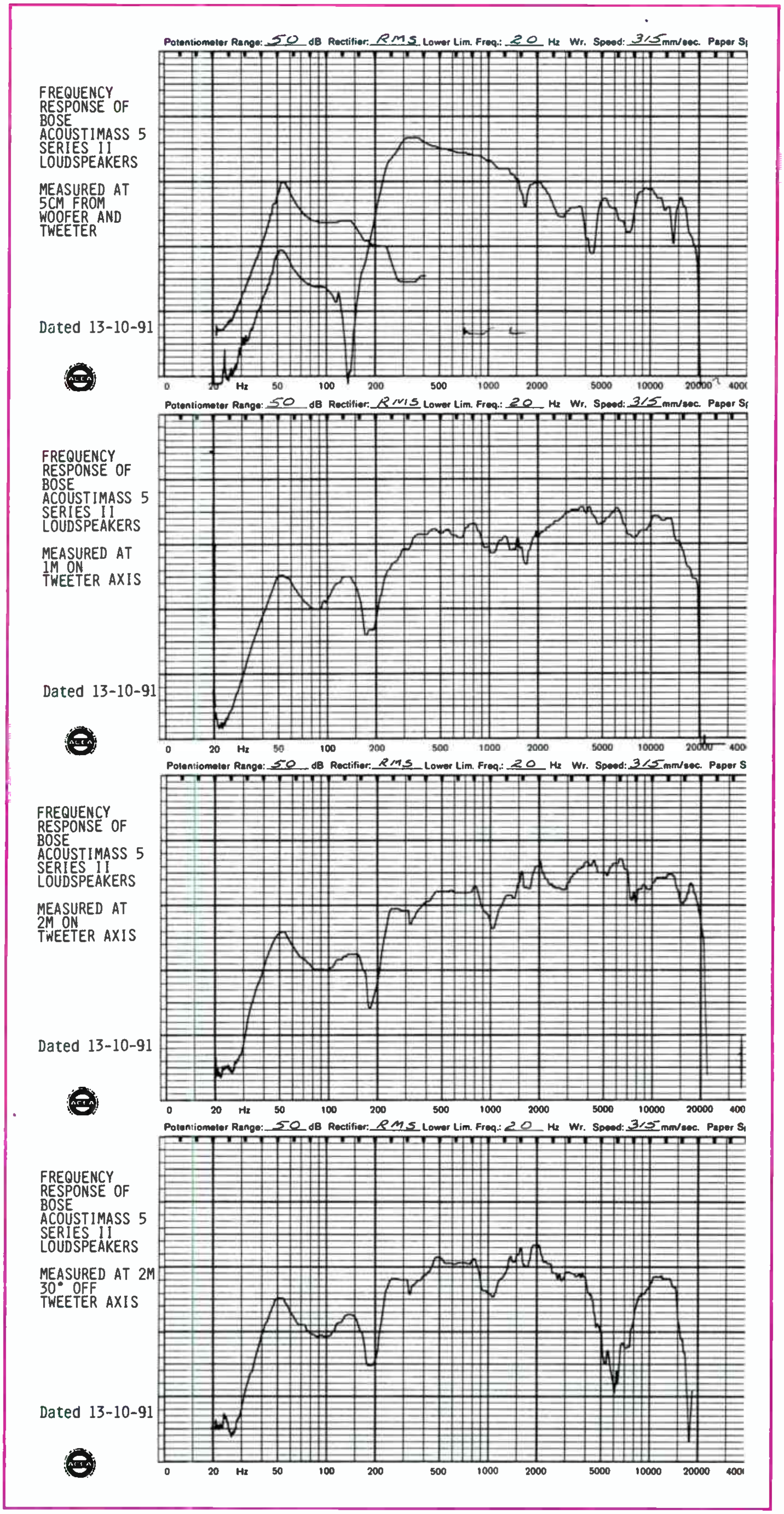
An equally significant factor is readily deduced from the polar plots. These reveal that the high frequency output (i.e., that above 6.3kHz) is fairly directional, so that you really do need to point the stacked modules in different directions in order to obtain a more diffuse and better balanced spread of their output signals.

It is obvious that sometimes one attribute may have to correct for some other potential limitation, and that would appear to be very much the case with these pairs of satellite drivers at the upper end of the audible frequency spectrum. By the same token, if the satellites are placed close to the corners of a room with one or both speakers pointing into the corner, you can achieve truly wonderful dispersion.

When the tone burst tests were examined, it was clear that the satellite speakers display no obvious vices. I was particularly pleased to note that the cumulative decay response curves reveal a transient decay performance that is remarkably smooth — particularly when it is realised that these so-called 'tweeters' use what some people may consider to be conventional dynamic drivers (but which are in fact relatively non-conventional long throw electrodynamic radiators) to cover two full decades of the audible spectrum, stretching all the way from 200Hz to 20kHz.

Frankly this is no mean feat, and you have to admire the perspicacity of whoever it was at Bose who had the audacity to propose, and subsequently achieve that goal. An examination of the decay response spectrum reveals relatively few dominant resonances, with only one modest one at 2kHz, a somewhat lower one around 8kHz and a single dominant one at around 22kHz — which is well above what most people can hear, and above the range of what most CD's produce.

When viewed in the light of their price and more importantly their size, the decay response spectra of the Series II's are remarkably good, and certainly much better than I might have



The frequency response curves reveal a typical double-peaked bandpass response from the bass unit and a very small notch in the crossover region. Over all the response is pleasingly smooth.

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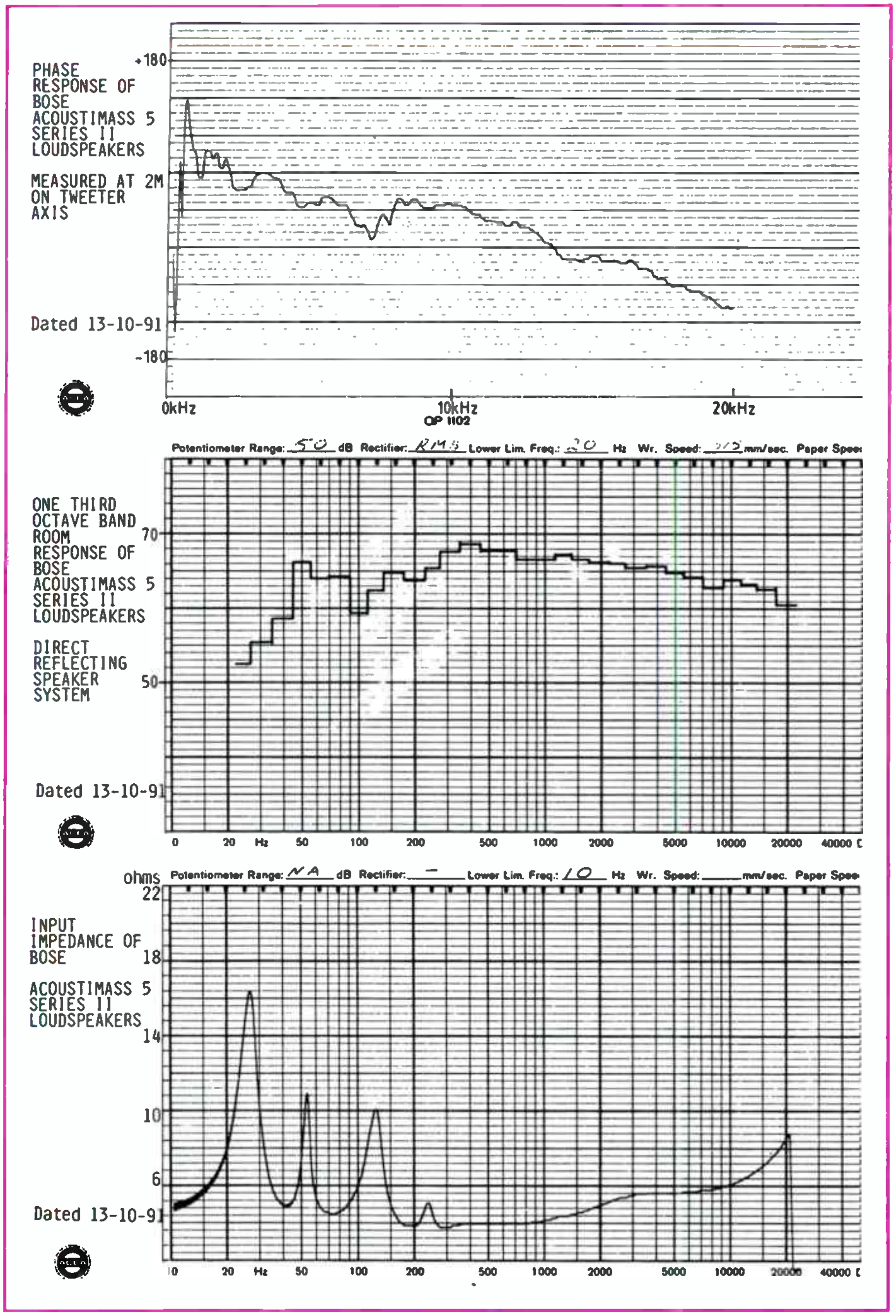

Three further curves for the Acoustimass 5 system. Note the multiple peaks in the input impedance curve, and the minimum level of around 4 ohms.

reasonably expected from the Series I performance characteristics. The 'on axis' phase response is also remarkably smooth.

But again that is one attribute that could reasonably be expected from a combined mid-range/high frequency system that uses single drivers (or more accurately four separate singles) to cover those two difficult frequency decades.

The one-third-octave band room response measured with a pink noise input is again relatively smooth and unquestionably good. Whilst I have seen results that are as good, or even better, with few exceptions those results were achieved with speaker systems that cost considerably more than the Acoustimass 5 Series 2's.

Last but not least, I evaluated the distortion and impedance characteristics — only to find that the distortion figures are particularly low, and that these speakers present a very real 4 ohm input impedance over much of the range.

Which means that you really shouldn't parallel them with any other speaker systems, unless your amplifier is capable of driving a 2 ohm (or at worst a 3 ohm) load.

Subjective tests

I spent considerably more time in the subjective evaluation of the Acoustimass 5's than I have for almost any other speaker system I have recently reviewed. As well as carrying out the evaluations by myself, I also used various members of my family and of course friends to assist me. Yes, you guessed it — I invited Ray and his wife along one evening, to give them a chance to review the speakers and to gauge their feelings and responses.

I started off with some delightful new classical music discs, featuring Claudio Abbado and the Chicago Symphony Orchestra playing Tchaikovsky's *1812 Overture* (Sony Classical SK 47179) — if for no other reason than that you have real cannon to listen to! Consequently it provides a really telling test of the bottom end frequency performance, of these or any other speakers.

Claudio Abbado's style is somewhat different from Solti's (one of whose versions I have) and his handling of this piece, although somewhat different is nonetheless delightful, and the orchestra clearly warms to his direction.

When I got to the cannon I set up a conventional 'A-B' replay with the CD player, so that I could sequentially compare the Acoustimass 5's against my B&W 801M monitors. Whilst the Acoustimass 5's wouldn't reproduce the 20 to 40Hz components with anywhere near the same ease or fidelity as did the 801's, they still provided an acceptable cannon shot — even if it was a trifle muted.

The following selection on the same record, the *Romeo and Juliet Fantasy Overture* is exquisitely rendered, and some of my review committee stated they were having difficult in detecting substantive differences between the performance of the B&W 801M's and that of the Acoustimass 5 Series 2's. But I had no difficulty, and I clarified the differences by performing true 'A-B' comparisons.

The next disc I used for reviewing the speakers was a new release of an old version of Dvorak's *From the New World* Symphony No 9, with Eugene Ormandy and the London Symphony Orchestra (Sony Classical SBK 46331). This is a wonderful, rich and warm rendition and is one of my favourites. I suspect it would be acceptable to almost all listeners, even those who claim that they prefer rock and pop. Both my reviewing panel and I were exhilarated by the music, and were without exception impressed by the Series 2's performance. It was clean, undistorted and without any real signs of colouration or distor-

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tion. I reviewed a large number of other discs, one of which I was offered to evaluate the speaker's performance on more modern idiom.

This was *If I Can Find a Clean Shirt*, by Waylon and Willie. The music was not really to my taste, but the wideband performance provided by the speakers was first class, and I noted that the younger members of the evaluation panel were more than suitably impressed by both the music and the speakers' ability to render it.

In summary

The Bose Acoustimass 5 Series 2 is unquestionably a good speaker system. Bose has obviated and overcome virtually all of the vices of the Series I, and although not being 'almost invisible', as the manufacturer's literature boldly claims, the system comes jolly close to achieving that accolade — particularly if you place the bass driver module at an appropriate and innocuous point on the floor, from which it is not clearly visible to the uninitiated.

At $1599 the Acoustimass 5 Series 2 could hardly be described as being inexpensive. Notwithstanding, I believe that they do constitute good value for money.

Measured Performance of Bose Acoustimass 5 Series 2 Loudspeakers — Serial No 89113

Frequency Response	40Hz to 20kHz =+/-8dB			
Crossover Frequencies	200Hz			
Sensitivity (for 90dB average at 2m)	4.2 VRMS = 4.4 Watts (nominal into 4 ohms) (Total system input each separate channel 4.0 ohms)			
Harmonic Distortion (forindicated levels @ 1m) (Total system both channels)		**96dB 100Hz**	**96dB 1kHz**	**90dB 6.3kHz**
	2nd	-33.3	-45.7	-45.23-dB
	3rd	-40.6	-50.1	-48.9 dB
	4th	-53.2	-62.7	-55.9 dB
	5th	-52.2	-68.0	-
	THD	2.4%	0.61%	0.68%
Input Impedance (Total system)	100Hz	6.0 ohms		
	1kHz	4.1 ohms		
	6.3kHz	5.6 ohms		

Especially if you have any restrictions on space for installing your speakers, and if you want to achieve better performance without disrupting your residential or working abode.

Guess what? After our panel review, my friend Ray and his wife have now decided to buy not one pair, but two!

I, however, decided that if I was to purchase an Acoustimass 5 Series 2, it would have to be the Plexiglass demo model — which offers both performance and additional visual interest. I suspect the marketing people at Bose Corporation may find it worthwhile to offer this version as an alternative to the standard models, even if it had to carry an additional cost premium.

By the way, the dimensions of the Acoustimass 5 Series 2 bass module are 360 x 190 x 485mm, while each satellite unit measures 160 x 80 x 120mm. The overall weight of the system is 12kg, including cables.

Further details are available from Bose dealers, or direct from Bose Australia, PO Box 327, Rydalmere 2116; phone (02) 684 1022. ❖

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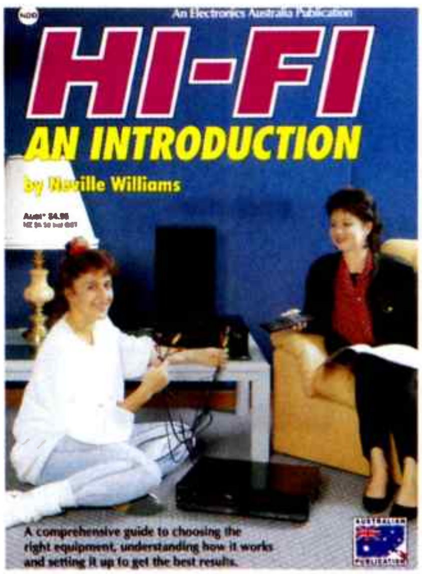

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Profile of a pioneer in satellite navigation:

'BLIND' MAN SHOWS THE WAY IN USING GPS

Trimble Navigation is probably the best-known US maker of both military and civilian navigation receivers based on the satellite-based Global Positioning System. Its binocular-sized handheld GPS receivers were a big hit with the US Army during the Gulf War, and undoubtedly helped decide the outcome. Not surprisingly, the firm's founder is a traditional entrepreneur — energetic, hard working and highly motivated. But considering the fact that his products are being used around the world to show people where they are, more clearly and accurately than ever before, it's ironic that he's also legally blind...

by MIKE LANDSBERG

'Charlie' Trimble, founder of Trimble Navigation in Sunnyvale, has always been doggedly determined and relentlessly self-analytical. As a high school freshman in Fallbrook, then a rural farm town north of San Diego, Trimble decided he would attend the California Institute of Technology because "I thought it was the hardest school in the country to get into."

Once he arrived at Caltech, Trimble realised his IQ of 145 was only average for the intensely competitive school, and coolly decided to drop his first choice of studying mathematics in favour of engineering and physics.

He later opted not to stay for his doctorate because, he said, students needed an IQ of 160 to get a doctorate in three years and he didn't have the patience to study any longer than that.

Trimble instead moved north to Silicon Valley, spending 14 years at Hewlett-Packard's integrated circuit division in Santa Clara before starting Trimble Navigation in 1978 — to build marine navigation equipment.

The company soon branched into a new technology the Global Positioning System, or GPS, a network of US Air Force satellites that allows receivers on earth to instantly measure longitude and latitude within 50 feet (within inches on military systems).

Some of the navigation receivers produced by Trimble Navigation. Most are equipped for GPS, in some cases in combination with other services such as LORAN and Omega.

Gulf war 'hit'

Hand held GPS receivers built by Trimble Navigation were a big hit with the US Army during Operation Desert

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Charles Trimble himself, founder and chief executive of Trimble Navigation.

Storm, putting a sudden spotlight on the man and his company.

Commerce Secretary Robert Mosbacher and US Senator John Seymour visited Trimble Navigation late last year to praise the company's technology. And Trimble was chosen as one of 12 'Best Entrepreneurs of the Year' in a competition sponsored by *Inc.* magazine.

Trimble, who recently turned 50, isn't basking in the glow of his company's newly acquired high profile. He is working 65 hours a week to achieve his goal of building a Fortune 500 company.

If Trimble Navigation sustains its current pace, Trimble won't have to wait long. Financial analysts expected the company to reach US$145 million in sales for 1991, more than double the 1990 results, and four times 1989's sales.

Trimble's GPS Pathfinder Basic is a compact portable GPS receiver with inbuilt antenna, which computes either latitude and longitude or latitude, longitude and altitude. It's roughly the same size as a pair of binoculars.

To get into the Fortune 500, Trimble will need sales of about US$600 million.

Trimble is already reaping in the financial rewards of his company's progress, including a recent initial public stock sale. His salary at US$258,000 is still modest by Silicon Valley chief executive standards, but he owns company stock worth more than $25 million.

Risking it all

Yet, money isn't what motivates Trimble. In the late 1970's, he invested US$10,000 with a few friends to buy a Mountain View apartment building, a deal that netted him US$100,000 five years later when the complex was sold.

Convinced he could find another job if his new venture wouldn't fly, he invested everything he owned into Trimble Navigation. His initial salary was half the US$48,000 he was making at HP.

"The people who do this are achievement oriented," Trimble explains. Trimble's management style is casual but intense. He sits quietly in meetings and doesn't complain when others interrupt his conversation, waiting for the right moment to toss out a carefully worded question that focuses the debate.

"He sees the big picture very clearly," said his brother, Gordon Trimble, an economist for the state of Hawaii's Foreign Trade Zone in Honolulu. "A lot of us get caught up in details and remember things that aren't of great importance."

"I think he's very proud of the fact the company is called Trimble Navigation, but I don't think it's gone so far that he thinks the company is a one-man show," added Bradford Parkinson, a Stanford Professor and Trimble director who helped develop GPS while serving as an Air Force officer during the 1970s.

Just about everyone at Trimble Navigation calls the boss 'Charlie' during his regular walking tours of the company's eight buildings. His office door, rarely closed, is jsut a few steps from the office of his 75 year old father, Robert, who officially retired from a lifelong career of chemical engineering more than a decade ago but still works 60-hour weeks as Trimble Navigation's corporate secretary and treasurer.

"He's always been an entrepreneur," said Robert Trimble of his son. "He's the easiest guy in the world to motivate."

Legally blind

Trimble took to the business world early, selling soap door-to-door to raise money for YMCA summer camp and peddling avocados from the 1100 avocado trees on his family's farm, even

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though he said he never liked to eat them. This determination to succeed overwhelmed a potential handicap. A genetic condition that causes a buildup of scar tissue inside the eye left Trimble legally blind from birth. He is able to read by holding books a few inches from his face, but without enough vision to obtain a driver's licence.

To get through Caltech, Trimble carried a small pair of binoculars that allowed him to follow lectures and take down notes from the blackboard. But his diminished vision isn't an issue at Trimble Navigation. "I'm annoyed that I don't drive, but other than that, it's not a big effect on me," Trimble said.

Trimble, who lives in Los Altos Hills with his wife and 13 year old daughter, recently had to give up sailing, one of his favourite hobbies — not because of his vision, but because of his schedule. He sold a 30 foot racing boat docked in Sausalito because "it ended up racing a lot more than I did..."

"The reason you do this sort of thing is not because you want to get rich, but because you have a dream of seeing something that wasn't there before. The real risk you take is ego risk as opposed to financial risk, because you wind up tying your whole ego into what you're doing," he continues. "None of us wants to be face-to-face with being a personal failure." Trimble has probably accomplished enough to avoid the label of personal failure, regardless of what happens to Trimble Navigation, but the company's path to the Fortune 500 is covered with obstacles.

GPS is clearly destined to become a major industry in the 1990's. The US Air Force has spent 20 years and US$10 billion designing satellites called Navstar, which can provide exact position information to ships, airplanes, automobiles and — when the electronics get small enough in about three to five years — with portable receivers no bigger than cigarette packs. When the full constellation of 24 Navstar satellites are in place in 1993, GPS readings will be possible anywhere on the globe, 24 hours a day.

Competition looming

Trimble Navigation is now the biggest company devoted solely to GPS and is regarded as a technology leader. But the market is quickly drawing new competitors. As many as 80 companies around the world are hard at work developing GPS receivers, according to Trimble, and he has to keep Trimble Navigation ahead of the pack. The newest entry is potentially one of the biggest threats: Sony has introduced a hand-held unit in Japan that will sell for US$1140, about half of Trimble Navigation's price.

Trimble's response is to plow 25% of its revenues into research, constantly seeking new ways to make GPS receivers smaller and more versatile.

"We believe we're investing more heavily in this technology than anybody else in the world," he declared. More immediately, Trimble is coping with a sudden inventory bulge after increasing production for the Persian Gulf war. With a glut of GPS receivers on the market, Trimble is scrambling to sustain a payroll that has swelled to 750 from just 475 at the end of 1990.

Trimble said the pressure can be overwhelming. "Discretionary time that you never knew you had gets sucked out of you." He cuts through the clutter by selecting five problems to resolve at any one time, solving one of them before allowing a new one to occupy his time. ❖

GPS and how it works

The Global Positioning System or 'GPS' was conceived by the US Air Force in the early 1970's, as a way of achieving pinpoint navigational accuracy anywhere on Earth. The full system will use an array of 24 satellites, but these won't all be in place until 1993. At present there are 16 of the Rockwell 'NAVSTAR' satellites in place, each rotating around the Earth every 12 hours at an altitude of 10,900 nautical miles, in orbits inclined at 55° to the equatorial plane.

GPS is a time-delay triangulation ranging system, using signals transmitted from the satellites on carrier frequencies between 1227.6MHz and 1575.42MHz in the UHF/microwave 'L' band.

The transmitted signals consist of special pseudo-random binary code sequences (PRBS), with accurate timings derived from on-board atomic clocks. Each satellite has its own characteristic PRBS, allowing them to share common frequencies.

A receiver for GPS uses the signals from a number of the satellites, comparing their exact timing to determine its distance from each. This allows the receiver to determine its own position, knowing that of the satellites.

Larger and more costly GPS receivers have multiple receiving channels, and can compare the signals from two, three or four satellites in real time. This allows them to give faster results, and also to provide information on speed and course heading as well as location. More compact receivers generally have a single receiving channel, and use time multiplexing to receive and compare the various signals needed. This makes them slower, and usually only capable of specifying location.

Digital auto-correlation techniques are used in GPS receivers, to perform signal averaging of the PRBS codes and allow reliable operation with very low signal levels; this in turn allows the use of very small receiving antennas.

To justify the massive US$10 billion cost involved in setting up the GPS system, the US Air Force agreed to allow it to be used for civilian as well as military purposes. To allow this to be done, there are actually two differents levels of PRBS signal transmitted from the GPS satellites. The signal available for use by civilian GPS receivers is known as the 'C/A' or *clear acquisition* code, while that which can only be accessed by military receivers is the 'P' or *protected* code.

The C/A codes use a PRBS length of 1023 bits, biphase modulated on each GPS carrier at a rate of 1.023MHz. These sequences therefore repeat every millisecond. In contrast the P code uses much longer PRBS lengths, again biphase modulated on the carriers but in this case at a rate of 10.23MHz — 10 times that of the C/A code. The P-code sequences apparently only repeat every 267 days or so, but each one-week segment of this code is unique for each GPS satellite, and is reset weekly.

The accuracy available to military users using the P code is said to be 'within inches' — particularly when *differential* techniques are used with multiple receivers. The P code is also said to be virtually impossible to jam.

A good civilian GPS receiver using the C/A code will typically be able to determine its location to within 20-30 metres anywhere on the earth's surface or in the atmosphere, when stationary and once the full complement of GPS satellites is operational.

However the US Air Force can deliberately degrade the accuracy available using the C/A code, using an operational mode known as *selective availability* or 'S/A'. This adds programmed clock timing errors to the transmitted C/A codes, with the idea of hampering use of the GPS system by enemy forces in time of war.

Only 'friendly' GPS receivers provided with the necessary enciphering 'key' are able to maintain their accuracy when the S/A mode is activated. All other receivers using the C/A code have their accuracy degraded by a factor of around four or five times. The S/A mode was reportedly activated during the recent Gulf War.

The GPS system is recognised as having enormous potential for improved navigation and location on land, sea and in the air. Receiver size has already been reduced to the hand-held level, and still smaller receivers are predicted. The cost of the cheapest receivers is still around $2500, but this is also expected to fall significantly in the next few years.

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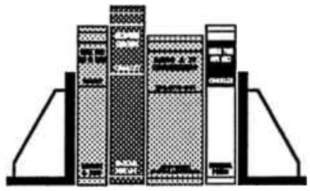


Basic robotics

INTRODUCTION TO ROBOTICS, by Phillip John McKerrow. Published by Addison-Wesley, 1991. Hard cover, 240 x 190mm, 811 pages. ISBN 0-201-18240-8. Recommended retail price $48.95.

Courses in robotics tend to teach mechanics and control systems in depth, or to cover many topics at a fairly shallow level. This book aims to bridge the gap between these two approaches by covering the whole of robotics at sufficient technical depth — the student should then be able to engage in further independent study.

Chapter 1 gives a brief history and meaning of robotics with a brief look at the social impact and human consequences of using robots, while chapter 2 covers components and subsystems. Chapters 3-5 explain the theory behind object location and the kinematics involved in manipulator position and motion. Chapter 6 analyses the forces and torques involved in manipulation, while chapter 7 combines the motion and force models developed in the previous chapters. All these chapters are presented in a rigorous mathematical style.

The remaining chapters, 8-12, are written in a descriptive algorithmic style. The algorithms must be understood in order to program the robotic systems.

Chapter 8 deals with mobile robots, chapter 9 with task planning, chapter 10 with the major sensors used in robotics, chapter 11 with the control systems and chapter 12 with programming for users, applications programmers and systems programmers. A brief mathematical appendix revises the mathematical manipulations referred to in the text.

The book is well set out, and the descriptive chapters are easy to read. The mathematics of the earlier chapters require more solid study, while the exercises at the end of each chapter help to revise the major ideas.

The review copy came from Addison-Wesley Publishing Company, 6 Byfield Street, North Ryde 2113. It is available through most bookshops. (P.M.)

Radio antennas

THE ARRL ANTENNA BOOK, 16th edition, edited by Gerald Hall. Published by The American Radio Relay League, 1991. Soft cover, 210 x 280 x 35mm. ISBN 0-87259-206-5. Recommended retail price $US20.

The first edition of the *Antenna book* appeared way back in September 1939, and each new edition has been dedicated to providing more and better information about the fascinating subject of radio antennas. This latest edition still uses many of the drawings, virtually unchanged, of those early editions, which reflects the fact that much of the pioneering work in antennas and propagation was performed in the early 1930s. But this edition also contains a wealth of updated information on antenna design and radiation patterns, based on computer analyses using state-of-the-art software.

A look at the 28-chapter index shows how thorough and complete the treatment is — the index itself runs to 14 pages!

The early chapters deal with safety, antenna fundamentals, the effects of the earth and how to select an antenna system (Ch.1- 4). Then follows the various types of antennas: loop, limited- space, multi-band, multi-element and broadcast (Ch.5-9). The different designs include log periodic, Yagi and quad arrays and long-wire and travelling wave antennas (Ch.10-13).

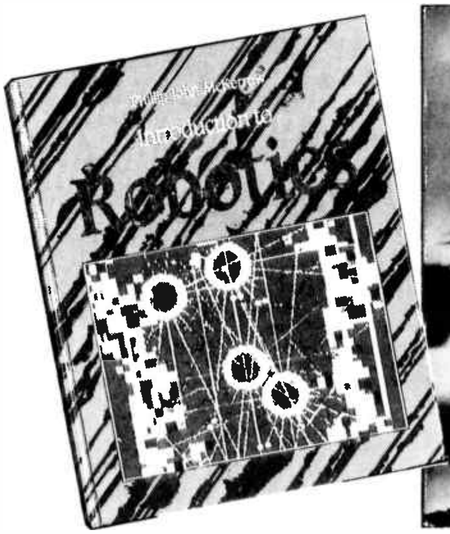
Various uses are covered in Ch.14-17: direction finding, portable, mobile and maritime antennas, and repeater systems. VHF and UHF, and space communications antennas are covered in Ch.18- 19.

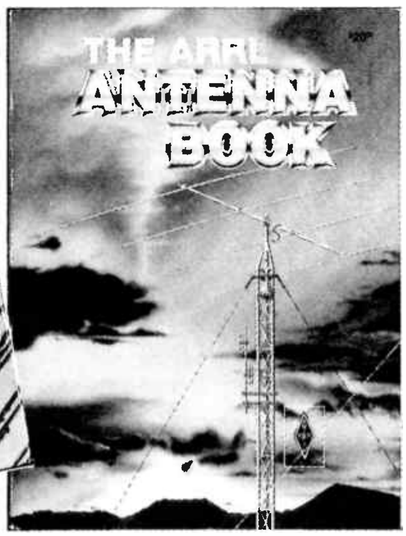
Next comes antenna materials, product suppliers and antenna supports (Ch.20-22). And finally, in Ch.23-28, radio wave propagation, transmission lines, coupling the transmitter to the line and the line to the antenna, transmission-line and antenna measurements, and Smith chart calculations.

The appendix contains a glossary of 113 amateur radio terms, plus a list of abbreviations and acronyms used throughout the book. Imperial-metric conversion tables are also given. Even though all measurements in the book are quoted in feet, metric equivalents are sometimes given, or can be easily calculated using the conversion tables mentioned.

For anyone interested in antenna design, it is all there. I found the book to be very well written, well illustrated with photos and diagrams, with the relevant theory being clearly explained, including mathematical equations and worked examples where appropriate. Thoroughly recommended.

The review copy came direct from the American Radio League, 225 Main Street, Newington, CT 06111 USA. It should be available by mail order from this address. (P.M.) ❖





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Adc 200µA, 2mA, 20mA, 200mA, 2A, 20A
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- Autoranging or manual selection
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- Data hold
- Memory offset

Ranges
Vdc 200mV, 2V, 20V, 200V, 1000V
Vac 200mV, 2V, 20V, 200V, 750V
Adc 200µA, 2mA, 20mA, 200mA, 2A, 20A
Aac 200µA, 2mA, 20mA, 200mA, 2A, 20A
Ohms 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ
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Other Functions
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Capacitance: 5nF to 5µF
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Frequency: 5Hz to 1MHz
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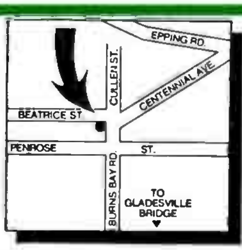

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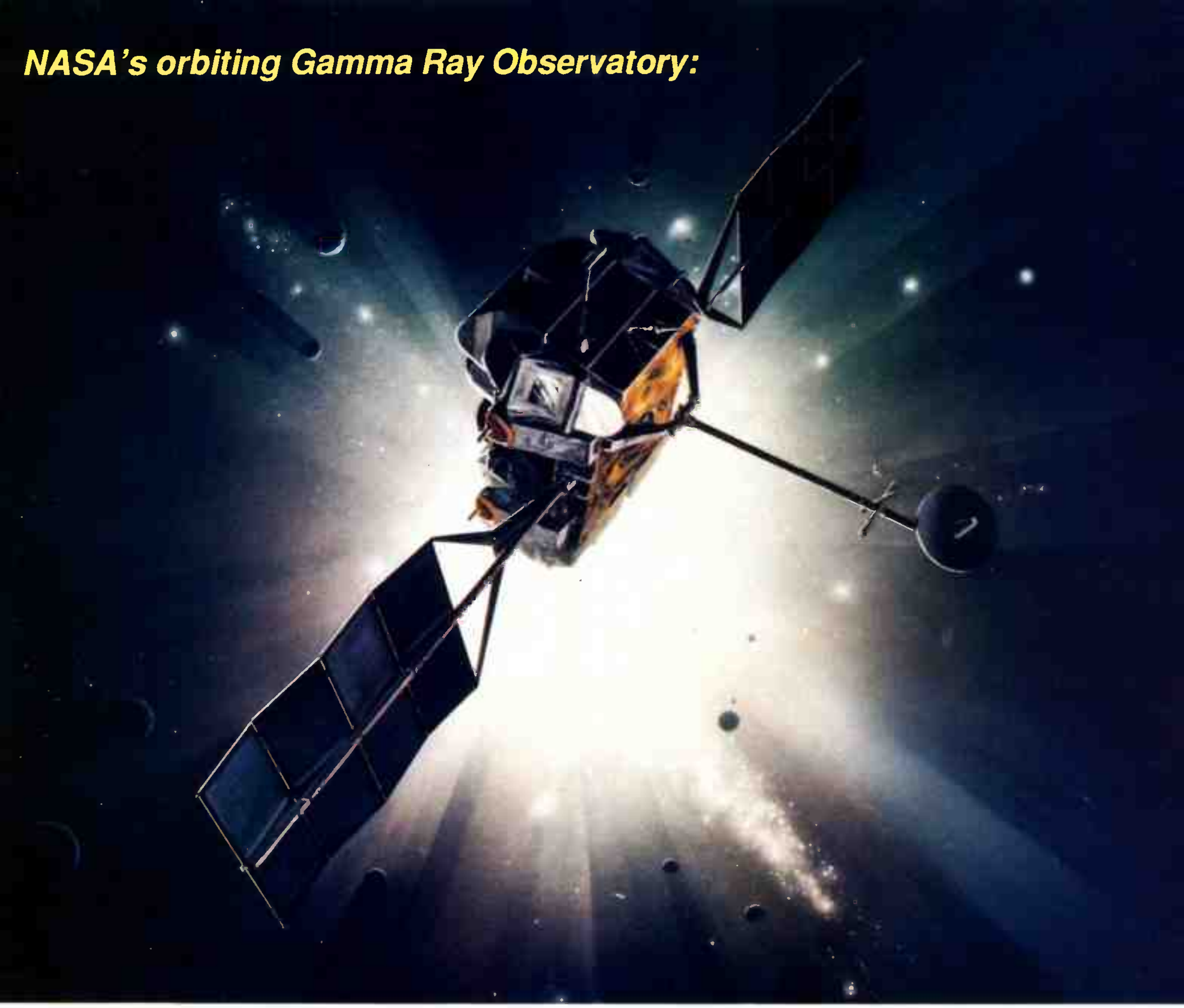
NASA's orbiting Gamma Ray Observatory:



SCANNING THE VIOLENT UNIVERSE

Since its deployment last April via Space Shuttle *Atlantis*, NASA's 16-tonne Compton Observatory has been orbiting the Earth at around 450km, with its instruments scanning for bursts of gamma radiation from supernovae, pulsars, quasars and black holes. Already the results are surprising the world's astrophysicists, and causing them to revise their theories about the structure and development of the universe.

by KATE DOOLAN

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In the first 35 years of the Space Age, space-based observatories and telescopes have taught us more about astronomy than had been discovered in the previous five thousand years.

The latest addition to space-based astronomical instruments is the recently launched Gamma Ray Observatory (GRO), a part of the 'Great Observatories' program of the US National Aeronautics and Space Administration (NASA).

The Great Observatories program has been built to study the universe across the electromagnetic spectrum. The first observatory, the much aligned Hubble Space Telescope, was launched by the space shuttle in April 1990 and it studies the visible light and ultraviolet spectrums. The Gamma Ray Observatory studies the gamma ray spectrum. Both the Advanced X-ray Astrophysics Facility, which studies the X-ray spectrum and the Space Infrared Telescope Facility, which studies the infrared light spectrum are expected to be launched later in this decade.

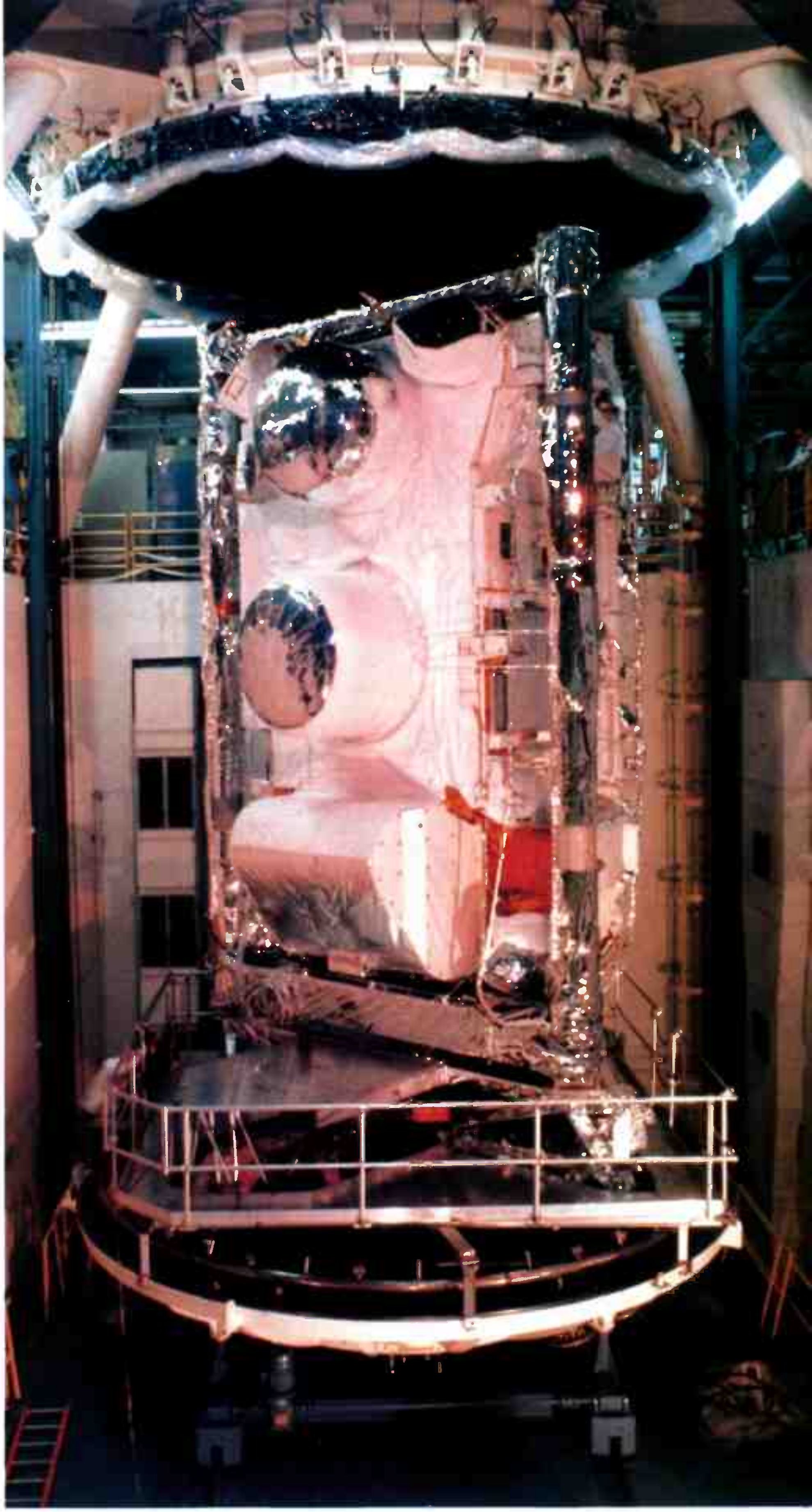
Other observatories which are not part of the Great Observatories program but will be tied in, include the European Solar Optical Telescope, the Extreme Ultra Violet Explorer and the ROSAT observatory.

As part of the Great Observatories program, the Gamma Ray Observatory plays an essential role, as gamma rays are emitted by some of the most mysterious and violent phenomena in the universe. Gamma rays do not penetrate our atmosphere and hit the Earth, so before the launch of GRO, astronomers used sounding rockets, balloons and satellite-borne instruments to get only small samples of gamma ray activity.

The role of the Gamma Ray Observatory is to probe the energetic events that emit a large amount of gamma rays. One such example was the 1987a Supernova which took place in the Magellanic Cloud. Six months later astronomers detected gamma ray emissions from the Supernova debris. The findings of the observations showed that supernovae are a significant source for gamma rays in the universe.

Heaviest payload

The Gamma Ray Observatory is the heaviest payload ever launched by a space shuttle. It is also the largest robot spacecraft that NASA has constructed. Weighing in at a hefty 15,875 kilograms, the GRO is nearly double the weight of the Hubble Space Telescope. It measures nine metres long and is approximately



The GRO in a test chamber at TRW, the spacecraft's prime contractor, prior to launching last April. Note the human figure at upper right — giving a good idea of the size of both the observatory itself and the test chamber.

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4.5 metres in diameter. When deployed, its two solar panels measure 21 metres from end to end.

GRO contains a self contained propulsion system that allows ground based controllers to keep the spacecraft at its correct altitude. This system also provides thrust for orbit changes, orbit maintenance, attitude control and if necessary a controlled re-entry into the Earth's atmosphere.

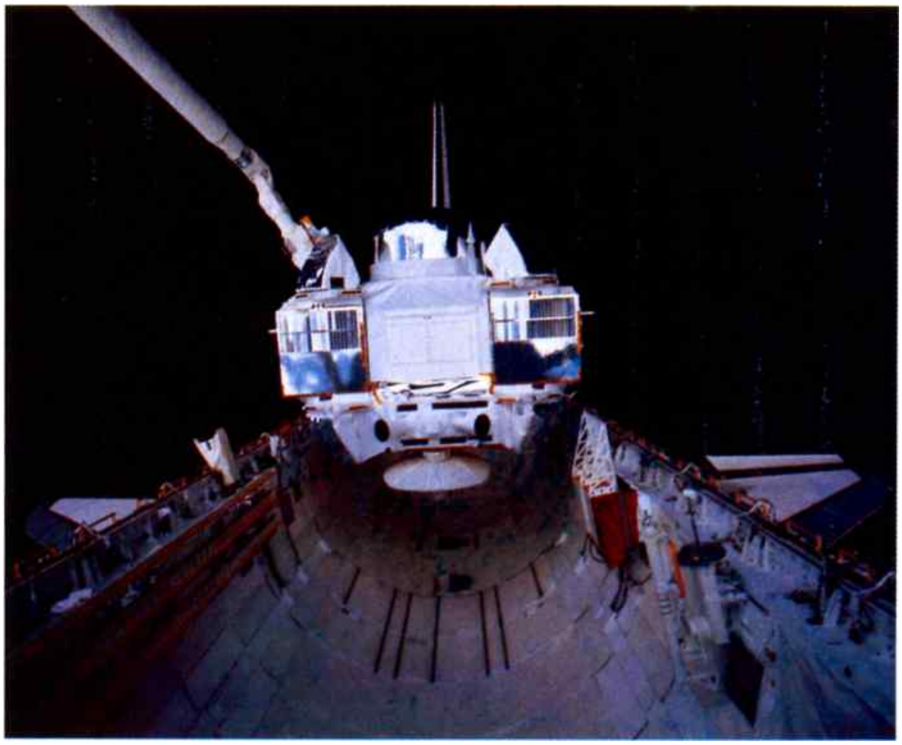
Four propellant tanks hold 1900 kilograms of hydrazine fuel. GRO has four 45 kilogram thrusters and isolation valves and also has two 2.2 kilogram thrusters for altitude control. The fuel tanks have been designed so that spacewalking astronauts can replace them, but according to the recent (August 1991) space shuttle flight manifest, no mission has been allocated for the next four years — although that can be altered if the spacecraft is in any danger of falling to Earth.

The role of GRO's Altitude Control and Determination (ACAD) subsystem is to point its instruments to selected gamma ray sources and to supply altitude information for data processing. The ACAD subsystem is a three-axis system which comprises standard NASA spacecraft components; sensors in the ACAD subsystem point the spacecraft and act as actuators for vehicle orientation.

The primary sensors are known as Fixed Head Star Trackers and the Inertial Reference Unit.

The star trackers relay data to GRO's onboard computers regarding the location of the spacecraft, based on the known positions of previously programmed guide stars. The Inertial Reference Unit relays altitude and position information based on the inertia, working in a similar manner to a gyroscope.

The GRO still sitting in the Space Shuttle's payload bay, with the doors opening for deployment. The shot below shows it being lifted out of the bay. Both shots were taken through the windows of the Shuttle's aft flight deck.



Communication and Data Handling (CADH) systems for GRO are based on similar designs used for both the Solar Maximum Satellite and the Landsat systems. Using modules, repair or replacement of damaged components can easily be replaced by spacewalking astronauts. An example of this was in 1984, when astronauts repaired the Solar Maximum Satellite — which was eventually boosted into a higher orbit where it operated until 1990.

The CADH subsystem comprises the CADH module, a 152 centimetre high-gain antenna, two omnidirectional low-gain antennae as well as a radio frequency combiner to interface the CADH with the antennae.

Also included on the CADH are two Tracking and Data Relay Satellite System (TDRSS) transponders for both incoming and outgoing transmissions to TDRSS, and for command and telemetry transmissions to the space shuttle during deployment sequences. Two standard tape recorders are included for data storage, to record data for later playback to scientists. Data dumps take place every two orbits, at a rate of 512 kilobytes per second via the high-gain S-band antenna and the TDRSS. GRO also has a clock that converts spacecraft time into universal time.

GRO's two solar power panels are ac-

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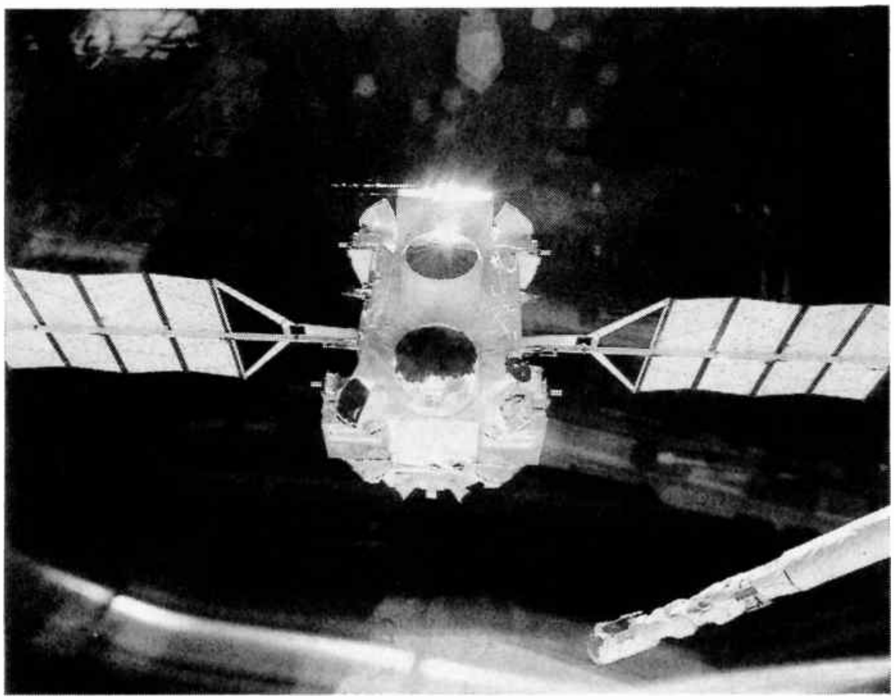


After an emergency 'extravehicular activity' by astronauts to manually free the GRO's jammed high-gain antenna, the observatory was finally released from the manipulator arm.

cordian style, rigid arrays which are deployed by motor driven booms. The total available power is 2000 watts. During the time when the spacecraft is in darkness, it is powered by NiCad batteries. Power can also be provided by external sources, mainly through ground-based testing and in the shuttle payload bay.

Three kinds of temperature-regulating heaters are used on GRO, each having duplicate heater elements and thermostats. Operational heater circuits are sufficient for orbital operations. 'Make-up' heaters replace the power of an instrument when it is turned off in orbit. Whilst GRO is in the shuttle payload bay, auxiliary heaters are used to maintain temperature.

Science instruments

There are four science instruments on GRO, which are basically telescopes for seeing gamma radiation. The science instruments observe gamma rays by monitoring flashes of visible light known as scintillations, which occur when gamma rays strike the detectors built into the instruments. GRO's scientific instruments are the largest and the most sensitive ever flown into space to detect gamma rays.

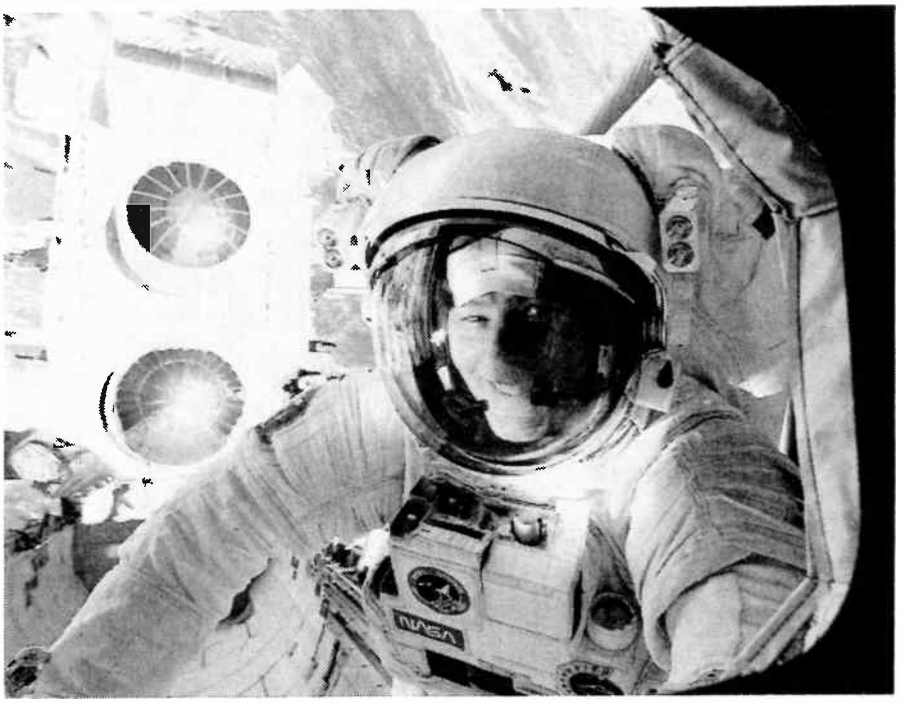
The gamma rays emitted from celestial objects span a large range of energies. The most energetic gamma rays that will be studied by GRO will have energies up to one million times greater than the weakest. This is a greater range of energy than is spanned by optical telescopes, and as yet no single instrument has been invented that can detect gamma rays throughout this range. GRO's four instruments together span the gamma ray range from approximately 20,000 to 30 billion electron volts (eV).

The Burst and Transient Source Experiment (BATSE) was developed to monitor large segments of the sky for the detection and measurement of short, intense bursts and other transient sources of gamma rays. BATSE comprises of eight identical detectors, with a detector placed at each corner of the spacecraft to give a wide field of view. BATSE operates in the low energy part of the gamma ray range (20,000 to 2 million eV), in which bursts are expected. Once a burst is detected by BATSE, it signals the other instruments to study the source in more detail. BATSE was developed at Marshall Space Flight centre in Alabama.

The Oriented Scintillation Spectrometer Experiment (OSSE), which was designed by the US Naval Research Laboratory in Washington DC, detects nuclear-line radiation and emissions associated with low-energy gamma ray sources (100,000 to 10 million eV). OSSE is especially sensitive to the spectral signature of radioactive elements, which enables the instrument to study supernovae and novae — where it is believed heavy elements are created. OSSE also will provide details on gamma ray emissions from neutron stars, quasars, pulsars and black holes.

The Imaging Compton Telescope (COMPTEL) was developed as an international venture between the European Space Agency, Germany, The Netherlands and United States.

The COMPTEL has been designed to



Spacesuited astronaut Jerry Ross is seen here peering into the Atlantis cabin from the payload bay, during the emergency 'EVA' operation to free the antenna.

observe moderate gamma ray energies (1 to 30 million eV). Although COMPTEL does not have a wider field of view than BATSE, it can locate gamma ray sources and one of its main roles will be to compile a map of the sky as seen in moderate gamma rays.

Another international venture is the Energetic Gamma Ray Experiment Telescope (EGRET) developed by the United States and Germany. EGRET's role is to search the universe for high energy gamma rays measuring up to 30 billion eV. Another role is to produce a map of the sky as seen in the high energy gamma rays, to complement the map produced by COMPTEL. EGRET will also monitor gamma ray emissions from pulsars.

Instructions are sent to GRO by ground based controllers based in the GRO Payload Operation Control Centre (POCC) at Goddard Space Flight Centre in Maryland. This is the focal point for all pre-mission and orbital operations. The POCC is a part of the Multisatellite Operations Control Centre at Goddard that provides mission scheduling, telemetry data acquisition, tracking and command, and any processing required for down-linked data.

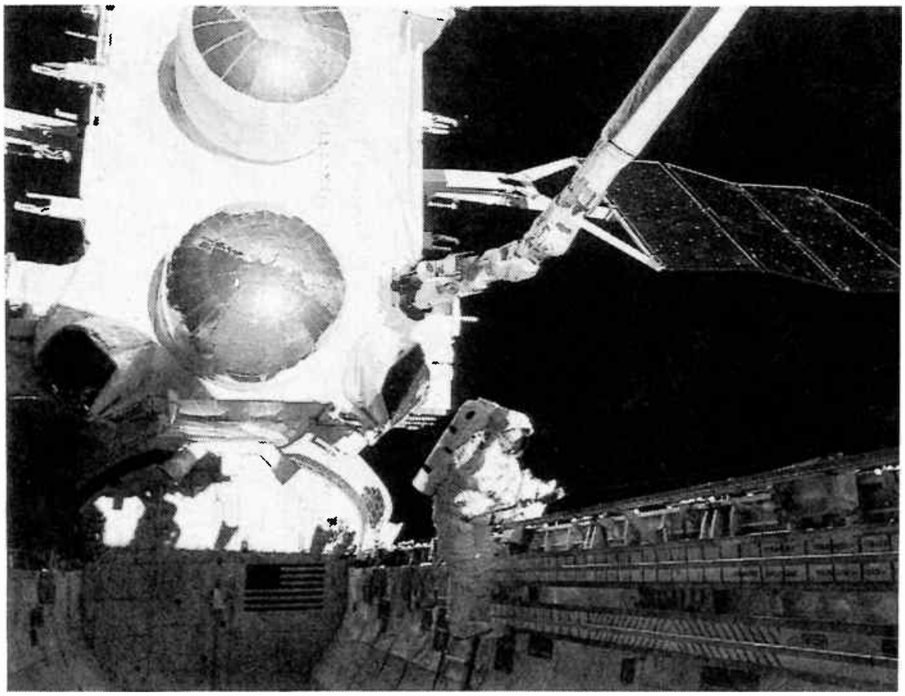
The engineering and experiment data of the spacecraft will be processed in the POCC and the Packet Processor Data Capture Facility (PACOR). Real time data will be received by the POCC as well as telemetry data from the NASA Tracking and Data Satellite Network. The PACOR will also receive real-time and playback data in parallel with the POCC, and after recording time order and quality checking, will transmit science data packets to the four instrument sites, using either an electronic mail system or magnetic computer tape.

The Mission Operations Room is responsible for mission control and is operated on a 24-hour a day roster. This will provide flight dynamics and communication support through the use of an extensive array of computers, television and microprocessors.

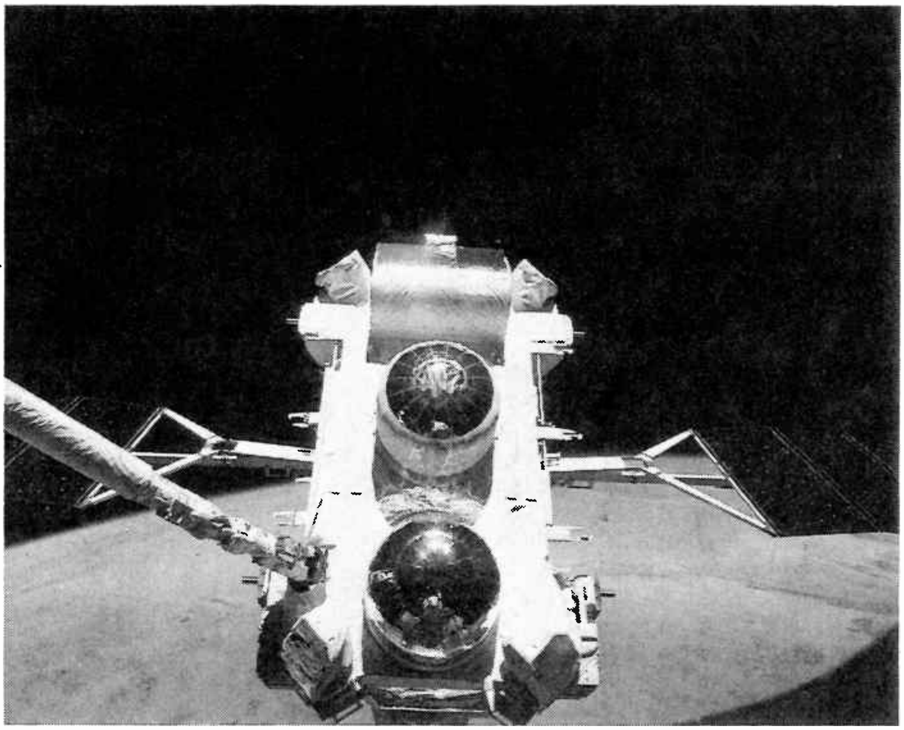
The launch

The Gamma Ray Observatory was the first payload for 1991 launched by the space shuttle. Atlantis lifted off from the Kennedy Space Centre in Florida on 5th April, with a crew of five astronauts aboard. The crew of commander Steve Nagel, pilot Ken Cameron and mission specialists Jay Apt, Linda Godwin and Jerry Ross spent their first two days in orbit checking out GRO and its systems.

On day three of the flight, Linda Godwin grappled the GRO with the shuttle's Remote Manipulator System (RMS) arm and lifted the spacecraft out of the payload bay. With GRO securely attached to the arm, the solar panels were unfurled and they immediately started to provide power to the spacecraft. The deployment of the spacecraft then proceeded normally, until the high gain antenna would not budge from its stowed position. Attempts to free the an-



Astronaut Jay Apt is seen here climbing out of the Shuttle's payload bay, during the emergency EVA to free the GRO's jammed antenna system. The GRO is still held by the manipulator arm (upper right).



Taken just before deployment, this shot shows the GRO with solar power pannels fully extended, but again still held by the manipulator arm.

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'SPECTACULAR' FIRST RESULTS FROM GRO

Early data gathered by the Compton Observatory's Burst and Transient Source Experiment (BATSE) suggest that sources of gamma ray bursts with energies between 20keV and 6MeV may be uniformly distributed in the universe, a result that is at odds with previous theories that such bursts originate from neutron stars in our own galaxy.

The Energetic Gamma Ray Experiment Telescope (EGRET) also seems to have discovered a distant quasar, emitting a gamma radiation energy level 1000 times larger than that emitted by our own galaxy at all wavelengths. The quasar is thought to be about 6000 light years away, and current theories cannot explain how it could produce such a high level of radiation.

The other instruments on board the observatory are also sending back highly impressive data, and scientists working with them have suggested that if later data supports that already received, many existing aspects of cosmological theory may need to be revised...

tenna by ground controllers failed, as did attempts by using the shuttle's control thrusters and by shaking the spacecraft with the arm. The last option was to send Jay Apt and Jerry Ross out on an emergency spacewalk to try and free the antenna. Seventeen minutes after the spacewalk started, Ross (who was tethered to the shuttle) used the highly non-technical means of pushing the antenna to free it.

Later investigation found that thermal insulation shaken by launch vibration had snagged on GRO, keeping the antenna stuck. For another four hours, both Ross and Apt stayed outside to ensure that no further problems developed. Following the remainder of the deployment checkout, GRO was released into a 535-kilometre high orbit.

The Atlantis then pulled away, but remained within distance in case anything went wrong. For the remainder of the STS 37 mission, the two astronauts Ross and Apt made another spacewalk and the whole crew conducted science experiments — including taking some spectacular photographs of war-ravaged Kuwait.

Following an extra day in space, due to bad weather at the landing site, Atlantis touched down at Edward Air Force Base in California on 11th April.

Results to date

The Gamma Ray Observatory has successfully undergone its on-orbit checkout and has started to send back data. At this time it is too early to predict results, but scientists are thrilled by the quality and quantity of data being returned.

The GRO has also been rechristened and is now known as the 'Arthur Holly Compton Gamma Ray Observatory' or the Compton Observatory. Dr Compton (1892 - 1962) was a Nobel Prize winning physicist who conducted experiments on high energy radiation.

At a cost of US$615 million, the Gamma Ray Observatory is the latest in a distinguished line of space based observatories and telescopes that will no doubt start to rewrite astronomy textbooks again and provide more details about the universe in which we live.

Before closing the author would like to thank Jim Elliott of the Goddard Space Flight Centre, Geoff Allshorn and Patricia Keen for their assistance in the completion of this article. ❖

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Moffat's Madhouse...

by TOM MOFFAT

The Science Fair

Science Fair — sounds like an Americanism, doesn't it? Well, I suppose it is. That's where the Science Fair started, but now they're coming to Australia, and this can only be a good thing.

Science Fairs encourage students to undertake research or construction projects. Near the end of the school year, participants gather at a central place where their projects are assessed in competition with each other. For the statewide winner, there's usually a big prize, such as a university scholarship.

Australia is getting right into this Science Fair idea — a local variation seems to be those competitions where students build bridges out of spaghetti, and the one that can take the greatest load wins.

Another variation is the 'most efficient paper glider' competition, or better yet, those for rubber-band powered model propeller planes.

My one Science Fair career was somewhat spectacular, but short-lived. I was half of a two-boy team that came in third in the state, but wasn't invited back.

That year's Science Fair was held at the New Mexico Institute of Mining and Technology at Alamogordo, half a day's car journey from my home in Albuquerque. Alamogordo is near the White Sands Missile Range where lots of space research was being carried out, and several scientists from the facility served as judges.

Much of their work involved haywiring things together for never-before-tried experiments; they were great consumers of bright yellow gaffer tape. The judges favoured student projects in which essential items were made or scrounged, not bought.

The fellow who won first prize certainly deserved it. He had built, from scratch, a television camera. This was back in the late 1950's, when such things never fell into the hands of enthusiasts, and to buy a 'closed-circuit surveillance' black- and-white camera would have cost thousands of dollars.

The winner had somehow managed to scrounge a working vidicon tube (the vision pickup tube) and a scanning yoke to fit it. These things back then were of course rare as hens' teeth, and the kid never did reveal where they came from. Very discreet, he was.

The rest of the electronics was built on a large cake baking tin for a chassis, with big transformers and filter capacitors and valves sprouting from it in great profusion. The output was hooked up to an elderly television that had been modified for direct video input, and the setup was arranged so that passers-by could see themselves on television.

Our project was a vacuum pump, made of the most basic and primitive materials. It didn't start out as a vacuum pump — just the opposite. The pump was the heart of a home-brew underwater diving outfit, of the type known as 'hookah gear' by professional divers.

We had inserted an old tyre valve into the side of a face mask. A 10-metre length of rubber hose ran from the mask to the pump. The idea was for the 'helper' to remain on dry land, operating the pump to force air to the diver below.

The pump — aah, what a weird contraption it was. There were two cylinders made of fruit tins, with wooden pistons which could move up and down inside them. There were 'piston rings' made of leather from the good old Tandy Leather Company, the ancestor of today's Tandy electronics stores.

Each piston was attached to the bottom of a long brass rod. The two cylinders were clamped top and bottom between sheets of shelving timber, held together with more threaded brass rods. There were holes in the timber for the pistons' connecting rods. The rods were attached to opposite ends of a wooden pivot which was equipped with half a broom handle.

The pump operator could work the handle back and forth, causing one piston to go up while the other went down. One cylinder blew while the other took a fresh breath.

Both cylinders attached to rubber hoses, which in turn went to a reservoir tank mounted on the upper shelving layer just forward of the pivot and handle. The tank itself was a bigger, catering-sized fruit tin, sealed by a round wooden lid with a piece of bicycle inner tube as a gasket. The tank was clamped together with more brass rods.

The air output of this amazing device was a right-angle plumbing fitting, screwed into the reservoir tank's wooden top. The diver's hose attached to the right-angle fitting.

Inside the tank, over the inlet holes, were one-way 'flapper valves' made of bicycle inner tube, to prevent the stored compressed air flowing back into the cylinders.

These valves were the most critical part of the whole assembly. They had to be supple enough to blow out of the way as air rushed in. But at the first breeze of air trying to move back out, the valves had to snap shut, completely sealing the air inlet holes.

We first tested the diving apparatus at the local swimming pool, as a skeptical crowd of onlookers and vigilant lifesavers stood by. With such an esteemed audience we decided to show unlimited bravery and headed straight for the deep end — all three metres of it.

We tossed a coin; my team partner Bob would make the first dive, and I would pump. I can't say I was too disappointed; drowning didn't seem such a pleasant afternoon's activity.

Right! Mask on, and I started pumping. Bob was getting air, standing there by the edge of the pool. It stank a bit of rubber and leather and oil, but it was air.

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Over the side he went, cautiously, until his head was just above the surface. And then he began descending.

As he went down, bubbles emerged, excess pressure going past the mask. So far, so good.

But then the pump began hissing from around the reservoir tank. The deeper Bob went the fewer bubbles came up — so the harder I pumped to keep the air flowing, and the louder the hissing became.

Then, after less than a minute, a great burst of bubbles erupted and Bob popped up, coughing and spluttering. He'd torn the mask away from his face.

"It's useless!", he yelled. "The air stopped coming before I was half way down. The pump could have just as well been sucking as blowing!"

Well, that was true. With a bit of pressure applied the reservoir tank, squeezed together with brass rods, was trying to blow itself apart.

It would have been much better if it had been sucking itself together. Yeah, maybe we ought to cut our losses and try it out the other way around — as a vacuum pump!

Back to the drawing board. We took the pump completely apart and started over, first reversing the direction of the leather piston rings so they provided suction instead of 'blowtion'.

The flapper valves had to be removed from the reservoir tank and reinstalled in the cylinders, so the airflow could be blocked in the other direction. Soon we had our vacuum pump.

It worked, but not really well. The leakage around the reservoir tank had stopped, as expected, but something else was still letting air leak the wrong way.

This time it turned out to be the flapper valves. In the big reservoir tin they worked all right, but in the smaller diameter cylinders they wouldn't conform to the shape of the holes; they were too stiff. We needed to find some more flexible rubber.

We dismembered a balloon next — cut little rectangles from it, stuck them over the cylinder inlet holes, and tried again. They were better than the inner tubes, but still a little stiff.

And as we used the pump the constant flexing and pressure caused the balloon rubber to perish, and it soon developed little pinhole leaks that eventually lead to complete rupture. Back to the drawing board again.

What to use? What to use? Well, Bob got an idea. He remembered his parents kept these rubber things in their bedroom, and his illicit reading of certain books had taught him some facts of life: one, the rubber things were used to prevent the making of unwanted babies, and two, you did not speak of these things in polite society.

Remember, this was in the 1950's, and one did not even dare to speak the name of such rubber items, or even acknowledge their existence.

Nowadays they're advertised on television: CONDOMS!

We knew back then that these rubber goods were sold in chemist shops from under the counter, but neither of us was game to front up and ask for them.

The chemist might think we were going to do something despicable with them, to our everlasting shame. He'd never believe the vacuum pump story. So a bit of petty theft was in order.

One day, when his parents were out, Bob slipped into his parents' bedroom and Bingo! We were in the vacuum pump business.

The condoms, cut into little squares, made perfect flapper valves and seemed to last forever.

Off we went to the Science Fair with our timber-and-tin-can, high efficiency vacuum pump. We arranged demonstrations with it, like blowing up a balloon within a bell jar by sucking the air out of the jar. We caused certain liquids to boil, simply by lowering the pressure. We pumped, and onlookers stared in amazement, and nothing hissed. There were no leaks.

Judging took place in mid-afternoon. All spectators and participants were removed from the hall, and the judges went from project to project, poking, prodding, inspecting the workmanship. We later learned, to our dismay, that some things were even taken apart to see inside...

That night, at the Science Fair dinner, the winners were announced. And we were number three — Whee!

After the announcement one of the scientists gave a lecture on the physiology of rattlesnakes (really!), while the three winners got their thoughts together. After the lecture they would be called up to the stage, one by one, to answer questions about their winning projects.

The TV camera fellow bowled them over. His camera setup was already on the stage (he'd been tipped off in advance, methinks) and he panned the camera around the room, picking out faces to display on his television set. People beamed and giggled in embarrassment, but they loved it, seeing themselves on the little square box.

As for the second place winner, I can't for the life of me remember who it was or what his project was.

While he was on stage being questioned we were packing death out the back, facing our first-ever stage appearance.

And then it was our turn, called out from the wings, and there on a pedestal was our scruffy old vacuum pump, looking a bit floppy because all the nuts had been removed from the threaded rods to facilitate quick disassembly.

One of the scientists twisted a nut and off popped the pump handle and pivot assembly. "How did you make this?" he asked.

"Out of a broomstick, clamped between those two pieces cut out of plywood". The audience smiled.

Then off came the top, and he pulled out a piston. "That's a wooden disk just smaller than the can diameter, and that oiled leather disk prevents air slipping past the piston."

Next he grabbed a cylinder, pulled the hose loose, and held it up. "That's made from a fruit tin."

"And what about this little flapper valve inside? That looks like a delicate piece of work..."

"That's made of rubber."

"What kind of rubber? It's very fine..."

"Latex rubber."

"Where did you get it?"

"Er... ahh... a cdmm..."

"Sorry, what was that?"

"Cndum."

"Please, speak up!"

"They were cut from a CONDOM!"

Well, with the utterance of 'that word', polite people in the audience carefully averted their gaze from each other, and especially from us.

The master of ceremonies, his face so red he looked like he would burst into flames, gave us a quick 'thank you' and ushered us off the stage.

Another fellow was waiting to hustle us right out the back door. And then there were the parents, who wanted to know where we'd got the (unmentionable) from...

All this goes to show that a little lateral thinking goes a long way in this world. But sometimes it is wiser to safeguard certain design features as 'trade secrets', rather than to admit you diverted some totally outrageous product into rough-and-ready service.

Still, although it ended in some embarrassment, this little yarn might entice some of you students out there to have a crack at a Science Fair project. It could turn into a real adventure. ■

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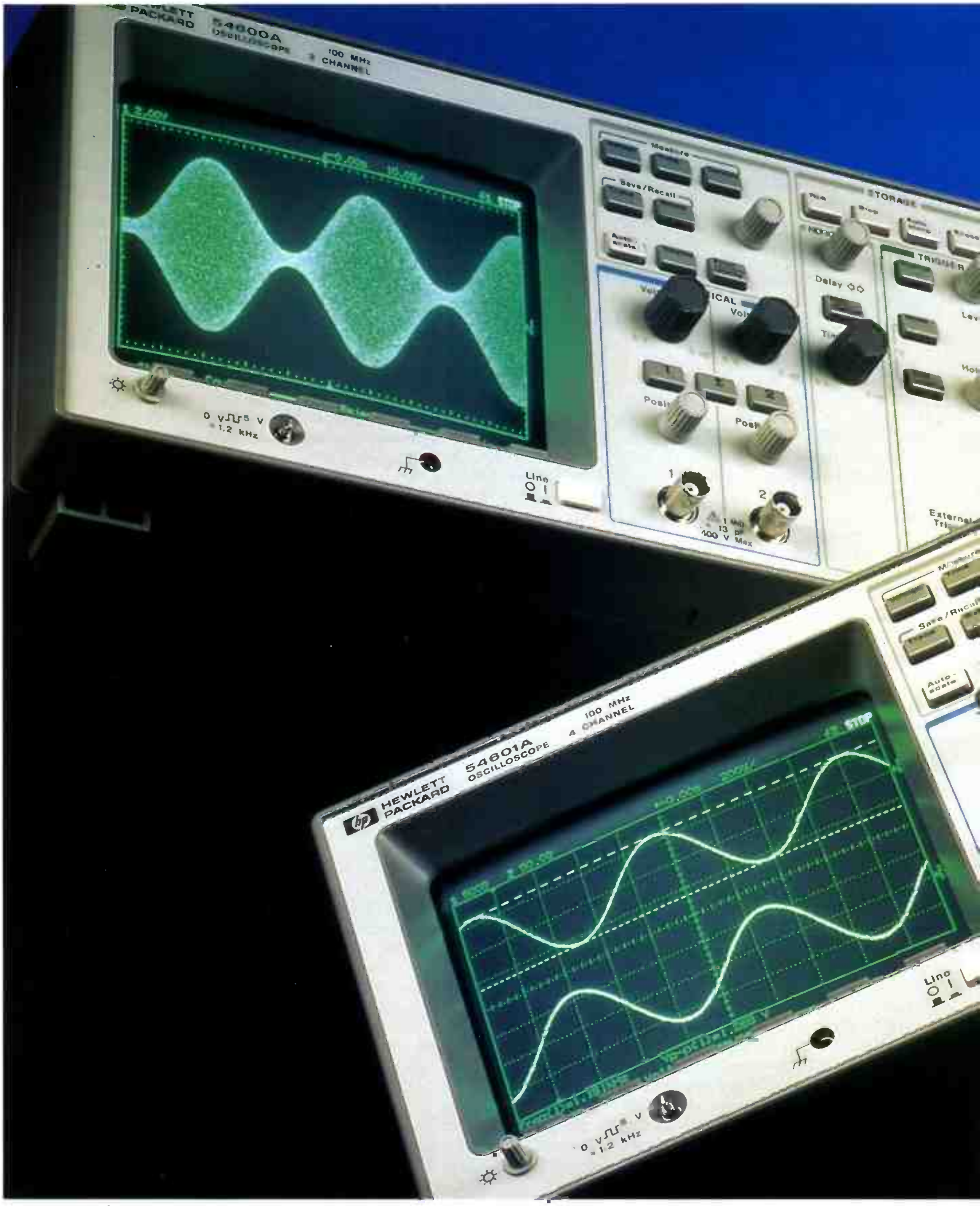

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Historical feature:

WIRELESS AT SEA - 2

Following on from the first of these articles, and also from his earlier articles describing the construction of various items of 'replica' vintage wireless gear from the spark transmitter era, the author here describes the final items necessary for a replica wireless station of 1909.

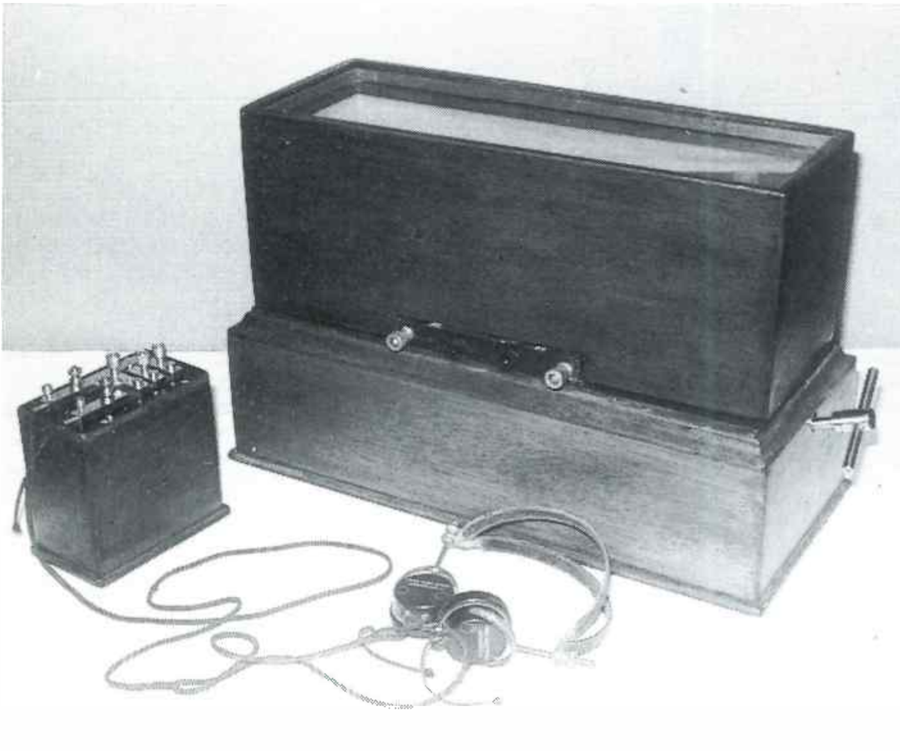
by PETER R. JENSEN (VK2AQJ)

If you are one of those readers of this magazine who, over the last couple of years, has been following my series of articles concerning elements of early wireless, then you will by now have realized that the key elements of such a system have been fully described.

However, just as for Marconi in his early experiments, there is a considerable difference between having access to, and knowledge of, the elements of wireless and making a system of communication which will actually work. In order to replicate the genuine article, a number of supplementary devices are required and access to a good contemporary schematic is also of considerable help.

However before starting to describe these supplementary devices, it is appropriate to include what amounts to a short postscript to the Magnetic Detector, described in November and December of 1989. It may not have been entirely apparent from the tenor of the article, but one of the elements of this replica, which the author found less than satisfactory, was the moving band in which is created the time-varying magnetic field. This, in turn, is affected by the transient radio frequency energy picked up by the antenna.

The ultimate solution described in December 1989 consisted of a piece of magnetic audio tape and this was clearly a long way from the multi-stranded iron wire band referred to in the *Wireless Operators Handbook*. This little compromise 'niggled' away at the back of the author's mind until, reading through Degna Marconi's recollections as a basis for the present article, the way to a solution presented itself. In describing the activities of her father in constructing the original multi-strand iron band for the first Magnetic Detector, Degna referred to his efforts to find wire fine enough for his purpose until, finally, he realized that the material used by florists to tie up flowers was just what was needed.



The author's magnetic detector with its enhancements. The capacitance box is on the left connected to the earphones.

With this vital clue, a visit to the local florist revealed that very fine iron wire is still used for binding up bouquets of flowers. At least something has not changed radically in nearly 90 years! However two small problems soon became apparent.

Firstly the fine wire was pre-cut into 450mm-long bundles, and secondly the material is not made in Australia, but imported from Belgium. With all the wealth of iron in the Hammersly Hills this was a rather disturbing revelation.

However not completely dismayed and with the assistance of the Yellow pages and a pair of nimble fingers, at last the local agents for this material were tracked down and they, fortunately, import the wire uncut. With the gratefully acknowledged assistance of Mr B. Delahunty of the firm of Melwire in Melbourne, a small quantity of the 'rare' material was despatched to Melwire in Sydney and there picked up.

The next problem was to turn it into something approximating the original Magnetic Detector wire rope. For this purpose a timber frame was made up, approximately 1200mm long by 300mm wide, and a series of fine panel pins were driven into it at 1.5mm spaces. The fine iron wire was then wound onto the frame, in a series of parallel lines so that,

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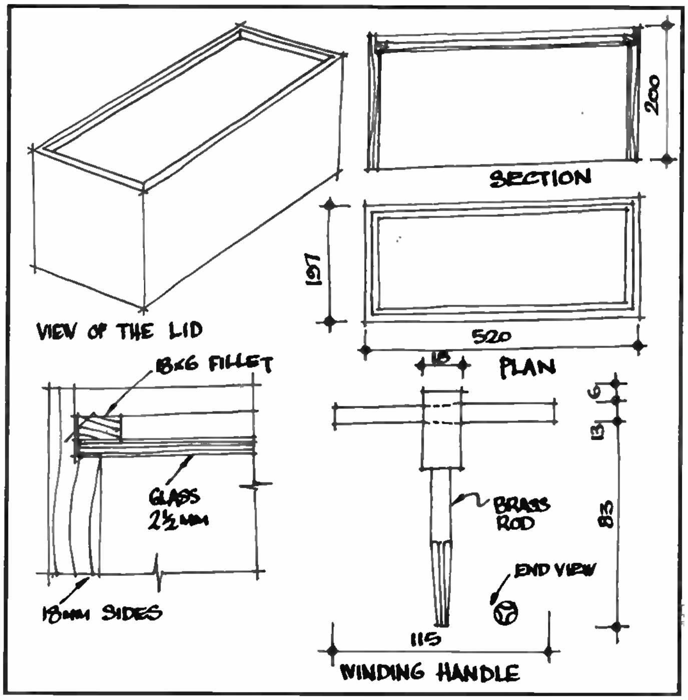
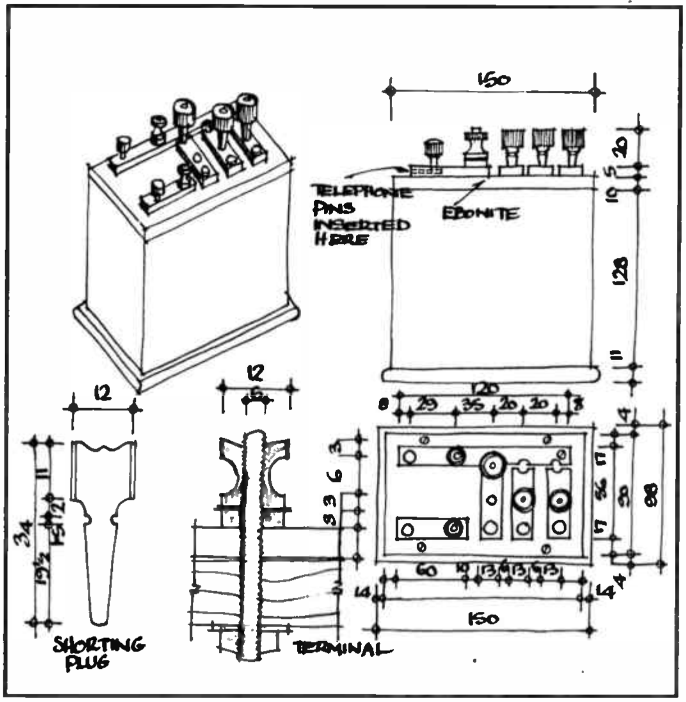


Dimension drawings of the protective cover and winding handle made by the author for his Maggie.



Similarly, here are the dimensions for the author's 'telephone condenser box' (AKA capacitance box).

in the end, it looked a bit like an Irish Harp.

A coating of Estapol varnish was then painted onto the wires to provide the insulation, and this was allowed to dry for the best part of a week. The wires were then stripped off the frame and wound up carefully into a 70-strand rope, which finished at about 2.5mm in diameter. Incidentally the fine wire was 36 gauge as supplied by Melwire.

The length of this rope was then checked against the pulleys of the Magnetic Detector and cut off on a fine splay, so that the overlap of the two ends was about 35mm. The rope was threaded onto the Magnetic Detector and then the ends were bound together with a single strand of iron wire. The result seems excellent, even though the wire is not cotton covered as in the genuine article.

While still on the subject of the Magnetic Detector, it is also to be noted that a standard feature of this device was a timber box cover. This is provided with a panel of glass to allow the operator to see the movement of the pulley wheels. Of course this is rather important for, if they stop, there can be no detection occurring. Again a supplementary sketch establishes the required dimensions.

Another small addition to the Magnetic Detector is a brass winding handle. In the version that was described in the December 1989 article, the original cranked handle, as used in the gramophone from which the clockwork motor came originally, was reused.

However, again, access to a lathe has made it possible to produce a far more authentic looking winding handle and this can be seen in the illustrations. It is dimensioned in the diagram.

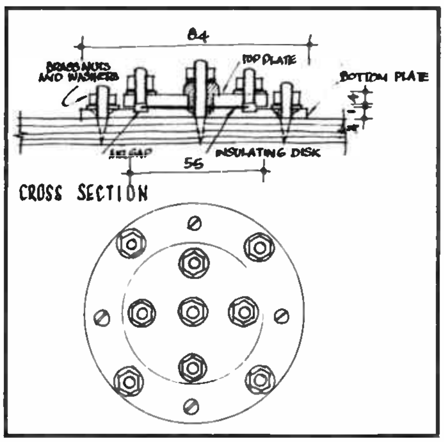
Capacitance box

The next item to be described is an adjunct to the Magnetic Detector and consists of a variable capacitance, contained within a box and provided with plugs to allow the capacitance to be varied over a range of 0.055 to 0.22 microfarads. The illustration and sketch drawing make clear what is required and the finished device is wired in parallel across the headphones. It allows the frequency response of the headphone circuit to be matched to the preferences of individual operators. While initially this device was not used with the Magnetic Detector, by 1909 it is evident that it formed a normal part of the ships installation as supplied by the Marconi Company.

The case of the variable capacitance box consists of Western Red Cedar panels, being offcuts from a nearby timber board fence. As you might guess, it was a pretty up-market house and fence! Anyway the material proved quite ideal and with the application of a little stain and a couple of coats of satin sealer, courtesy of Wattyl, an excellent finish was possible. The bus bars consist of brass plate salvaged from a friendly nonferrous scrap metal recycler at Alexandria. The terminals are cut out of brass rod and knurled with the tool used for the Tuner project. The top panel of the capacitance box is cut from another piece of the Formica obtained from Cadillac Plastics, as was used in the construction of the Multiple Tuner.

Earth Arrestor

The next item to be constructed is the Earth Arrestor. This device is the part of the installation which is particularly concerned with allowing 'break-in', as referred to on more than one occasion in previous articles. As can be seen from the illustrations and the schematic, the Earth Arrestor consists of two brass plates separated by a small gap, in which is located a thin piece of Mica sheet in-



And here are the details of the replica Earth Arrester.

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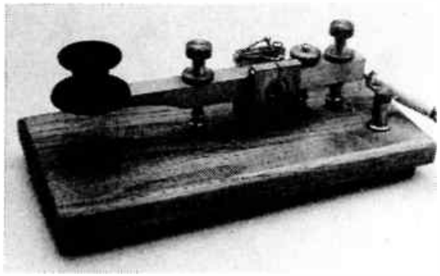
sulation. In the case of the replica a piece of polythene building sheet was substituted. As the schematic indicates, the Earth Arrestor is placed in the earth leg of the secondary of the Jigger and actually connects to earth via the Magnetic Detector.

One small problem of construction with the earth arrester is the fixing into position of the threaded brass studs. The plates were drilled and tapped to take the threaded rod, and when screwed into position were secured so as not to be able to rotate by using a centre punch on the back surface at the junction line of the stud and plate. Two indentations are probably enough to prevent the studs unscrewing when nuts are attached to the front face. Connections to the studs are preformed loops which are still a standard accessory in the automotive department of most large hardware shops.

In the transmitting mode the strong currents set up in the antenna circuit jump the gap in the earth arrestor to make the connection to earth. Any residual high voltage which reaches the Multiple Tuner is kept away from the sensitive coils and capacitors by the Micrometer Spark Gap. In addition it will be observed in the wiring diagram that another essential item, the Morse Key, is provided with a set of back contacts which act to short circuit the headphones, when the key is depressed for sending.

In that context it is to be noted that the headphones are unusual in that they are provided with 80-ohm impedance windings, to match the solenoid of the Magnetic Detector. No doubt a reasonable match could be established with a small output transformer from a transistor radio, although the trade-off would be loss of signal due to the inefficiency of the transformer.



A solid brass Morse key made by R.A.Kent Engineering in the UK.

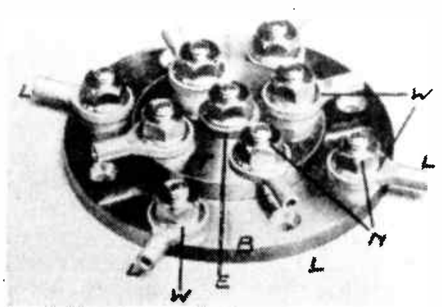
Switch board

The next major addition to the array of items to be created for the replica marine wireless station, is a power distribution and switch board. This may be seen in both the illustrations of stations as displayed in the Science Museum at London and the replica station built in Sydney. The supply of power for early ship's stations was invariably direct current at about 180-200 volts, and was used to charge the station batteries via a series of dropping resistances. The batteries served as the primary power source while the station was on the air.

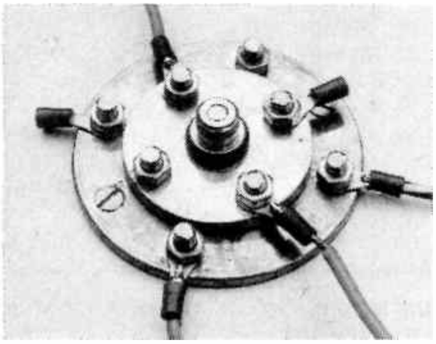
The parts required for the switchboard are a couple of large meters, preferably calibrated in DC amps (20 amps say) and DC volts (50 volts say). No immediate source of supply for such meters can be suggested as, unfortunately, A.C.E. Radio closed its doors during 1989. Also with the demise of Waltham Dan and the fire at his premises, 1989 has not been a good year for 'replica radio ratbags'. All the Policemen seem to be looking younger every year too! As usual the dedicated scavenger will no doubt find a source of supply.

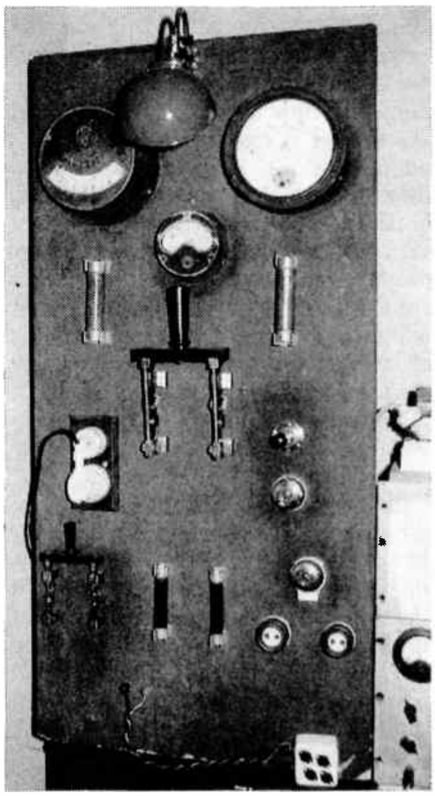
Apart from the meters, you will require two sets of copper knife switches, a couple of sets of panel mounting light switches together with two sets of power outlet sockets with timber escutcheons. Also required is a downlight to illuminate the front of the switch board. A number of the items mounted on the replica, as illustrated, came from various redundant electrical systems in the basement of a well known Sydney cinema. Here the resident Electrician was extremely helpful and obviously pleased to see such items go to a good home.

The actual panel for the switchboard consists of modern particleboard, painted with matt black (chalkboard)

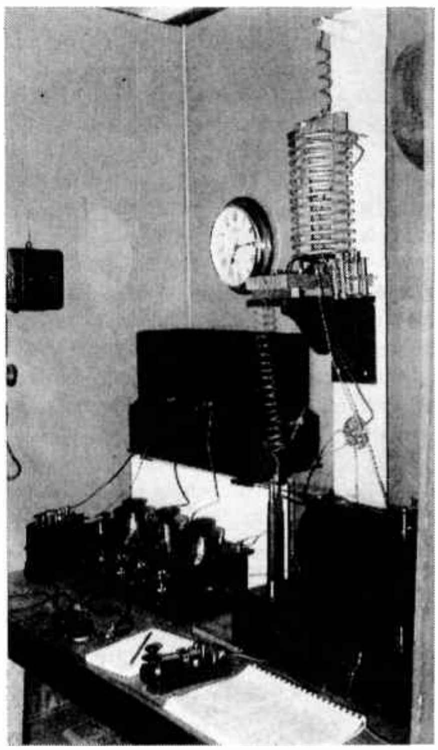


Above is the original Earth Arrester assembly, while below is the author's replica.





A view of the power control board.



The author's replica of a ship's wireless station, circa 1910.

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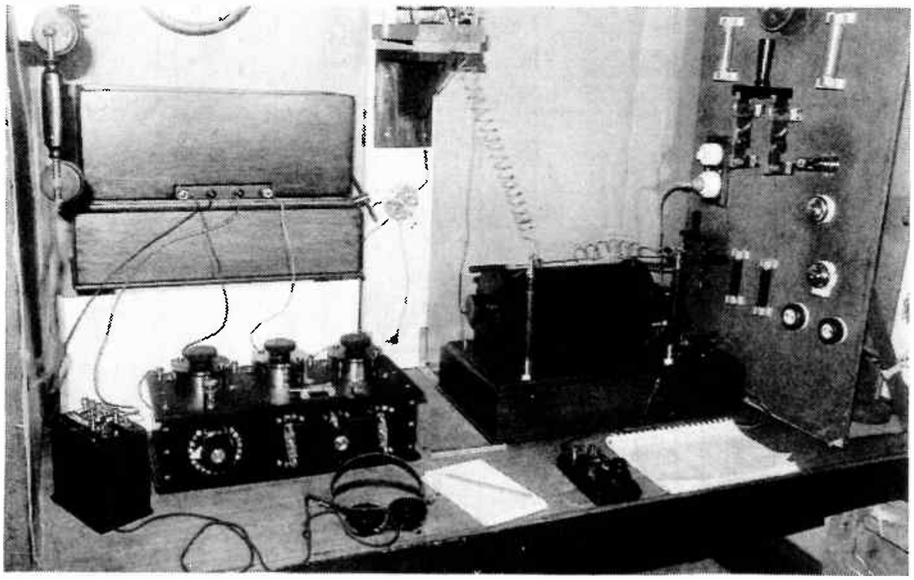
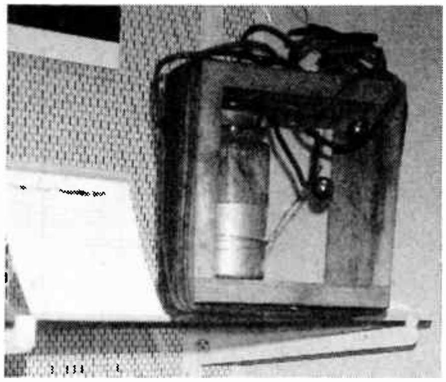


The replica ship's wireless station taken from a different angle, showing the power control board on the right.



A Marconi 'Jigger' of around 1902 on display at the London Science Museum.

paint to simulate the Ebonite that would probably have been used originally. The panel, in turn, was fixed back to a steel angle frame salvaged from a much younger radio, made by Kingsley in the late 1940's.

Other items that add authenticity to the replica station are a wall clock and an early intercom telephone. The first of these came from Target and, while the face features Roman numerals and is surrounded by a timber escutcheon, lurking inside the case is a quartz crystal regulated, electronic clock. It looks the part, nevertheless! The second item was salvaged from the demolition of the Wintergarden cinema at Rose Bay, bound for the tip.

Jigger

In the antenna circuit will be required a Jigger, as referred to in the description of the development of the Multiple Tuner, and some form of tapped inductance.

In the book by R.N. Vyvyan, one of the Marconi company engineers, there is a technical description of what can be seen in the photograph of the Jigger in the Science Museum, London. As he says, it is made in the following manner:

The oscillation transformer, or transmitting jigger, was constructed on a wooden frame, over which was wound a number of heavily insulated copper conductors of large cross section, joined in parallel, making one turn of extremely low resistance. In some cases two or more turns may be employed. Over the primary winding a secondary winding of five or more turns was wound. This secondary circuit was inserted in the aerial circuit as above described. When connected up as shown in the (diagram), the oscillation transformer forms an inductive coupling between two circuits — one the primary closed circuit of large capacity and low inductance, and the other, containing the aerial, an open circuit of much smaller capacity but much greater inductance. By the adjustment of the variable inductance in the aerial circuit the two circuits are brought into resonance with each other.

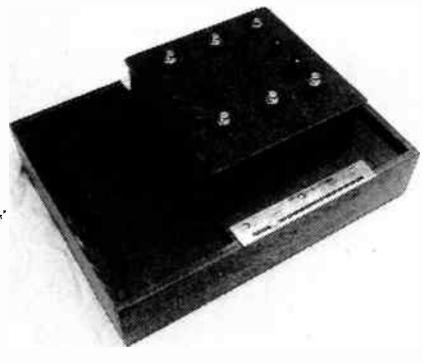
By the time that the multiple tuner was in common use, say 1910, the Jigger had become a little more complex than that described by Vyvyan. As can be observed, the unit constructed for the working replica consists of a helix of copper strap set on a diagonal framework, and held in position with some common or garden string. The helix was designed to resonate with a single Leyden jar at 3.5 megahertz, and the dimensions are given in the diagram.

It is to be recalled that the limit of the Multiple Tuner was 80 metres, which of course is just as familiar to radio amateurs when used to describe the 3.5MHz band.

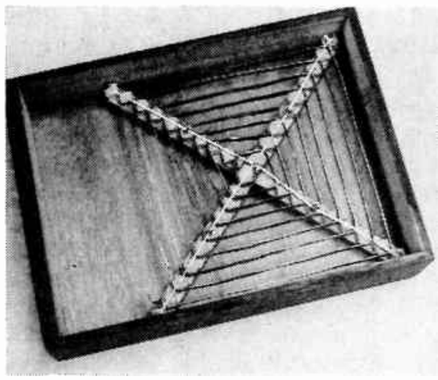
Over the top of the Jigger winding is arranged another box which slides relative to the helix and allows the degree of coupling to be varied. Onto this upper frame is wound an inductor, such that the ratio of turns for the two coils is 0.15 to 1, with the primary helix being the smaller winding. In this particular arrangement the Jigger provides all the inductance required to bring the primary or spark side of the transmitter into resonance at 3.5MHz when the Leyden jar capacitor is in series.

In ships' installations, where the frequency of transmission most generally used was considerably lower, around 600kHz, it was usual to have an adjustable inductor as well as the Jigger. This was generally in the form of a pair of rods with a sliding contact across them to set the exact frequency of resonance. At 3.5MHz the tuning of the primary is so broad that any refinement of that sort is really not necessary. In any case the coupling to the outer end of the helix is via a 'crocodile' clip connection and so it is possible to adjust the circuit to resonance by simply moving the point of contact of the clip.

It should be noted that the timber



The author's Jigger with its sliding inductor in position on the top.



Underneath the replica Jigger.

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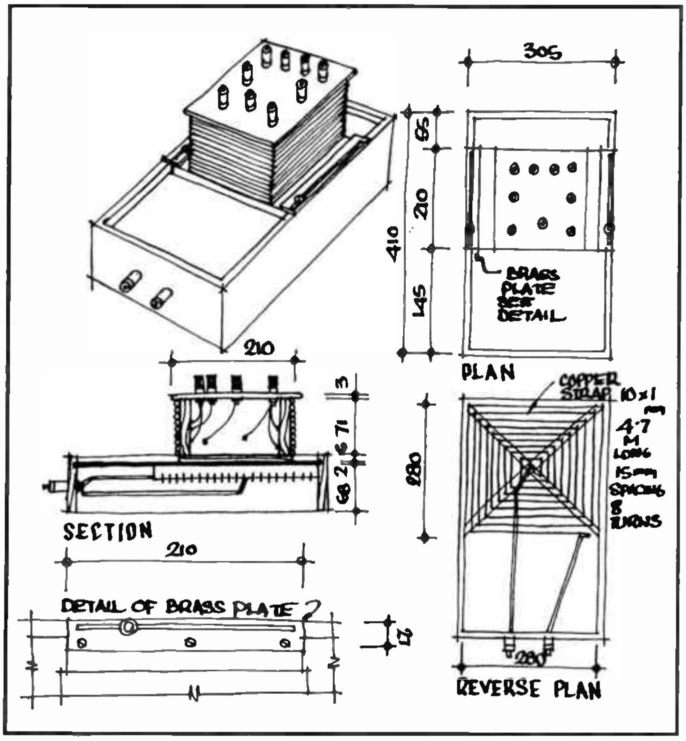
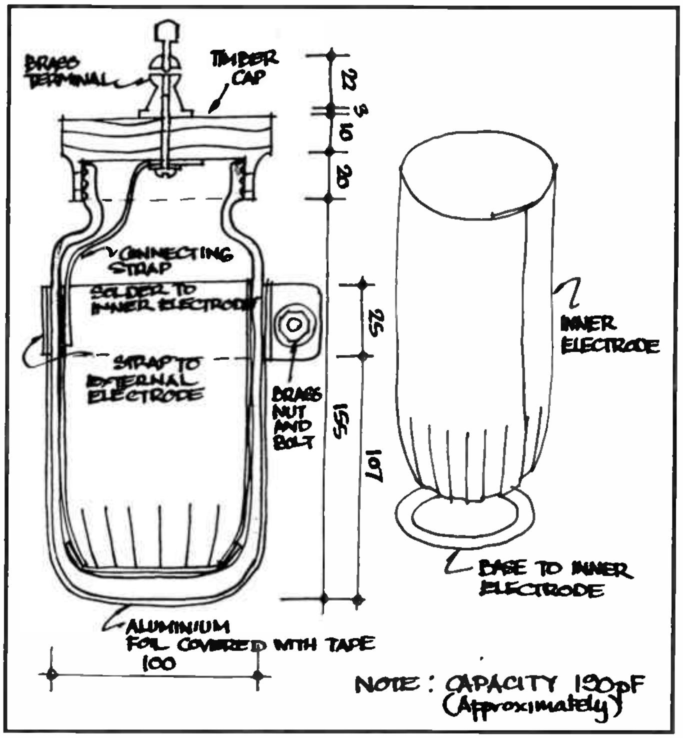


And here are the dimension drawings for the Jigger.



How the author made his replica Leyden Jar capacitor.

frame is screwed and glued together using brass screws rather than steel, which would have a significant impact on the inductance of the Jigger.

The primary helix is connected to the high voltage poles of the Induction Coil, via a Leyden jar capacitor and as indicated in the diagram. The Jigger secondary is then connected to the aerial (antenna) from its upper end, via the open inductance coil.

From the lower end of the Jigger secondary a connection is taken to the centre pole of the earth arrester.

With the outer plate of the earth arrester connected to earth and the Multiple tuner and headphones attached as described in the schematic wiring diagram, the station is almost ready to operate. The only other important items to construct are the Leyden jar capacitor and the open aerial inductance.

Leyden jar

The Leyden jar is basically much the same as one described some years ago, in an introductory article concerning the basics of Spark technology. However for this replica it was decided that an increase in capacitance was desirable, the earlier example being a mere 90 picofarads. In passing it is worth noting that the standard Naval 'jar' of this period was rated at 900 to the Farad, and this of course leads to a capacitance of about 1100pF.

The jar that was constructed for this project finished up with a capacitance of about 190 picofarads, which is evidently far less than the genuine article. However, as it is incorporated in a system designed to tune up on 80 metres, this is no great handicap. The important point is that this device can accomodate the very high voltage which is output from the Induction coil, without breaking down.

A quick trip to BBC Hardware in Sydney resulted in the acquisition of a large glass jar designed for preserving fruit. As indicated in the diagram this jar is about 100mm in diameter and approximately 180mm high. The inner electrode consists of a sheet of tinplate neatly cut from a large tin of Chum. The dog did not really object, since it was empty at the time!

How the Leyden Jar appears when completed.

The tinplate was cut around its lower edge, so as to fit the bottom of the jar more snugly and the circular top of the tin was also cut down somewhat to fit below the sleeve.

Next this circular lid was dropped into the bottom of the jar and then the sleeve of tinplate was wound up to fit through the neck of the jar and slid into position, with the cut bottom edge turned in to overlap the circular lid. Just prior to placing the sleeve inside the jar, a tag of tinplate was soldered into position to provide the contact to the lid of the Leyden jar.

Once the tinplate sleeve was correctly positioned, the jar was filled with tightly packed newspaper, rolled into balls, to expand the sleeve into the glass shell. The top edge of the sleeve was then quickly soldered at the junction with a standard 'Scope' iron, using flux cored solder.

Half of the newspaper packing was removed and a second solder joint made at the mid point of the sleeve. Finally the remaining newspaper was removed and a final joint made at the bottom of the

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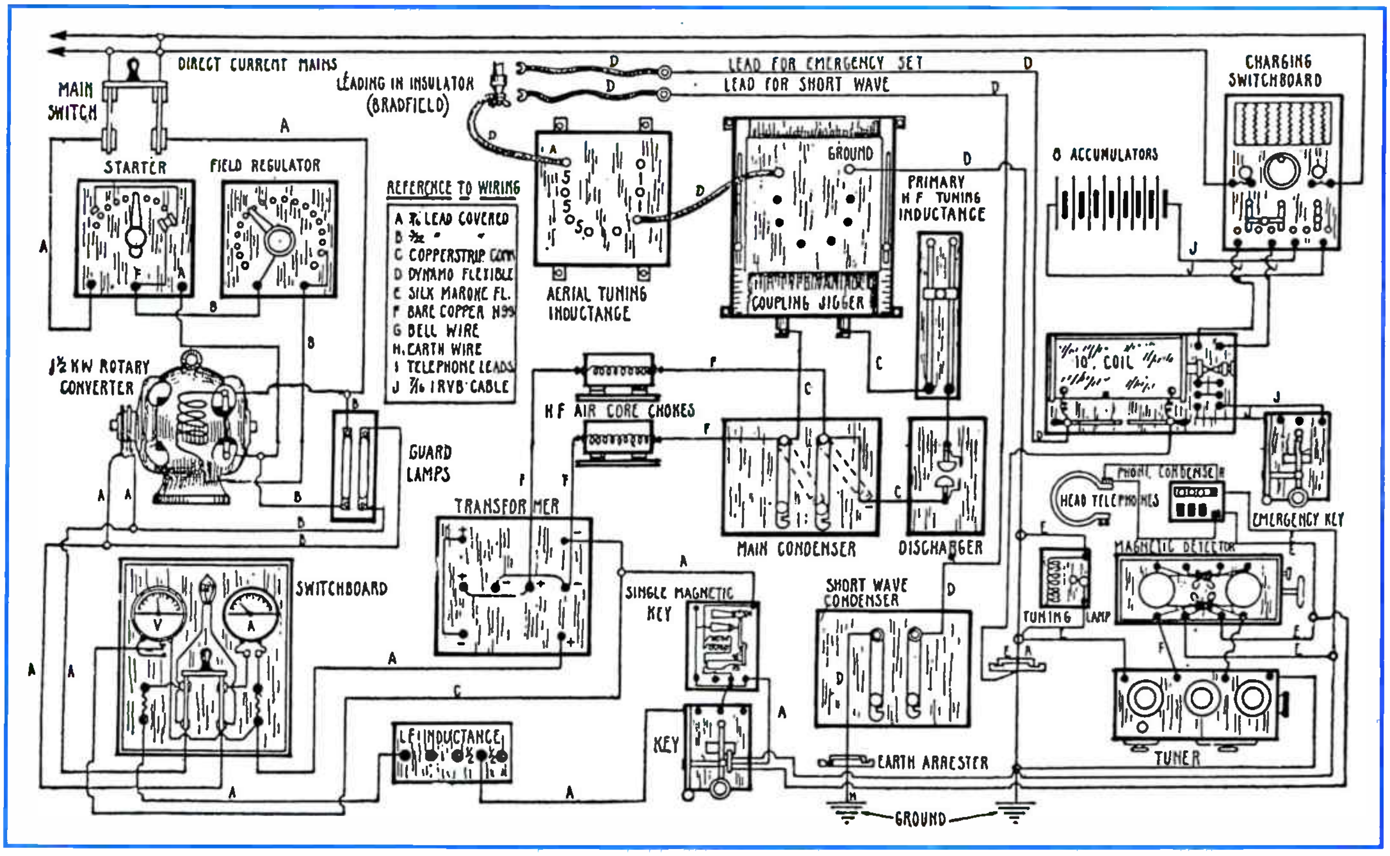
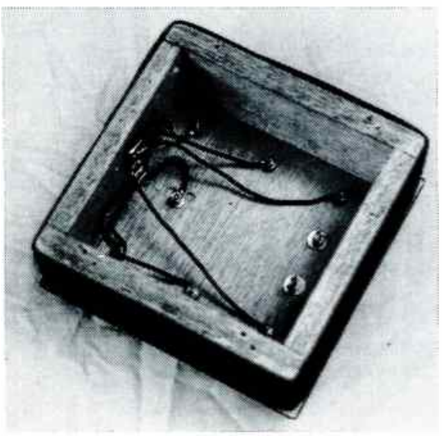


The complete schematic/wiring diagram for a 1.5kW ship's wireless station of 1912, reproduced from 'Audel's Easy Lessons in Wireless Telegraphy.'

tinplate sleeve, which also connected to the circular base plate.

Next the outer electrode was made up, consisting of ordinary household aluminium foil, in two layers. This was stuck to the glass at the seam with a line of Selley's *Kwikgrip* (Contact adhesive) and turned neatly under the jar to maximize the capacitance.

Over the top of this electrode was placed a circular strap to provide a point of contact, taking care not to tear the thin aluminium foil.



Underneath the aerial coupling inductor, which slides along the top of the Jigger to vary the coupling.

To protect the foil, its surface was then covered with plastic 'transparent' tape. This special form of plastic tape is used by draughtspeople, as it does not cause a shadow in the printing of drawings.

The reason to use it in this context is that the glue used is far more stable than that normally found in adhesive tape. Also the tape is a milky white colour, rather than slightly yellow, which looks far better over the top of the foil.

The lid of the jar is simply a piece of hardwood, turned up on the ubiquitous lathe, with a brass terminal connected to the inner strap of the Leyden jar.

Aerial inductance

In the replica station the main aerial inductance, as it was finally constructed, consists of a section of tubing from a discarded refrigerator cooling system, set up on a small timber frame and fixed back to a timber stand for the portable demonstration station.

The tapping is provided by another large battery charger style 'crocodile' clip and a length of cable to bridge the helix of the inductance.

Other small items required are a log book, a note book for message handling, Marconigram blank forms, pencils and last but not least a brass Morse key.

Cautions

Finally it is perhaps appropriate to issue a small cautionary reminder. Firstly the voltage available from the Induction coil, although involving a very small current, is at a very high level and is quite capable of incapacitating the unwary operator at the very least. Indeed for someone with a 'pacemaker' it might easily prove fatal.

However providing a short circuit for 200,000 volts is not recommended under any circumstances.

Secondly, while the apparatus described has been very deliberately constructed so as to be capable of operation, it is as well to remember that 'spark' transmission has been banned since the 1930's and for very good reason. While it was quite effective as a means of communication, it was by its nature extraordinarily greedy of the radio frequency spectrum.

If anyone were tempted to 'fire up' the replica, there is little doubt the one's neighbours, within a very considerable radius, would suffer from radio and television interference.

No doubt the Radio Inspectors would soon be knocking on your door. Of

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Our evolving network of communications - 3

In this third and final article in this series looking at the new technologies that are being introduced into the world's telecommunications networks, the author looks at ISDN — the Integrated Services Digital Network.

by ROBERT OWEN

The Integrated Services Digital Network, or ISDN, represents a major change to the way subscribers interact with the telephone network. What the ISDN does, however, is not to provide new voice and data services, but to combine all the presently available services into a single access point to a single network.

With previous systems, depending on the type of service that people wanted to use — e.g., voice, video, packet switching or digital data lines — a subscriber may have separate phones, terminals or even complete private networks dedicated to these tasks. This situation is both wasteful of resources and inflexible.

Currently, if a subscriber wishes to make a phone call he or she picks up the phone and enters the digits of the number to be called. The important point is that the same channel used to transmit speech between the telephone and the exchange is also used to transmit the dialled digits.

This dual use of the speech channel for both signalling and speech severely limits the use of the telephone network — as, for instance, care must be taken during a call so that any sound transmitted is not mistaken as a signal to 'take down' the call.

Just as with SS7 signalling, where a separate channel is used to transmit signalling and control information between telephone exchanges, the ISDN also uses separate channels between the subscriber's phone or terminal and the telephone exchange, to transmit signalling and speech. An ISDN interface also differs from the regular telephone interface in that *two* voice channels are provided, not just one. The voice channels are called 'B' channels, while the signalling channels are called 'D' channels.

Thus we get the '2B+D' description for a subscriber's ISDN interface, signifying two voice channels and one signalling channel per interface. The 2B+D interface is called a *Basic Rate Interface*. The way that an ISDN terminal will use the D channel to set up and take down calls between a telephone set and an exchange is similar to the way that the SS7 network uses signalling links to set up and take down calls between exchanges.

Indeed, ISDN was built around SS7 signalling and is dependant on it for many of its more advanced features. Also, like the SS7 speech channel, each B channel to the subscriber's terminal or phone is a 64kbps digital channel.

With ISDN, the B channel can be used for either digitised speech or digital data, as shown in Fig.10. Any of the available modes of operation can be selected by the subscriber at the time of call set up, or even switching between modes during a call. This is not generally possible in today's telephone network, where a subscriber must select one mode or the other at the time of installation of the service by the telephone company.

In the future it will be possible for a subscriber to combine together multiple 64kbps channels to form a single high capacity channel. This will be done as needed, and can be used to download large computer files. There is, however, a difficulty in developing this service.

Say two 64kbps B channels are needed to transmit large amounts of data. Because the two channels are independent of each other as far as the network is concerned (only the user sees them as a single 128kbps channel), the two B channels may take separate paths to get to the same destination.

If the path taken by one of the B channels is longer than the path taken by the other B channel, then data that was synchronised onto both channels during transmission may be out of synchronisation at their destination, as in Fig.11.

This could severely distort the data being transmitted. It will be several years before the standards and technology be-

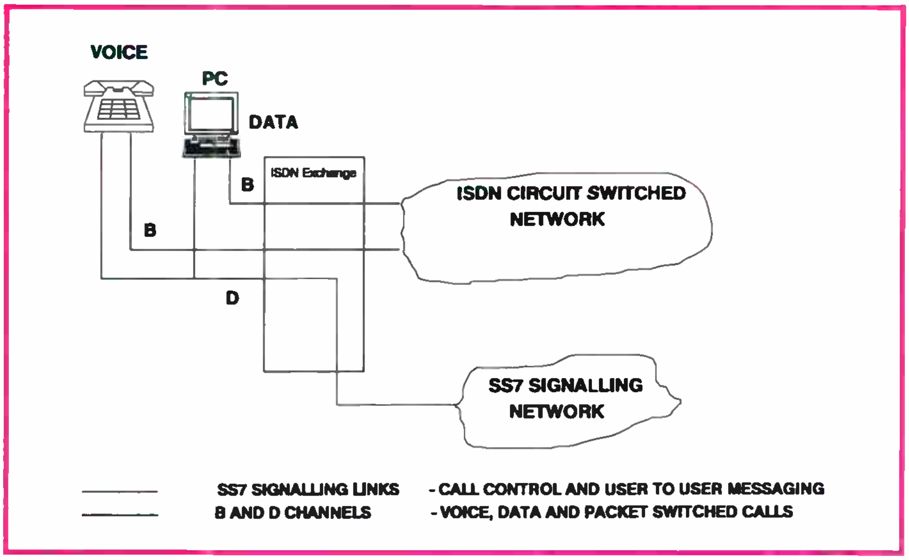

Fig.10: With the ISDN, a basic rate interface (which Telecom Australia calls a Microlink) has two 64kbps 'B' channels and a 16kbps 'D' channel. The B channels are used for either voice or data, and the D channel for SS7 signalling.

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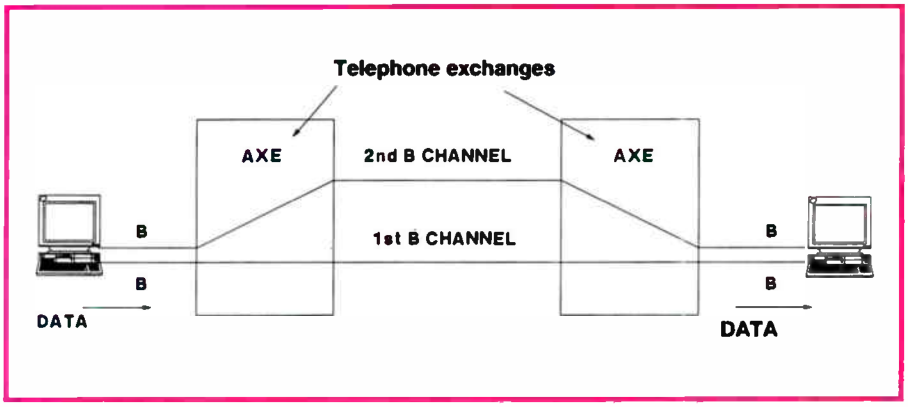

Fig.11: ISDN allows the two 64kbps B channels to be combined in order to achieve a total bandwidth of 128kbps. However, timing problems can occur if the two channels are transmitted along different paths.

come available to effectively deal with this problem at the telephone exchange, although equipment is available today for this to be performed by the customer.

Although each B channel transmits data at a bandwidth of 64kbps, each D channel only transmits data at a band-width of 16kbps — one quarter of the B channel rate. This lower bandwidth for the D channel is due to the smaller amounts of data that the D channel is designed to carry.

With Basic Rate Access, the B and D channels are time multiplexed onto a single copper twisted pair between the telephone exchange and the custo-mer's premises. This is different to SS7, where a separate signalling link circuit will be used to handle the signalling packets.

The Basic Rate Interface circuit between the telephone exchange and the home or office was designed to make use of the existing twisted copper pairs.

Since only one pair of wires is provided, both the two B channels and the D channel must be multiplexed together onto the wire pair. Simple arithmetic gives us that a bandwidth of 144kbps must be used, although in practice a bandwidth of 160kbps is used to provide for additional timing and control signals.

Once the Basic Rate Interface twisted pair reaches the subscriber's premises, the line is terminated by a device called a *Network Terminator* or 'NT1'. The Network Terminator acts both as a multiplexer/demultiplexer for the B and D channels, and as a controller for the ISDN terminals. At the customer's premises the incoming twisted pair circuit is split up into four pairs of wires.

One pair transmits B and D data from the Network Terminator to the terminals; the second pair transmits B and D data from the terminals to the Network Terminator; the third pair can be used to provide power to the terminals; while the fourth pair is presently unused, as shown in Fig.12.

If a user wishes to make a packet-switched call using a B channel, this mode is selected and the ISDN telephone exchange to which the caller is connected will route the call directly to Austpac, the Australian Public Packet Switched Network, via the Packet Handler — as shown in Fig.13.

So far we have said that the D channel is used for call set-up information and for changing the mode of the call during a call — e.g., from speech to 64kbps data or to combine several 64kbps channels for the bulk downloading of data. But like the SS7 signalling links, the D channel can also be used to send packets of data that are specified by the user.

For example, because voice and data calls are conducted on the B channel, the D channel is used only intermittently. If a subscriber phones a busy ISDN number, although the calling party will get an indication that the B channel is busy, it will still be possible to communicate with the called party via the D channel. The calling party could send a message saying 'Phone me when you are free — Mary'.

D channel messages will always be able to get through, totally changing the concept of what is meant by a 'busy' phone. We have said that a B channel can be used for transmitting digitised voice, data or packet data, and that the D channel is used for transmitting various types of signalling information and also short messages between users — called User-to-User signalling. The D channel is of course dedicated to packet type data transfer.

Because the D channel is only used for the above purposes intermittently, efficient use of the D channel would also allow it to be used for sending packet data between, say, a PC and another terminal or mainframe. In this case, the device sends or receives X.25 packet data via the D channel to the local telephone exchange.

The local exchange will recognise that the packets contain user data, rather than signalling information, by a flag set in the control field of the header. The packets will then be transmitted via the Packet Handler to the public packet switched network, and from there to their destination. Although the D channel has a bandwidth of 16kbps, typically the data rate for devices connected to the D channel would be up to 9600bps.

A Basic Rate Interface is different from a regular phone connection in that up to eight ISDN phones or terminals can be connected and used at the same time.

Only one application at a time can use a B channel, so in the case where two B channels are being used, the other six terminals can only use the D channel. Typically, a terminal sending or receiving data via the D channel would be a PC or a printer — a voice call on the D channel not being allowed.

Because up to eight devices can be connected to the same Basic Rate Interface, the possibility arises of two or more devices trying to gain access to the D channel simultaneously. A device will wait until the D channel is idle before sending data on it.

Once the data has been received by the Network Terminator, a duplicate of the received data will be reflected back to the sending device.

The transmitting device will compare the data received with that being sent to ensure that no other device started to use the D channel at the same time. If the data transmitted and received are not the same, the device will stop sending and wait for the channel to become idle again.

Today there are many small islands of a limited ISDN service available worldwide. The problems facing telephone operating companies as they plan to upgrade the network include a lack of common standards to build equipment to, the complexity of the ISDN network and a lack of suitable terminals for use by the end user.

It will be the mid 1990's before a full ISDN service will be available to subscribers.

Primary Rate Interface

We have discussed the ISDN '2B+D' Basic Rate Interface in detail, but there is a second type of ISDN interface available from the telephone company. This second interface is called the *Primary Rate Interface*.

The Primary Rate Interface groups together the 32 64kbps PCM30 cir-

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cuits into 30 B channels and one D channel. It is used to interconnect a PABX or a Local Area Network to the telephone network, and will not be useful in the home.

Note that the Primary Rate Interface D channel has a bandwidth of 64kbps, not 16kbps as with the Basic Rate Interface.

This is because packet data, as distinct from call set up messages, will not be sent on the D channel of a Primary Rate Interface. Thus a proportionately smaller D channel band-width is used.

Broadband ISDN

We have shown how the existing ISDN network is made up of 64kbps channels, and that if more than this bandwidth is required for a particular application, multiple channels can be combined together — to form, say, 128kbps or 364kbps channels. But why do we need to transmit data at rates greater than 64kbps? After all, this is a fast rate for a switched network.

Consider local area networks, or 'LANs'. Currently these can have bandwidths up to 20Mbps. If a company wished to connect together two such local area networks using the public telecommunications network, then data sent between the two would need to be slowed down considerably for transmission.

This is inefficient and would cause bottlenecks in the transmission process. So we need to be able to switch data at least up to the bandwidths that we expect local area networks to run at into the foreseeable future.

Another example is the transmission of video signals. Currently, low quality video can be sent at 64kbps. This bandwidth would give a low resolution picture and would not be able to track fast movements of the subject — giving a jerky appearance to any motion. Although this may be adequate for security surveillance, its usefulness is limited.

If we were to transmit broadcast quality video signals, a bandwidth between 20-45Mbps would be required — considerably greater than anything that is available today using the public switched network. Also, there are many applications where even the picture quality of current broadcast video transmissions is not adequate.

In this case we need to use high definition television (HDTV) — a system comparable in resolution to 35mm film projection, which will ultimately put the quality of TV reception in the home at the same level as the cinema.

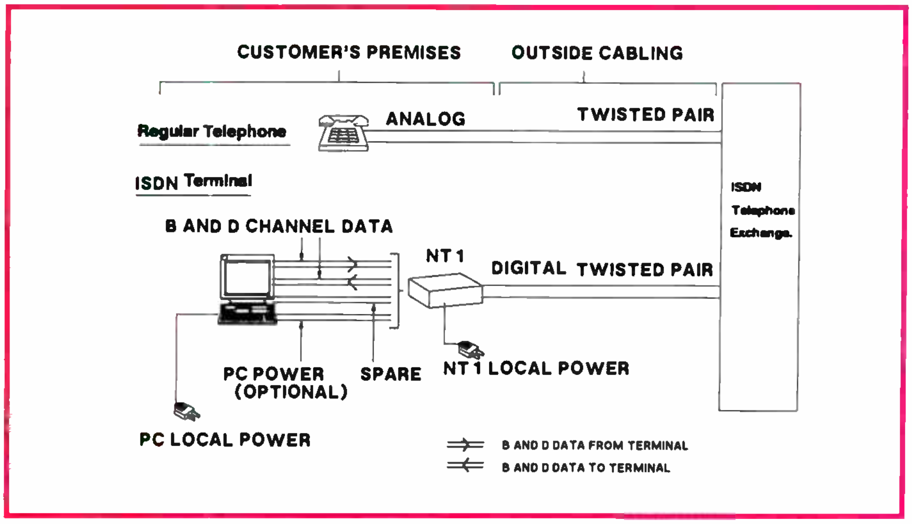

Fig.12: For an ISDN basic rate interface, the subscriber's twisted pair line is terminated in a Network Terminator (NT1) — which performs multiplexing and demultiplexing of the B and D channels.

With HDTV, not only is the picture quality superior, but the width/height ratio of the image is greater. In order to transmit such signals, the telecommunications network needs to be able to switch bandwidths from 92-200Mbps, which is beyond currently available technology.

In the next decade, as the cost of video equipment decreases and the facilities to transmit these bandwidths become available, we will see a large increase in the use of video both within the office and within the home.

To transmit data at these speeds copper wire is inadequate, and the entire network will need to be interconnected with optical fibre.

Optical fibre has now reached a stage of development where tens of gigabits per second can be transmitted over tens of kilometres without the use of electronic repeaters. During the last 10 years, much of the transmission capability of the public network has been upgraded to optical fibre.

Transmitting these high data rates, therefore, is not a problem. The problems occur at the nodes that are required to switch these kinds of bandwidths, since combining the required number of 64kbps channels becomes impractical at higher data speeds.

To overcome these problems, network planners are looking beyond the current ISDN to see how the next generation of public telecommunications equipment will evolve. Various organisations, both within Australia and overseas, are working on a set of standards that define a system called *Broadband-ISDN.*

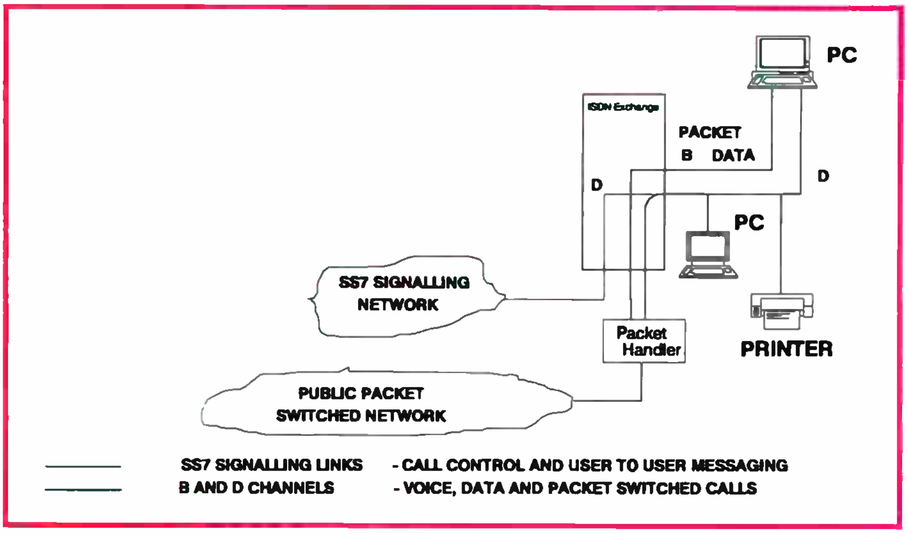

Fig.13: An ISDN basic rate interface can be used for transmitting packets of data as shown here. The D channel is used to set up a link to the public packet switched network, via a packet handler/node connected to the local exchange.

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Although the name is similar to the present ISDN, Broadband-ISDN will be based on network architectures and technologies radically different from that presently available.

To differentiate the two ISDN's, the present ISDN is often called *Narrowband-ISDN*, while this future ISDN is called Broadband-ISDN.

To accommodate the high data rates required in the future, Broadband-ISDN is to be standardised around data rates of 155Mbps and 620Mbps. The Broadband-ISDN will need to handle data rates from as high as 200Mbps for HDTV, to as low as a few hundred bits/second for alarm or telemetry applications.

To accommodate this wide a range of data rates, a simplified form of packet switching called the Asynchronous Transfer Mechanism is to be employed.

With Broadband-ISDN there will be no equivalent to the dedicated 64kbps B channel or voice channel found in the existing network. Everything will be packet switched, although what are now called 'packets' will be called 'cells' in the Broadband-ISDN — with each cell being a fixed length containing up to 48 bytes of data and a five-byte header.

It is expected that Broadband-ISDN networks will start to appear in the mid 1990's, although it will be well into the next century before the system becomes widely available with a mature set of features. Many organisations cannot wait until the mid 1990's for the kind of services that a Broadband-ISDN will be able to offer. As an interim measure, high bandwidth packet-switched networks called Metropolitan Area Networks are being introduced with bandwidths up to 155Mbps for video transmission and LAN inter-connect. Metropolitan Area Networks, which will become available in Australia in 1992 under the FASTPAC, will serve an area about the size of a city.

As mentioned, one of the biggest applications for Broadband-ISDN will be video switching. With the kinds of bandwidth that Broadband-ISDN will make available, it will be possible for a viewer in the home to select via the public telecommunications network a television programme from many thousands available.

In the business sector, multi-location video conference calls could be set up. At each location of the call, the participant's video screen could be split up to show the other participants. As an alternative example, a 10,000 page encyclopaedic entry could be transmitted in a few seconds.

Perhaps the most surprising aspect of Broadband-ISDN is that even voice calls will be packetised for transmission. In this case, a priority mechanism will be standardised so that in case of network congestion, voice cells will get a higher transmission priority than data cells which can be buffered. Also, in case of cell corruption, the Broadband-ISDN can request that data cells be retransmitted.

However with voice cells, due to the real time nature of speech and the tolerance of the human ear to reduced sound quality, corrupted voice cells will be passed on to the listener in the corrupted form.

Although we have discussed how the public telecommunications network is going to develop over the next say 15 years, there is one point we must keep in mind. The telephone operating companies have invested vast amounts of money in the existing telecommunications network.

Much of the equipment that is installed today will still be working effectively well into the next century. Not only is it unrealistic to expect telephone operating companies to replace all this equipment, they could never afford to do so.

The new systems that have been described will be an important part of the telecommunications network of the future.

But as in every other aspect of technology, the old and the new will have to live side by side. ❖

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Automotive engine control - 2

This article continues our discussion of how and why electronics is finding its way into the modern motor car. This month the author looks at sensors, actuators and systems.

by TONY MERCER

In order for the engine control system to determine the amount of fuel to be let into the engine, it needs to know the mass of the air in the cylinders and the situation the engine is being asked to operate in. This last statement refers to whether or not the operator is requiring a cruise condition, high load, idling etc.

The controller gets this information from its sensors, and then it effects the actuators for the desired results.

In the present chapter we will look at how this is done, from an electrical point of view, with some discussion on the system in operation.

We will also look at some current systems, but only so far as the control of fuel delivery goes and not at other things — such as means taken to cool the engine, fuel evaporation control, effects of air conditioner operation on the idling performance, and so on. To go into these aspects would considerably increase the size of this article, without adding a great deal more understanding of fuel control.

Measuring air mass

As was mentioned in the first article, the controller needs to determine the quantity of air in the cylinders in order to calculate for how long to turn on the fuel injectors. There are two ways this is done:

1. The speed density mode, as used on the EA Falcon; and
2. Either direct measurement of the air volume, and then measurement of the air temperature to determine air mass, as used on the electronic fuel delivery of the Ford Laser; or direct measurement of the air mass, as used on the Ford Corsair.

Speed density (EA Falcon)

In the speed density mode, the controller determines engine speed and, knowing the cubic capacity of the engine, works out the theoretical volume of air in the cylinders. For the actual mass it needs to know three other parameters:

A. *Manifold atmospheric pressure (MAP).* This gives it a value for the load being put on the engine, and is read from a sensor located in the intake manifold after the throttle (it also needs to know the ambient atmospheric air pressure, which it gets from the same sensor before the engine is started);

B. The temperature of the air entering the engine. This will enable the controller to work out the density of the air, and is read from a sensor located in the air intake system; and

C. The volumetric efficiency of the air intake system, including the intake manifold. This data is available to the controller from a 'look-up table' in its memory, and is conditional on such things as RPM, air temperature, MAP reading, etc. This look-up table has been arrived at by the system engineers after system design, extensive road-going and chassis dynometer trials.

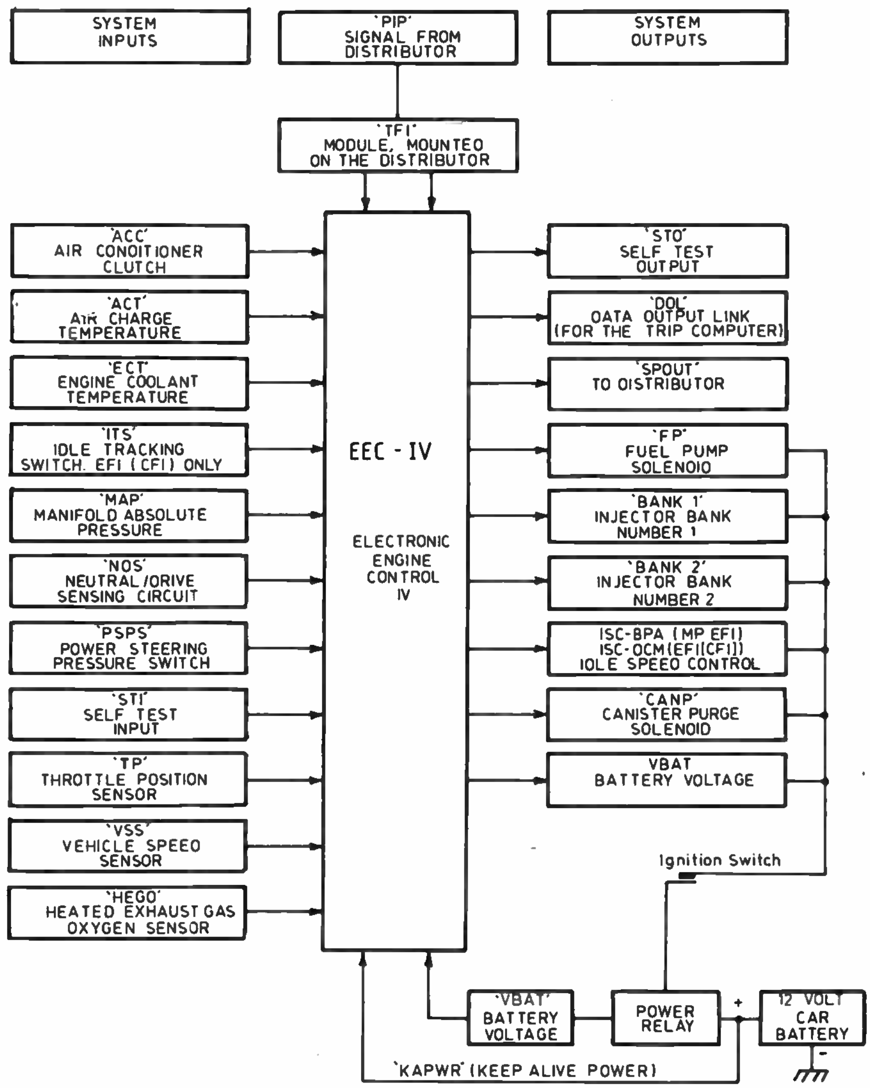

Fig. 2.1

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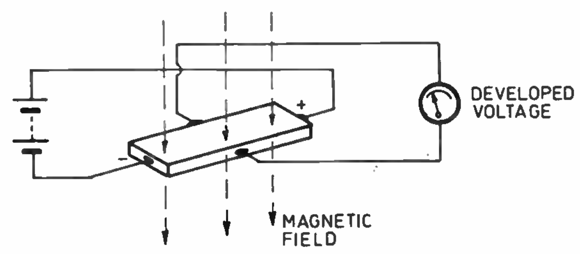

Fig.2.2

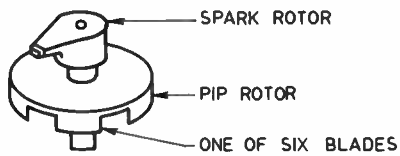

Fig.2.3

The sensors that the system uses in order to alter the air fuel ratio for operating conditions such as acceleration, cold starting, idling etc., are engine coolant temperature, MAP, throttle position, the vehicle speed sensor and so on (Fig.2.1).

The engine RPM is determined by a signal from the distributor called the *Profile Ignition Pulse* (PIP). This PIP signal is generated from a *Hall effect* device, which works on the following principle. If a current is made to flow through a piece of semiconductor material, as a result of a voltage being applied to its length, and this same piece of semiconductor material is subjected to a magnetic field, there will be a slight voltage developed across the semiconductor at right angles to the original applied voltage (Fig.2.2).

In the distributor the magnetic field is interrupted by a revolving magnetic shield, which has three slots cut into it (Fig.2.3). This results in a PIP waveform that has a positive edge transition corresponding to the top dead centre of each piston. This enables the controller to determine what position the engine is in, timing wise, for each part of the cycle.

But the controller can determine RPM from this signal as well, by timing the PIP pulses using an accurate clock of its own. The faster the engine is running the more PIP pulses there will be in a given time, and consequently a shorter time between successive pulses. Conversely the slower the engine is running the longer the time between pulses.

The controller measures the time between pulses (using computer interrupts and special counting registers) and either uses a look-up table, using the count as an address, (faster but uses more memory) or a subroutine written for this task (uses less memory but is slower) to determine RPM (Fig.2.4).

The MAP sensor sends a square wave signal to the controller. The frequency of this signal indicates air pressure — actually the pressure measured can never be higher than atmospheric, because the reading is an indication of the amount of vacuum in the intake manifold.

There are two versions of this device. One works on the principle of a variable capacitor (the plates of a capacitor moving closer together or further apart), to control the frequency of an oscillator. The other is a strain gauge, located as part of a Wheatstone bridge.

A Wheatstone bridge works on the principle of a voltage difference between the junctions of two resistor strings R1, R3 and R2, R4 (Fig.2.5), being caused by a difference in the ratios of these two resistor strings:

V_A = applied voltage * R1/(R1 + R3)

V_B = applied voltage * R2/(R2 + R4)

If R1 increases in resistance, then VA will decrease and the difference between VA and VB will alter.

The actual MAP sensor is a piece of semiconductor material that has four resistors etched on it, and connections to make the Wheatstone bridge. The material is about 3 x 3mm and very thin (250um, or 0.25mm). When a force is applied to the centre R1 and R4 will increase in resistance and R2 and R3 will decrease.

This will cause a voltage difference between V_A and V_B, although one that is so small that it needs an amplifier to bring it to a magnitude sufficient to be of any use. The amplifier uses an op amp, with V_A connected to its inverting input (-) and V_B to the non inverting input (+), as shown in Fig.2.5.

The air temperature sensor is a temperature-dependant resistor, which sends back to the controller an analog voltage proportional to the measured air temperature. The engine coolant temperature sensor works on the same principle.

The throttle position sensor is a switch that sends to the controller the fact that the throttle is either closed (idling), fully open (high load), or somewhere in between. These sensors are used in the 'proactive' mode, where control is based on these readings. But for finer control, the amount of oxygen in the exhaust needs to be measured as part of a closed-loop or *reactive* mode.

This needs to be such that it indicates an air/fuel ratio of 14.7:1, which is what is known as *stoichiometry*. This enables efficient operation of the catalytic converter and acceptable fuel consumption.

The device that determines the amount of oxygen in the exhaust is mounted in the exhaust branch, just below the exhaust manifold (Fig.2.6). Essentially

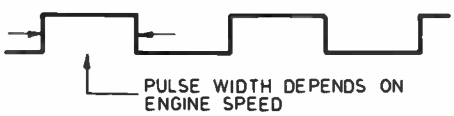

Fig.2.4

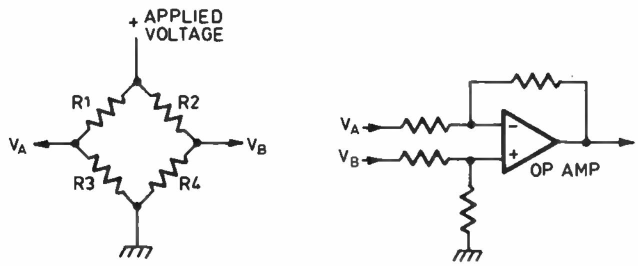

Fig.2.5

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Automotive engine control - 2

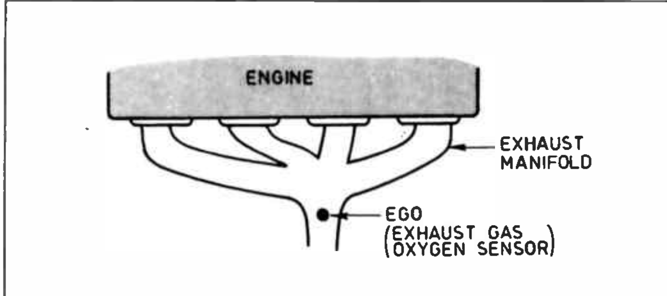

Fig.2.6

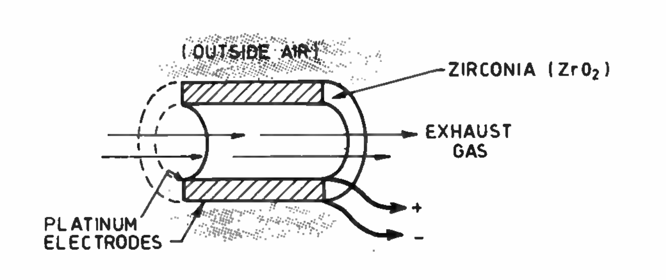

Fig.2.7

this device works on the principle of there being a difference in the oxygen content between the outside air (reference) and the exhaust.

If the exhaust has little or no oxygen, it is considered to be the result of an overly *rich* mixture (:1). If there is a certain amount of oxygen then it is considered that the air/fuel ratio is *lean* (14.7:1).

The device itself is a thimble-shaped piece of zirconium oxide or *zirconia* (ZrO_2), which has thin platinum electrodes on the inside and outside. One platinum electrode is in contact with the air and the other with the exhaust gas (Fig.2.7).

In any quantity of gas containing oxygen there is a distribution of negatively-charged oxygen ions. The more oxygen there is in the gas then the more oxygen ions there will be. The ZrO_2 attracts these oxygen ions and they build up on the surface, just inside the platinum electrodes. Consequently there will be a voltage charge between the inside and the outside of the ZrO_2 thimble, depending on the difference in the amount of oxygen between the exhaust and the outside air. This charge will be such that the inside of the thimble will be positive (less ions because there is less oxygen) with respect to the outside (more ions because there is more oxygen).

This sensor is arranged such that for a mixture just below stoichiometry (:1) there will be a positive voltage produced, while for just above stoichiometry there will be a much less positive voltage.

As there is very little range in between, the controller is constantly swinging the air/fuel ratio above and below 14.7:1. There is an amount of transfer delay (time taken for a change being initiated and an effect measured) present, and the controller needs to be aware of this and not cause massive swings.

The characteristics of a good oxygen exhaust sensor are that:

1. It should switch abruptly about the 14.7:1 mark;
2. This switching time should be quick;
3. It should produce large swings in voltage (around a volt or so); and
4. The device is stable in respect to these characteristics, with regard to temperature.

The problem is that the differences in output between lean and rich mixtures tends not to be as great for low temperatures (,°C) as for high temperatures (750°C).

The sensor switching time is also effected (it is about 0.1 second for an exhaust temperature of. 350°C and 0.05

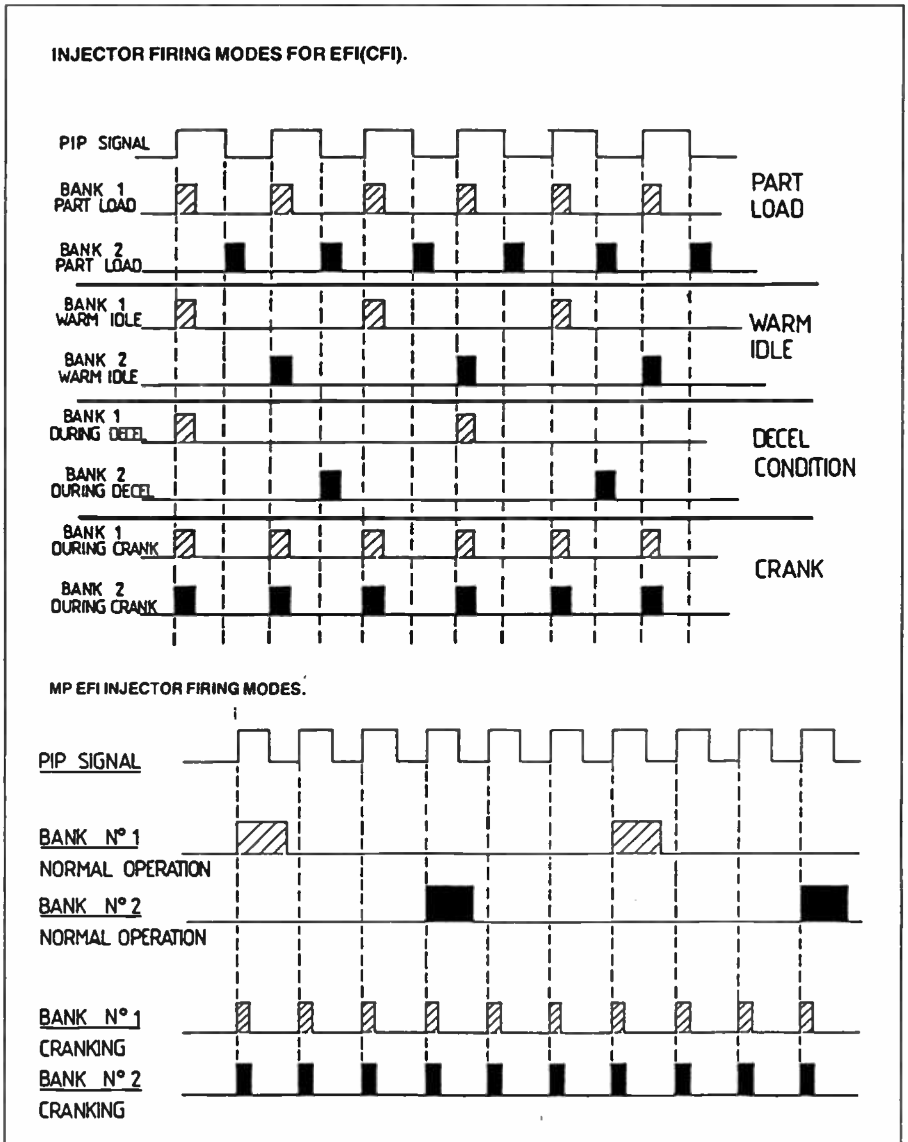

Fig.2.8

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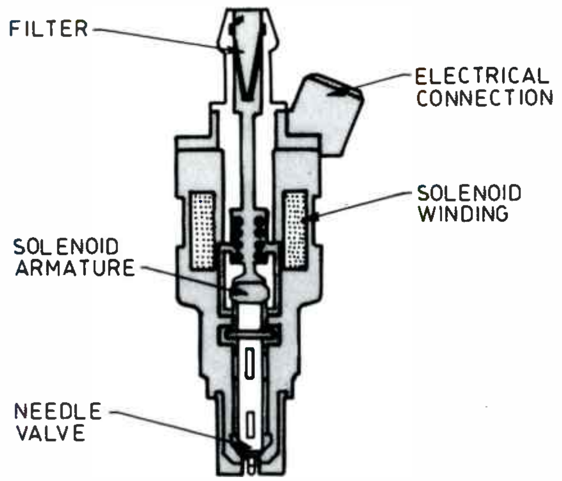

Fig.2.9

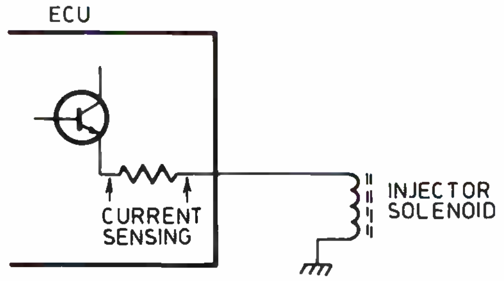

Fig.2.10

second for 800°C). For this reason the sensor is not used in the control loop until such time as it can be assumed to be properly heated up.

The other input sensors shown are used by the controller to adjust idling speed, and are not part of the air/fuel ratio control loop. The 'VSS' sensor is a device connected to the back of the transmission housing, which produces 10 pulses for each sensor revolution; 'ACC' is a switch which informs the controller that the air conditioner clutch is engaged, and the 'PPS' is a pressure switch informing the controller that the power steering is being used.

The outputs that concern us are the two banks of injectors (solenoid operated 'taps') that allow fuel into the intake manifold. The Falcon uses six injectors on the 'multipoint' system, arranged into two banks of three. On the Central Fuel Injection system (CFI) there are two injectors. Because of the problems of controlling small amounts of fuel with short injector opening times, the injectors are opened less often for small fuel requirements. Fig.2.8 shows the injector opening times for the various fuel delivery requirements. The injectors themselves (Fig.2.9) cause a needle valve to open for extremely short times (100 to 500 microseconds) and for very short distances (1mm or so). This is achieved by having solenoids of small turns of wire (low inductance), capable of carrying high currents. This means that when the current through the solenoid coil stabilises there must be some means to reduce it, otherwise the coil would burn out.

In days gone by, there were some solenoids that needed external resistors. But these days the resistors are included in the control unit (Fig.2.10). This enables the controller to measure the voltage across the resistor and when it reaches a certain peak, corresponding to maximum current, this current can be reduced.

One other sensor not mentioned, but nonetheless important, is the battery voltage sensor. If the battery voltage is low, then the fuel injector solenoids will take longer in time to open. The controller will therefore need to open each solenoid earlier and for a longer time than if the battery voltage was higher. The controller recognizes this, and acts accordingly.

Measuring the air mass directly

The Ford Laser uses a potentiometer to produce an analog voltage corresponding to the flow of air into the engine (Fig.2.11). This rate of air information is combined with the speed of the engine, determined from the distributor pulse in the same way as the Falcon's engine, and the temperature, derived from a temperature-dependant resistor, in order to arrive at the air mass. There is no sensor to determine manifold atmospheric pressure, as it is not needed.

There are problems with a sensor such as this, not the least of which is the fact the air flap presents an obstacle to the air flow. The Ford Corsair, instead, uses a 'hot wire' system that enables the air mass to be measured more or less directly. This hot-wire sensor is in the intake air stream (Fig.2.12).

In order to understand the operation of the hot-wire sensor four basic concepts need to be understood:

1. The resistance of a piece of wire will increase as its temperature increases;
2. An increase in voltage across a piece of wire, causing an increase in current,

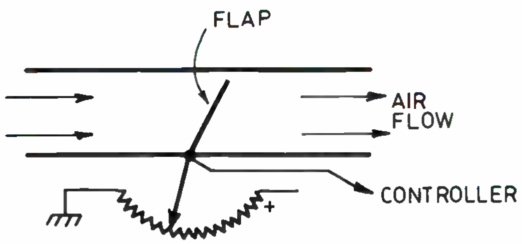

Fig.2.11

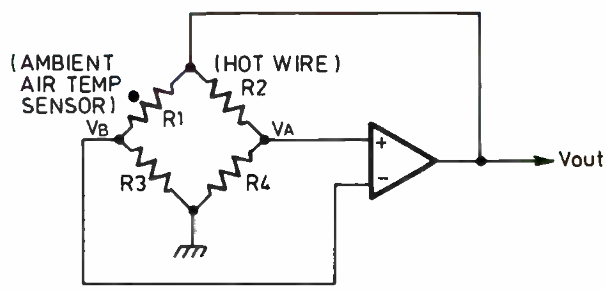

Fig.2.12

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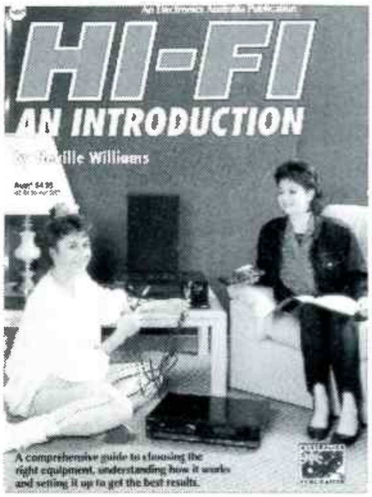

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Automotive Engine control - 2

will cause an increase in power dissipation ($P=I^2*R$), and hence a rise in temperature;

3. The principle of a Wheatstone bridge (see earlier); and
4. An operational amplifier will amplify the difference in voltage between its inverting input (-) and its non inverting input (+). This amplification is very high (20,000) and a difference of 100uV (microvolts) will result in a Vout of:

$$Vout = diff*20{,}000 = 100*10^{-6}*20{,}000 = 2 \text{ volts}$$

When the engine is idling, a certain amount of air is passing over the hot wire, effecting its temperature and consequently its resistance. The op amp adjusts its output such that it applies a current to the hot wire, in an attempt to cause V_A and V_B to be very nearly the same, and the circuit is stabilised.

If the driver puts his foot down, opening the throttle, this allows more air to be drawn over the hot wire — cooling it down, and decreasing its resistance. V_A will increase, causing a larger difference voltage to be seen by the op amp.

The op amp's output rises, causing more current to be driven through the hot wire (and also the other leg, containing the temperature dependant resistor R1). This results in the hot wire heating up, its resistance to increase and V_A to falling back to V_B.

(V_B has also increased, due to an increase in the applied voltage, but not to any change in resistance). Because V_A and V_B have come close together again the op amp output will reduce and eventually stabilise.

If the throttle is closed, the hot wire will heat up due to loss of air cooling. Its resistance increases, V_A falls, the op amp reduces its output, current through the hot wire falls, its temperature drops and its resistance reduces, V_A increases and again Vout will stabilise with V_A very near V_B.

Typically Vout is used to alter the frequency of a voltage controlled oscillator (VCO) and the controller, by measuring this frequency, can determine air flow.

R1 is used so that the temperature of the incoming air can be taken into account. The reading will therefore be an indication of the air mass.

The air mass readings are again a part of the pro-active state, and the Laser and Corsair use an exhaust oxygen sensor in the reactive state for finer control.

The other output not mentioned so far is the signal to the amplifier of the ignition coil. As was mentioned in the first article, the controller takes care of determining the amount of ignition timing advance needed. It uses all the sensors mentioned before for fuel control, in both the open and closed loop mode.

One thing the controller can't do is set the base timing, or the actual relationship between the pickup sensor and the piston position when the engine is stationary. This needs to be done by service personnel.

One sensor not used on the Falcon, but likely to be in the future, is a *knock* sensor. As the name implies, this senses any pre-ignition that is occurring in the engine. The optimum engine timing is just before pre-ignition, but we don't want it to occur before we can sense it — due to the likelihood of engine damage.

Fortunately there are some tell-tale signs just before this happens, but they can be difficult to pick up — particularly if only one sensor is being used.

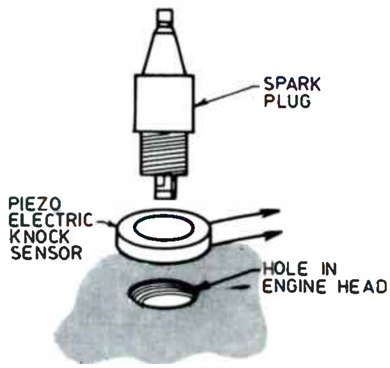

Fig.2.13

In the future there will probably be a knock sensor comprising a ring made of a piezo-electric material, placed between the spark plug and its hole in the head (Fig.2.13). This will lead to the controller being able to optimise the timing for each cylinder.

The preceding discussions have described the systems used on three of the motor vehicles manufactured by Ford Australia. These examples are representative of vehicles sold by other manufacturers as well.

In the third of these articles I will be describing what goes on inside the 'black box' itself — the actual controller.

(To be continued) ❖

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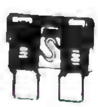

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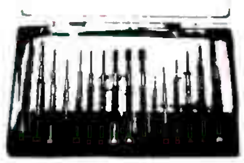

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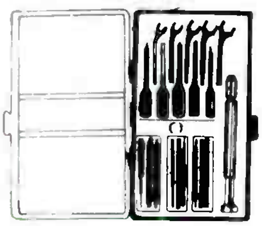

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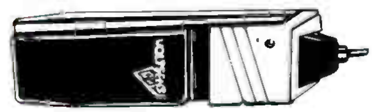

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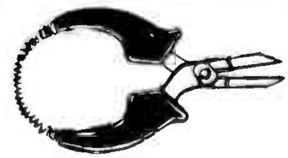

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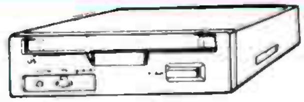

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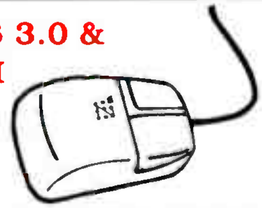

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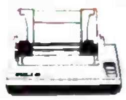
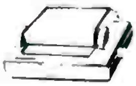
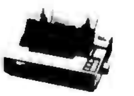
LX-400 80 Col, 9 Pin Dot Matrix, 180 Cps Draft 30 Cps NLQ, Pull Tractor C22054..................$249



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



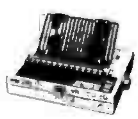
FX-850 80 Col, 9 Pin Dot Matrix, 264 Cps Draft 54 Cps NLQ Push Tractor Smart Park Feature $750



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

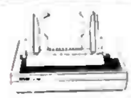
SQ-850 80 Col, 24 Nozzel ink jet, 600 Cps Draft, 198 Cps LQ, Push Tractor, Smart Park Feature. $1,225

LQ-200 80 Col, 24 Pin Dot Matrix 192 Cps Draft, 64 LQ, Pull Tractor, 8 Bit Map fonts. $475



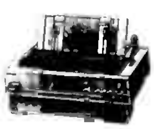
SQ-2550 80 Col, 24 Nozzel Ink jet, 600 Cps Draft, 198 Cps LQ, Push Tractor, Smart Park Feature, ...$1995

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

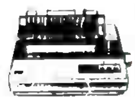


LQ-570 80 Col, 24 Pin Dot Matrix, 252 Cps Draft, 84 Cps, NLQ Scalable Fonts 8 to 32 points, 11 LQ Fonts 360 x 360 DPI, Top, Rear, Bottom and Front paper feed paths, Convertable Push/Pull Tractor. $575

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



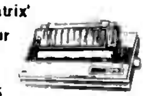
LQ-860 80 Col, 24Pin Dot Matrix' 295 Cps Draft,98 CPS LQ, Colour Standard,Push Tractor Smart Park Feature...................................$1095



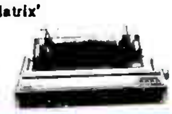
LQ-1070 136 Col, 24 Pin Dot Matrix, 252 Cps Draft., 84 Cps NLQ, Scalable Fonts, 8 to 32 point, 11 LQ Fonts, 360 x 360 DPI, Top, Rear, Bottom, and Front Paper Feedpaths, Convertable Push/Pull Tractor $775

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

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



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



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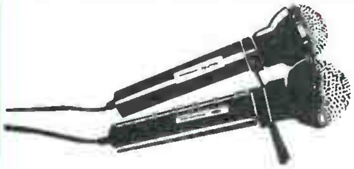
MICROPHONES

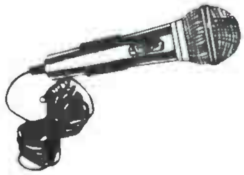
STOP START MICROPHONE

With on/off switch for remote control of cassette player. Complete with desk stand for hands free operation.
SPECS:
Type: Omni directional
Impedance: 200 Ohm
Freq response: 250Hz to 10kHz
Sensitivity: -74dB
Plugs: 2.5mm (remote) 3.5mm (mic)
A10126.................................$5.95



PAIR OF MATCHED DYNAMIC MICROPHONES

With black plastic bodies, chrome mesh grilles and desk stands.
SPECS:
Type :Omni directional
Impedance: 500 Ohm
Freq Response: 80Hz to 12Khz
Sensitivity: -73dB
Cord/plug: 3 metre/6.35mm plug
A10124...$14.95



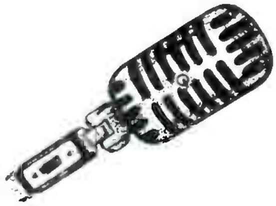
DYNAMIC MICROPHONE

Dynamic microphone with black plastic body ideal for use with existing Kareoke systems. Can also be used with tape or cassette recorders.
SPECS:
Type :Uni directional
Impedance: 600 Ohm
Freq Response: 60Hz to 12Khz
Sensitivity: -76dB
Cord/plug: 3 metre/6.35mm plug
A10136...$19.95

HAND HELD CB MICROPHONE

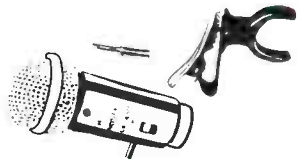
This low impedance microphone was designed with a push to talk switch built into the body specifically for use with CB radio and other communication equipment. Ideal for the truck, mobile radios as well as base station setups.
SPECS:
Type :Uni directional
Impedance: 500 Ohm (low impedance)
Freq Response: 500Hz to 10KHz
Sensitivity: -56dB
Cord/plug: 2 metre curl cord/bare ends
A10128...$17.95

AUDIO EQUIPMENT



BALANCED MICROPHONE WITH "AKG" INSERT

This unique old style designed microphone with an AGK insert is ideal for studio and stage work. It mounts directly onto a floor stand or boom arm and is constructed from heavy duty die cast . It is complete with lead, on/off switch and inbuilt swivelling microphone to stand mount.
SPECS:
Type :Uni directional
Impedance: 600 Ohm
Freq Response: 40Hz to 18Khz
Sensitivity: -75dB
Cord/plug: 5 metre/Cannon to 6.35mm plug
A10135...$149.95



TIE TACK WIRELESS MICROPHONE

Miniature ball head tie tack tunable microphone fitted with on/off switch. Comes complete with tie tack clip microphone and battery
SPECS:
Type : Unidirectional
Freq Response: 50Hz to 16Khz
Tuning range: 88-108MHz
Field strength: 15mV/100m
Battery: 1.5 V LR44 or SR44
A10127...$39.95

TIE TACK ELECTRET MICROPHONE

Miniture tie tack microphone fitted with on/off switch. Simply attach to your shirt lapel and plug into any low impedance microphone socket. Comes complete with tie clip, plug adaptor & windscreen
SPECS:
Type :Omni directional
Impedance: 500 Ohm
Freq Response: 50Hz to 16kHz
Battery: 1.5V (1 x AAA/UM4)
Plug: 3.5mm or 6.35mm with adaptor.
A10137...$39.95

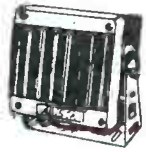
MINI INNER EARPHONES

Diaphrams fit directly into the ear for greater comfort and for keeping out unwanted background noise that can interfere with music. Each set is packaged in a protective plastic storage case complete with a spare set of foam earpads.
SPECS:
Type :Omni directional
Impedance: 32 Ohm
Freq Response: 40Hz to 18Khz
Sensitivity: -96dB
Cord/plug: 1.2 metre/6.35mm stereo phone
A14006...$4.95

COMMUNICATION SPEAKERS

COMMUNICATION SPEAKER

Minature sized extention speaker ideal for cellular telephone systems, CB and other communication equipment. Enclosed in a modern plastic cabinet with metallic mesh grille, the unit comes with a unique fully adjustable metal bracket that allows the speaker to be either permanently screwed or temporarily mounted with an easily removable magnetic base.
SPECIFICATIONS:
Speaker: 57mm mylar cone
Impedance: 8 ohms
Power: 3 watt RMS
Magnet: 1 ounce
Cord: 1.8 metres
Plug: 3.5mm
Size: 74 x 78 x 37mm
Weight: 200 grams
C10700...$29.95



COMMUNICATIONS SPEAKER

4" fullrange speaker designed for CB radio, communication equipment and other audio applications. The speaker is enclosed in a heavy duty plastic cabinet for protection, making it ideal for use in cars, trucks, vans, the garage or workshop.
- Complete with adjustable metal mounting bracket

SPECIFICATIONS:
Speaker: 10cm (4")
Impedance: 8 ohms
Power: 5 watt
Magnet: 2 ounce
Cord: 3 metres
Plug: 3.5mm
Size: 105 x 75 x 110mm
C10702...$23.95

POWER PACKS

300mA / 9 VOLT DC POWER PACK

240 volt AC input to 9 volt DC output.
Rated at 300ma
- Polarity reversible plugs and sockets
- Supplied with 1.0, 1.3, 2.1, 2.5mm DC plugs

M19014...$19.95

1000mA (1 AMP) 6 VOLT DC

240 volts AC input to 6 volt DC output.
Rated at 1000ma
- Ideal for the workshop or test bench
- Polarity reversible plugs and sockets.
- Supplied with 2.5mm DC plug

M19016...$19.95

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ROD IRVING ELECTRONICS - No.1 FOR COMPONENTS

BNC PLUGS AND SOCKETS

BNC MALE PLUG

	1-9	10-99	100+
P10514	$2.50	$2.25	$1.50

BNC PANEL SOCKET

	1-9	10+	100+
P10516	$2.50	$2.25	$1.50

BNC CRIMP PLUG

	1-9	10-99	100+
P10530	$3.95	$3.75	$3.00

BNC SOLDERLESS TWIST ON PLUG

	1-9	10-99	100+
P10531	$3.50	$3.25	$3.00

CANNON PLUGS AND SOCKETS

CANNON TYPE 3 PIN CHASSIS MALE

	1-9	10-99	100+
P10962	$3.50	$2.95	$2.50

CANNON TYPE 3 PIN LINE FEMALE

	1-9	10-99	100+
P10964	$3.95	$3.50	$2.90

CANNON TYPE 3 PIN CHASSIS FEMALE

	1-9	10-99	100+
P10966	$4.95	$4.50	$3.50

CANNON TYPE 3 PIN LINE MALE

	1-9	10-99	100+
P10960	$4.50	$3.50	$2.50

COMPUTER CABLES

· Six conductor shielded computer interface cable.

W12670 · CIC6 6 con.		
1-9M	10M+	100M+
$1.30M	$1.10M	$1.00M
W12672 · CIC9 9 con.		
1-9 M	10M+	100M+
$1.60M	$1.50M	$1.20M
W12674 · CIC12 12 con.		
1-9M	10M+	100M+
$2.50M	$2.20M	$1.90M
W12676 · CIC16 16 con.		
1-9M	10M+	100M+
$3.50M	$3.20M	$2.50M
W12678 · CIC25 25 con.		
1-9M	10M+	100M+
$3.90M	$3.40M	$3.00M

LEDS

QUALITY 3mm LEDS

	1-9	10-99	100+
Z10140(R)	$0.15	$0.12	$0.10
Z10141(G)	$0.20	$0.18	$0.15
Z10143(Y)	$0.20	$0.18	$0.15
Z10145(O)	$0.20	$0.18	$0.15

QUALITY 5mm LEDS

Z10150(R)	$0.15	$0.12	$0.10
Z10151(G)	$0.25	$0.20	$0.18
Z10152(Y)	$0.25	$0.20	$0.18

FLASHING LEDS

RED 5mm	1-9	10+
Z10159	$1.10	$1.00

RECTANGULAR LEDS

	1-9	10+	100+
RED	20c	15c	12c
GREEN	20c	15c	12c
YELLOW	20c	15c	12c
ORANGE	20c	15c	12c

IC SOCKETS

LOW PROFILE IC SOCKETS

Save a small fortune on these "Direct import" low profile IC sockets! PCB mounting solder tail. All tin plated phosphor bronze or berryllium and dual wipe for reliability.

		1-9	10+	100+
P10550	8 pin	15c	12c	10c
P10560	14pin	20c	18c	15c
P10565	16pin	20c	18c	16c
P10567	18pin	30c	25c	22c
P10568	20pin	35c	30c	25c
P10569	22pin	35c	30c	26c
P10570	24pin	35c	30c	26c
P10572	28pin	45c	35c	30c
P10575	40pin	45c	40c	35c

WIRE WRAP IC SOCKETS

These quality 3 level wire wrap sockets are tin plated phosphor bronze.

P10579	8pin	$1.50	$1.40
P10580	14pin	$1.85	$1.70
P10585	16pin	$1.95	$1.80
P10587	18pin	$1.95	$1.80
P10590	20pin	$2.95	$2.75
P10592	22pin	$2.95	$2.70
P10594	24pin	$3.95	$3.50
P10596	28pin	$3.95	$3.50
P10598	40pin	$4.95	$4.50

ELECTRET MIC INSERTS

With pins for easy board insertion. C10170

1-9	10-99	100+
$1.20	$1.00	$0.90

ULTRASONIC TRANDUCERS

Designed to transmit at 40kHz (L 19990) & recieve at 40kHz (L19991) withup to 20V I/P on the transmitter. These units can't be heard so are ideal for TV remote controls, water level dectectors, burglar alarms, motion dectectors & information carriers as they can be either pulsed or used in a continuous wave mode.

	1-9	10+
Transmitter		
L19990	$2.95	$1.95
Receiver		
L19991	$2.95	$1.95

IDC PLUGS & SOCKETS

WOW ! FROM $1.00

D TYPE IDC PLUGS

	1-9	10+	100+
· DE9P 9pin plug			
P12166	$1.50	$1.20	$1.00
· DA15P 15pin plug			
P12168	$1.50	$1.20	$1.00
· DB25P 25 pin plug			
P12170	$4.50	$3.95	$3.50

D TYPE IDC SOCKETS

	1-9	10+	100+
· DE9S 9 pin socket			
P12167	$1.50	$1.20	$1.00
· DA15S 15 pin socket			
P12169	$1.50	$1.20	$1.00
· DB25S 15 pin socket			
P12171	$4.50	$3.95	$3.50

IDC CENTRONICS 36 WAY PLUG & SOCKET

	1-9	10+	100+
· Plug P12200	$3.95	$3.00	$2.95
· Socket P12201	$3.95	$3.00	$2.95

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Description	1-9	10+
7805UC	$0.50	$0.45
7812UC	$0.50	$0.45
7815UC	$0.50	$0.45
7905UC	$0.50	$0.55
7912UC	$0.60	$0.55
7915UC	$0.60	$0.55
78L05	$0.40	$0.30
78L12	$0.40	$0.30
LM324	$1.00	$0.90
555	$0.40	$0.38
741	$0.50	$0.45

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TEST DRIVE II	$69.95

DB25 CONNECTORS

DB25 CONNECTOR SPECIALS

		1-9	10+
P10880	DE9P	$1.00	$0.80
P10885	DE9S	$1.00	$0.70
P10891	DA15S	$1.00	$0.70
P10892	DA15C	$1.00	$0.90
P10895	DA15S	$1.00	$0.80
P10902	DB25C	$1.00	$0.80
P10904	DB25P	$1.00	$0.80
P10905	DB25S	$1.00	$0.80

ECONOMY TRANSFORMER

	1-9	10+
2155 240V 6-15V 1A		
M12155	$8.95	$7.95
2156 240V 6-15V A2		
M12156	$13.95	$12.95
2851 240V 12-6V CT 250mA		
M12851	$4.95	$4.50
6672 240V 15 30vc 1A tapped		
M16672	$12.95	$11.95

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12V DC FANS

80 x 80 x 25.4mm
12V DC. 1.7 Watt 0.14 Amp
T12469................$18.95
10+ fans, only $17.95

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Quality fans for use in power amps, computer hotspot cooling etc. Anywhere you need plenty of air.

240V 4 5/8" T12461..$16.95
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We have a great range of panel meters at great prices!

Q10500	MU45 0-1mA	$9.95
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Q10560	MU650-20V	$12.95

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	1-9	10+
2SJ49	$9.50	$8.00
2SJ56	$10.00	$9.50
2SK134	$8.50	$8.00
2SK176	$9.50	$8.90

TOGGLE SWITCHES

		1-9	10+
S11010	S.P.D.T	$1.20	$1.10
S11020	D.P.D.T	$1.30	$1.20

NEW SWITCH BOXES

9 PIN D SWITCH BOXES

2 WAY...............$59.95
4 WAY...............$69.95

MONITOR & KEYBOARD SWITCH BOXES

only $69.50

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Save a fortune on expensive throw away batteries with these quality Nicads and Rechargers!

	1-9	10+	100+
Size AA 450mAH			
	$2.95	$2.75	$2.50
Size C 1 2 A H			
	$9.95	$9.50	$8.95
Size D 1 2 A H			
	$9.95	$9.50	$8.95

HEATSINK COMPOUND

Heatsink compound is applied to the base and mounting studs of transistors & diodes. It maintains a positive heatsink seal that improves heat transfer from the device to the heatsink, thus increasing overall efficiency.

H11800 ..10g...$2.00
H11810.150g. $29.95

WIRELESS MICROPHONE

Tuneable:92-104MHz
Freq response: 50-15kHz .
Range: over 300 feet in open field.
A10450...........$24.95

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World Radio History

When I Think Back...

by Neville Williams

Vintage radio receiver design - 6: Pentagrid converters, diode detectors and AGC

Once 4/5-valve superhets, as described in the November issue, had identified and established the prime suburban receiver market, manufacturers sought to devise ways and means of attracting buyer interest to their respective products. Some such measures were mainly cosmetic in the way of cabinetware and controls; others had to do with on-going circuit design and performance.

As indicated in the November article, the single most troublesome aspect of the first wave of 4/5-valve superhets was probably that of gain — or volume — control. It came about because the IF amplifier stage was the only one available for gain control, and the range of adjustment was simply not sufficient to embrace both maximum gain for weak signals and minimum gain for powerful local stations. To make good the shortfall, it proved necessary also to attenuate the antenna input signal for local stations and this led to difficulties, as outlined in the earlier issue.

Smoother and more effective gain control could conceivably have been achieved by using a variable-mu valve as a mixer, in conjunction with a separate oscillator valve. It would then have been possible, with one bias control potentiometer, to vary the signal conversion — or translation — gain of the mixer, along with the normal stage gain of the IF amplifier. The catch was that it would have transformed the receiver into a 5/6-valve set, with a consequent and unacceptable price increase.

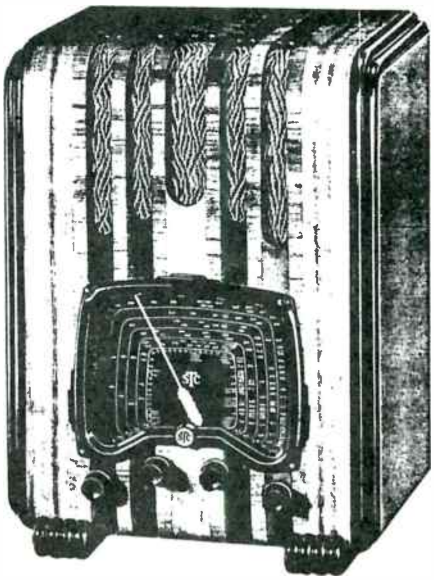
It was left to the valve manufacturers to solve the problem, by the release of special frequency-changer or frequency 'converter' valves which could perform the functions of oscillator and mixer more or less independently. For the Australian radio scene, the most notable such valve was the American designed 2A7 pentagrid converter — which was succeeded, in due course, by its 6.3V counterpart the 6A7, and its octal-based equivalents the 6A8, 6A8-G and 6A8-GT.

As a logical derivative of existing tetrodes and pentodes, the pentagrid converter also employed a comparable concentric electrode structure. But in this case there were five grids between cathode and anode — so arranged that they could perform the dual function more flexibly than the existing autodyne concept.

Fig.1, from an early *RCA Receiving Tube Manual*, depicts the electrode structure and the pin connections of the original 2A7 (applying also for the 6A7). Fig.2, from the same manual, shows RCA's typical circuit arrangement.

Oscillator and mixer

Grid 1, adjacent to the cathode, served as the oscillator grid and connected to the active end of the tuned oscillator coil L2 via the usual grid capacitor and grid leak. Note that the latter returned directly to cathode, so that the only bias would be that resulting from the oscillatory grid current — typically between 0.2 and 0.5mA.



STC's model 504E mantel radio of 1939 was fairly typical of sets using the 6A8-G, a later version of the 2A7/6A7.

Grid 2 served as the oscillator anode, and connected through the oscillator feedback winding L3 to an HT supply voltage in the range 100-200V.

As I recall from my days in the AW Valve Co, grid 2, often described as the 'anode-grid', was a grid in name only, with the diagram of Fig.1 adding to the fiction. In practice, it was nothing more than two bare side-rods, with no spiral grid, as such. The rods were simply held in place by the mica electrode support discs, connected together and wired to the relevant base pin.

However, being relatively close to grid 1 and cathode, and operating at 100V DC or more, the anode-grid (or side rods) would typically draw around four milliamps, completing an inner triode that was well able to oscillate in its own right in conjunction with the associated tuned circuit formed by L3, L2 and C.

Enclosing the inner triode — cathode/G1/G2 — was a screen grid designated as G3. Operating typically at 100V DC and bypassed to earth with an 0.1uF capacitor, it provided an electrostatic shield around the inner electrodes and also accelerated towards the anode proper those sectors of the electron beam that were not being attracted to the anode-grid side rods.

Immediately beyond this screen was the 'signal grid' G4, connected to the signal input tuned circuit L1/C. Beyond this again was another screen grid, G5. Connected internally to G3, this served the

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same purpose as the screen grid in an RF tetrode or pentode, by reducing the direct capacitance between signal grid and anode.

Frequency conversion

In normal operation, the wanted input signal would be fed to G4, being impressed on the anode current much as it would in an ordinary tetrode or pentode mixer/amplifier. In the pentagrid structure, however, the electron stream had already passed through G1 and thus been modulated with the oscillator signal, deliberately tuned above the signal frequency by (typically) 455kHz.

Intermodulation — or heterodyne effects — took place such that a multiplicity of signal components appeared in the anode current, including the original signal and oscillator frequencies plus direct harmonics of each and resultants at a variety of sum and difference frequencies. Most were rejected by the IF amplifier system, which was pre-tuned to the intended intermediate or 'difference' frequency — nominally 455kHz.

If this sounds very like what was said about the autodyne frequency changer in previous issues, it is, but with one vital difference: in the autodyne, the same control grid was directly involved in both functions — oscillator and mixer. If a variable negative bias was placed on the grid to reduce the conversion gain of the mixer, it would ultimately interrupt the oscillator, rendering the receiver inoperative.

In the case of the pentagrid converter, the inner triode was substantially unaffected by what was happening in the outer mixer section, so that the receiver designer was free to manipulate conversion or 'translation' gain by applying a control bias to the signal grid G4. Valve designers made the best of the facility by giving G4 a remote cut-off characteristic, comparable to that of contemporary variable-mu RF pentodes. With increasing bias, the translation gain of the 2A7 fell from 520uS (microsiemens, or uA/V, formerly called 'micromhos') at -3V to a mere 2uS at -45V.

Receiver designers breathed a sigh of relief when the 2A7 became available, abandoning the autodyne at the first opportunity, along with local/distant switches or compound gain control circuits. Once again adequate control could be achieved simply by varying simultaneously the bias of two stages: the mixer and the IF amplifier.

The success of the American-designed pentagrid converter prompted European valve manufacturers to produce their own frequency converters. But apart from the Philips 'octode', the American/-Australian made 2A7/6A7/-6A8 series reigned supreme in Australian receivers until the emergence of multiband receivers called for an upgraded converter with better performance at the higher frequencies. But that is another story.

Erratic sound level

Adequate gain control per medium of variable bias opened the way to the solution of another annoying problem in the early 1930's, namely a tendency for the volume level of receivers to vary spontaneously and erratically. Having been set for comfortable listening, the volume level, for no apparent reason, would suddenly become uncomfortably loud or drop to a whisper — a situation which resulted in numerous complaints and/or service calls.

In a few cases the problem turned out to be a faulty valve, a loose clip on the voltage divider, an intermittent cathode

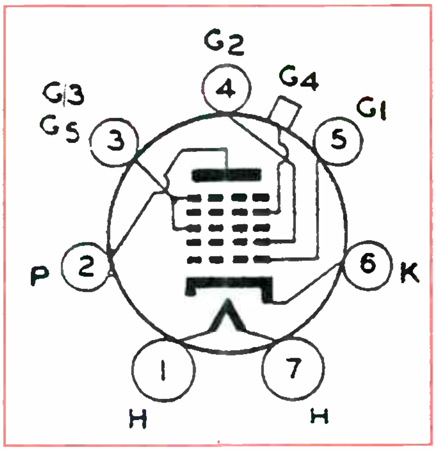

Fig.1: Pin connections for the 2A7 pentagrid converter, as viewed from the underside. The cathode, G1 and G2 provide the basic triode oscillator.

bypass, or such like. More commonly, no fault would be found and, back on the service bench, the set would perform perfectly. In such a case, attention would focus on the electrical environment in which the set was being operated.

As distinct from country areas, few receivers in urban homes were provided with a regular antenna and earth. There would be no earth, as such, and the antenna would be a few metres of 'bell wire' tacked to the picture rail. In these circumstances, the amount of signal fed through the primary of the antenna coil could be affected by the household electrical wiring and what lights and appliances happened to be switched on or off at any given time.

More subtly, house wiring in the early 1930's was commonly run through steel conduit, which was subject to erratic earthing by reason of rust and expansion/contraction effects with variations in ambient temperature. Given that receivers were often plugged into lamp sockets via 2-way adaptors, extension leads and/or bodgie power points, it added up to a very unstable environment for incoming radio signals.

Automatic gain control

While the immediate answer might have been installation of a new power circuit and/or a better antenna and earth, an attractive proposition for manufacturers was the incorporation of so-called 'AVC' (automatic volume control) which would hopefully counteract changes in signal strength with an automatic and complementary readjustment of the receiver gain.

It may be helpful to note here that, in recent years, technical writers have preferred the term AGC (automatic gain control) to AVC. Not only it is more accurate, but it is also more appropriate where the technique is applied to video or other equipment where the information being processed is something other than sound waves.

AVC/AGC was not a new idea, having already been featured in up-market receivers — as, for example, a 9-valve set manufactured in Sydney by Airzone for Palings and marketed, by arrangement, under the Victor label.

The technique involved the use of a diode detector, so wired that it would deliver a demodulated audio signal plus a negative DC voltage proportional to the strength of the incoming carrier. By applying the negative voltage to the variable-mu stages in lieu of a manually controlled bias, the front-end gain of the receiver would diminish automatically with increasing signal strength — and vice versa.

In short, it could obviate front-end overload by powerful local signals, counteract the effect of abrupt changes in signal strength and, by way of a bonus, compensate to some extent for night-time fading from distant transmitters. With the signal level from the detector thus regulated, the function of the manual volume control knob was simply to adjust the sound from the audio system to the required level.

Ironically, while the first-ever thermionic valve had been a diode, the only versions readily available around 1930 were power supply rectifiers. Small-signal detector diodes suitable for use in mains receivers were virtually unobtainable. As a result, designers of

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receivers such as the Victor, mentioned above, resorted to the use of triodes like the 27 or 56, with the grid serving as the diode anode. The anode was simply earthed, serving only as an impromptu shield around the diode elements.

In an up-market receiver, an extra valve provided just another reason for the higher price. But at a competitive budget level, an extra valve wired as a diode was no more acceptable than the same valve serving as a separate oscillator. The problem, in short, was to translate AGC into mass-produced 4/5-valve superhets — without adding to the cost.

Duo-diode triodes

Once again, valve manufacturers came to the rescue, aided by the fact that detector diodes could be very small — by reason of the relatively low voltage and current that they were required to handle. By fitting an otherwise ordinary valve with a slightly shorter grid/plate assembly and a slightly longer cathode, enough of the cathode could be exposed to serve one or two tiny circular or semicircular anodes, accessed through extra base pins.

The first such valve to become readily available in Australia was the 55, a general-purpose triode with a 2.5V heater, a 6-pin base, top-cap grid connection and two small-signal diodes suitable for detection and automatic volume (gain) control.

While it made possible a 4/5-valve superhet with AGC, the 55 proved a disappointment for another reason: with an amplification factor of 8.3, it offered a stage gain, as a resistance coupled amplifier of just under six times. As a detector/amplifier, this would have been roughly a tenth that of a 57 as an anode bend detector — resulting in a serious loss of receiver sensitivity.

There was an urgent need for a high-gain triode, which valve manufacturers subsequently met with the 2A6, followed in order by its 6.3V equivalents the 75 and the octal-based 6B6-G. With an amplification factor of 100, these offered a stage gain as a resistance-coupled amplifier of around 56, which just about restored the status quo.

I remember with lingering dismay the first prototype we cobbled together at Reliance Radio of a 4/5-valve superhet with AGC. Based on an existing model with a pentagrid converter and routine coils and IF transformers, the third socket was rewired to accommodate a duo-diode-triode instead of the anode-bend detector. An AGC circuit replaced the variable cathode bias system, and an audio volume control was inserted between the detector output and the triode grid.

Selectivity problem

The receiver certainly worked smoothly enough, but gave the impression of being atrociously broad in terms of selectivity — with stations seeming to overlap one into the other. We all agreed that, even if such a receiver eliminated complaints about erratic changes in volume level, there would be at least as many other complaints to do with poor apparent selectivity.

It transpired that the problem was the result of two effects — one real and the other subjective. The reality was that, whereas an anode-bend detector responded purely to the voltage across the associated input circuit, diodes were power operated, responding to the signal input voltage but at the same time drawing current from the source. In effect, a diode detector shunted the input circuit with a resistance about half that of the associated diode load. The end result was an immediate loss of both gain and selectivity in the associated IF transformer.

The subjective effect was due purely to the interaction of AGC with the tuning routine. In the case of manual gain control, detuning the receiver to either side of resonance caused the sound volume to fall away at the same decibel rate as the slope of the selectivity curve. But with AGC, detuning the receiver reduced the strength of the incoming carrier — yet at the same time the receiver gain was automatically increased, thereby partially offsetting the loss of sound volume.

To the user, the set appeared to be less selective. In fact, it may not have been so because, when an adjacent signal was encountered, the consequent reduction in gain could well be sufficient to render the original signal inaudible.

But real or subjective, possible consumer dissatisfaction caused manufacturers to take a long, hard look at IF channel design before committing themselves to diode detectors and AGC. The immediate result was that IF transformers wound with multi-strand ('litzendraht') wire became a necessity rather then an option.

Instead of single-strand wire, the windings were wound from so-called 'litz' wire comprising (typically) seven or more strands of 41 B&S enamelled wire, spun together to form a single silk-covered conductor. Because high frequency currents tend to flow on the surface of conductors, litz wire exhibits a lower RF resistance than a single wire of the same overall dimension, yielding a winding with a significantly higher 'Q'.

(This assumes, by the way, that the strands are all tinned and soldered together at each end of the winding. Fractured strands reduce winding efficiency).

While this was not the end of the story, the use of litz wire for IF transformers and the secondary of the antenna coil showed the way to more practical designs.

The art of tuning

Even so, consumers had to become accustomed to receivers equipped with AGC. Instead of just tuning for the loudest signal, they had also to learn to tune for the 'deepest' sound, with good bass and an absence of carrier 'swish' and/or sibilants on speech. It became almost routine to walk into a house and hear an 'edgy' voice or distorted music emitting from the new radio — a clear indication that it had not been correctly tuned.

One answer to the problem was the provision of a small back-lit tuning meter, visible through a cut-out in the dial or cabinet front. With a full-scale

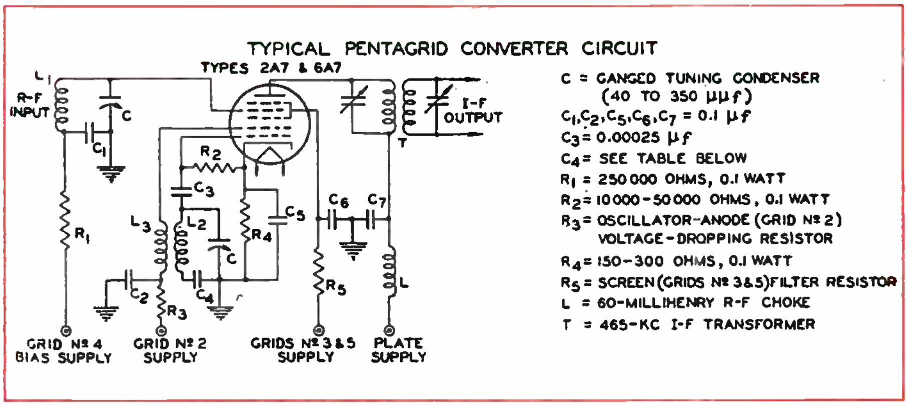

Fig.2: RCA's typical circuit for the 2A7 pentagrid converter, from an early RCA receiving tube manual. The oscillator circuit (bottom), the RF signal input circuit (left) and the IF output circuit (right) can be readily identified.

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sensitivity of about 10mA, it would normally be wired into the anode or cathode circuit of the IF amplifier. Under no-signal conditions, the meter would read full scale. When tuned to a station, AGC would reduce the anode or cathode current and the pointer would swing back towards its rest position. On the scale behind the pointer was an arrow and the words 'Tune for the greatest swing'. It was a useful fitment, but one that because of its cost was largely confined to up-market models.

Rather than becoming involved with a mechanical tuning meter, some manufacturers released receivers with tuning indicators contrived from low-current filament lamps or neon devices — none of them all that impressive.

Once again valve manufacturers came up with a practical answer, in the form of an 'electron ray' tuning indicator, subsequently dubbed a 'magic eye'. The first of these, the 6E5, was released in Australia around 1935, by which time most manufacturers had swung over to 6.3V valves. I understand that a 2.5V version was also released, but I cannot recall ever having encountered one. European manufacturers came out with their own configurations and type numbers, which appeared on the local market in limited numbers.

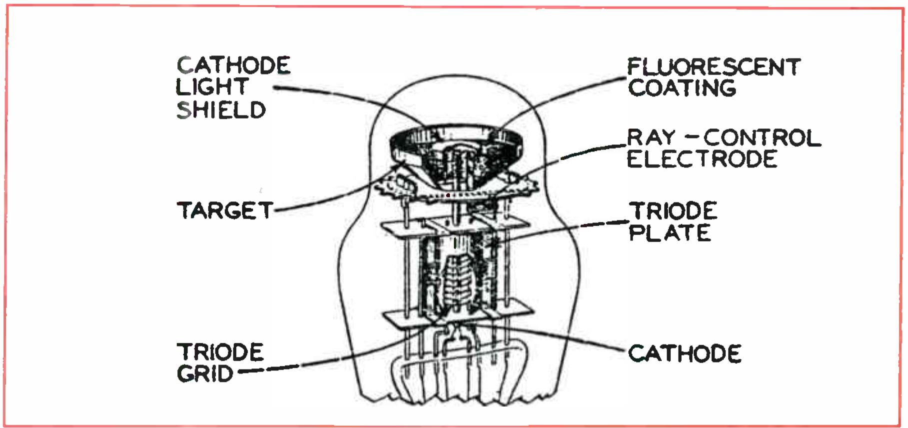

Fig.3: The electrode structure of the 6E5, taken from RCA literature. It was the first electron ray indicator to be widely adopted in Australia, and was followed by quite a few variants released by RCA and other manufacturers.

How the 6E5 worked

As illustrated in Fig.3, the 6E5 was based on a small general purpose triode in an ST-12 valve envelope, with the cathode extending into a display assembly occupying the domed top of the bulb. This involved a shallow cone-shaped target electrode about 20mm in diameter, with a phosphor coating similar to that used for green screen cathode-ray tubes. A small metal vane — the ray control electrode — attached to the triode anode, protruding on one side into the space between the cathode and target.

In use (Fig.4) the cathode was returned to earth directly or via a cathode bias circuit. The grid was connected to the AGC (AVC) line and the anode fed from the HT supply through a suitable load resistor. The target was connected direct to B-plus. In operation, electrons attracted from the cathode would strike the surface of the target electrode, causing the coating to glow a bright green. The indicator was normally mounted so that the top of the bulb was visible through the dial scale, or through a small hooded escutcheon set into the adjacent front panel.

With no signal input, there would be, at most, only a small negative potential on the triode grid. With a consequently high anode current, voltage drop across the anode resistor 'R' would result in a relatively low voltage on the anode and the ray control electrode.

Under these conditions, the ray control electrode would repel the adjacent electrode stream, creating a triangular 'shadow' extending on either side by about ±45°. With the cathode and ray control electrode hidden by a small internal shield, the user was aware only of a conical electrode, glowing bright green except for a 90° triangular shadow.

Tuning the receiver to a station would generate a negative voltage on the AGC line, therefore on the indicator valve grid. The anode current would fall, the anode voltage would rise and the shadow angle would be reduced — the edges of the illuminated area appearing to move together. The user was instructed to tune for the 'smallest shadow'.

'Magic eye' tuning indicators were less 'clinical' and more visible than small milliamp meters and, with their gimmicky name, became a strong promotional feature in the mid 1930's. They gradually disappeared, however, as listeners learned to do without them and especially when they realised that they had to be replaced from time to time when the 'magic glow' dimmed.

Mid-1930's receiver

Prompted by a stream of application data from the respective valve manufacturers, a style of domestic urban receiver gradually emerged that reflected Australian technology of the mid-1930's. It could be summarised as follows.

(The valve types shown in brackets are octal-based alternatives, which were either available as imports in all-metal construction or in view as octal-based glass types).

- Frequency changer: 6A7 (6A8-G) pentagrid converter, with automatic gain control.
- IF amplifier: 6D6 (6K7, 6U7-G) variable-mu pentode also with automatic gain control.
- Detector/amplifier: 75 (6Q7, 6B6-G) duo-diode high-mu triode providing diode detection, delayed AGC feed voltage and audio voltage amplification, with provision in some cases for phono input.
- Output valve: 42 (6F6, 6F6-G) pentode, with treble limiting and, in most cases, top-cut tone control.
- Rectifier: 80 (5Y3-G) with field coil filter system.
- Tuning indicator: 6E5.

Fig.5 shows a typical circuit using the above valve complement. It is not based on any one specific receiver but, like earlier circuits in this series, is typical of the era — while also providing a basis for relevant comment, beginning with the frequency changer.

Unlike the autodyne, discussed in earlier articles, the configuration of a pentagrid converter did not lend itself to much variation, apart from minor differences in the choice of component values. Grids 1 and 2 were simply wired as a triode oscillator, with the usual grid isolating capacitor and a resistor ('grid leak') returning direct to cathode.

Grids 4 and 5 provided a separate variable-mu tetrode function, accepting the wanted signal from the antenna coil, mixing it with the oscillator signal per medium of the internal electron stream, and delivering the required difference — or 'intermediate' — frequency to the IF system at 455kHz or thereabouts.

The 300-ohm resistor and bypass capacitor in the cathode circuit ensured the minimum specified bias of -3 volts for the signal grid (G4) under no-signal conditions. With a very strong signal input, the AGC voltage might apply an

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extra negative voltage to G4 of anything up to -40V, at which point the conversion gain would be reduced from 500uS to a mere 2uS — enormously simplifying the one-time problem of front-end gain control.

Incidentally, to measure the AGC voltage in such a circuit calls for an electronic voltmeter, with an internal resistance of several megohms. Using an ordinary multimeter, minor deflection of the pointer may usefully indicate that a negative control voltage is present — but the actual reading is meaningless, because of the shunting effect of the instrument on the very high impedance circuit.

Operation of the oscillator section can be checked by simply unsoldering the cathode end of the 50k resistor and bridging the gap with a DC milliammeter, positive connection to cathode. Normal grid (G1) current over the broadcast band was usually in the range 0.25 to 0.5mA.

No measurable grid current would indicate that the valve is not oscillating, calling for possible valve replacement and/or inspection of the circuit to identify some other possible fault.

The IF stage is essentially similar to those shown in earlier circuits, except that the gain is controlled by a negative potential from the AGC circuitry reaching the grid via the secondary of the first IF transformer. As in the case of the 6A7, a cathode resistor and bypass ensured that the 6D6 had the required minimum bias applied when there was no signal present to activate the AGC.

The diode detector

Turning to the duo-diode triode, the circuitry to do with detection, AGC and the magic eye function commanded a great deal of attention during the mid-1930's, as I well remember from my involvement in the A.W. Valve Co laboratory and technical publications. Valve manufacturers' recommendations were treated with considerable respect by the engineering fraternity.

When first introduced — or re-introduced — to the domestic receiver scene in the 1930's, diode detectors came in for a fair amount of criticism both for their effect on selectivity, as already mentioned, and for reputedly exhibiting higher distortion than the hitherto widely used anode bend detector.

The damping effect of a diode rectifier on the associated tuned circuit was inarguable, and had to be offset by the use of litz windings — and in due course, by the introduction of ferrite cores.

But analysis showed that distortion was not a problem in a basic diode detector, provided that the design of the receiver was such that the detector operated with an RF input of at least 10V peak — as would normally be the case with automatic gain control.

Where the difficulty arose was in the ill-considered addition of supplementary circuitry to feed the audio amplifier, to derive AGC voltage for front-end gain control, and provide drive voltage for the magic eye indicator. By requiring the detector to work into a so-called 'AC' load of much lower impedance than its direct 'DC' load, there would be a proportionate reduction in the modulation depth of the incoming signal which it could handle without distortion.

In a 'worst case' situation, a designer might choose a 1M diode load with the idea of minimising the damping on the input circuit. For audio take-off, he might shunt this with a 1M volume control, fed through a coupling capacitor. A 1M resistor might also be added to feed the AGC system, with a similar resistor to the magic eye grid — both bypassed at the remote end by a 0.1uF capacitor. As a result, the nett AC load would be only one quarter of the DC load, with severe consequent distortion on waveforms involving more than about 25% modulation.

In Fig.5, the direct or DC load for the diode detector is 0.55M, made up of a 50k resistor forming part of an RF filter network and a 0.5M potentiometer — the audio volume control. Signal for the audio amplifier is picked off from the sliding contact and, having in mind the tapered element in most volume controls, the audio circuitry may well be shunting only a few thousand ohms of the diode load at typical settings. As a result, its effect on the operation of the diode would be negligible.

The AGC circuit

If the AGC voltage were to be derived from the diode end of this same network — so-called 'simple AGC' — it would obviously impose an undesirable load on the detector circuit. It would also have the effect of feeding a negative bias to the converter and IF valves in the presence of even a very small signal, thereby marginally reducing the effective sensitivity.

To preserve the sensitivity to very weak signals, it was/is desirable that a threshold be established such that no AGC voltage would be applied until incoming signals reached a predetermined level. This is achieved in Fig.5 by using a separate diode as the AGC source, fed from the IF amplifier anode via a 100pF capacitor. Since its load resistor returns to earth, current can only flow when the signal peaks are sufficient to overcome the sum of the diode's own space charge and the volt or so of cathode bias.

The technique was/is commonly described as 'delayed' AGC — a rather misleading description, because the word wrongly suggests a time delay rather than a voltage threshold.

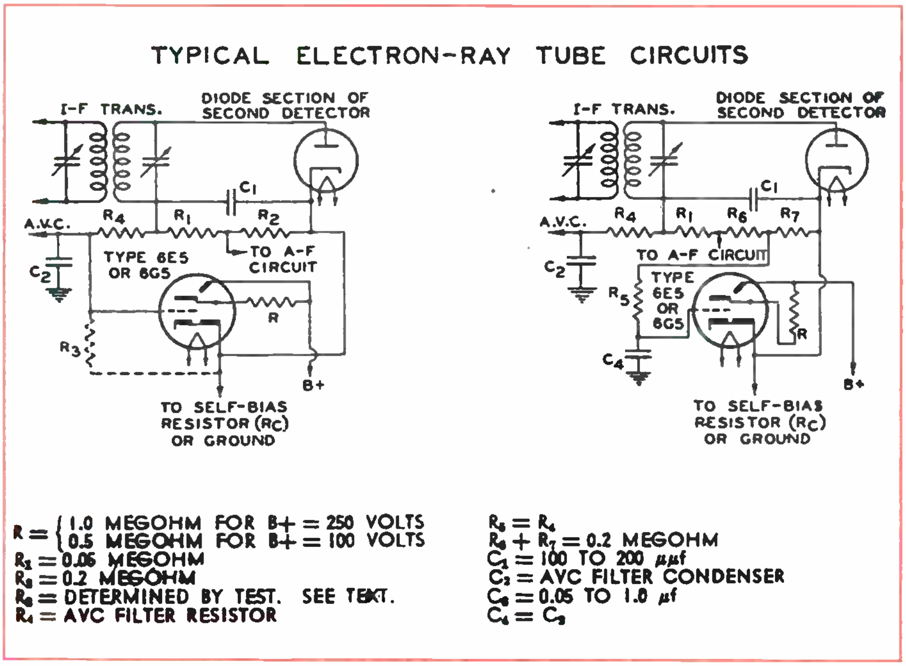

Fig.4: Typical early tuning indicator circuits published by RCA. The circuits were later refined in various ways, and the 6E5 itself was displaced by other types which offered improved display characteristics.

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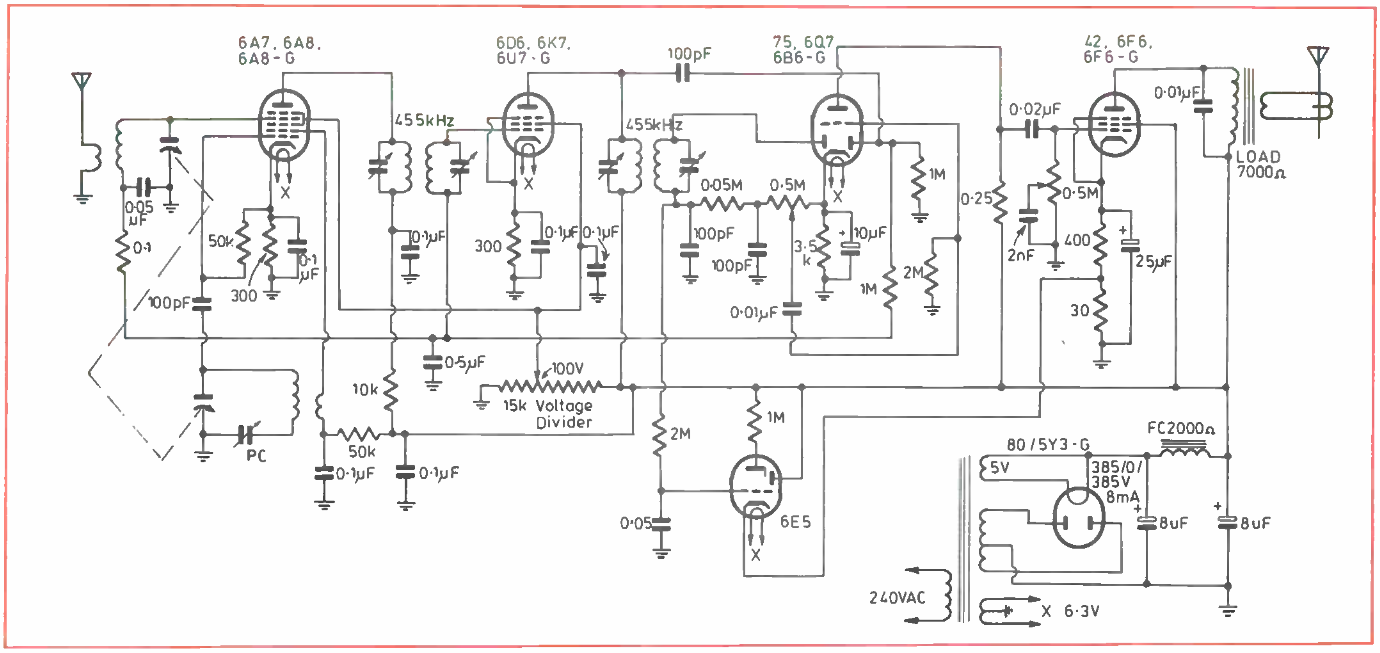

Fig.5: The incorporation of a pentagrid converter and AGC called for basic changes in the design of 4/5-valve superhet receivers. This circuit is not based on any particular model, but is nevertheless typical of overall Australian practice in the mid 1930's. With rare exceptions the 2.5V valves had been superseded and relegated to a 'replacement' role.

That aside, delayed AGC removed one of the potential shunts from the diode load — although it did have its own separate effect on selectivity, by shunting the IF transformer primary.

Ironically, while delayed AGC was desirable in terms of receiver sensitivity, the resulting AGC control voltage was less suitable for activating the tuning indicator. Even though a transmission may have been audible in the loudspeaker, it might not have registered on the tuning indicator, leading to the impression that the indicator was faulty.

To avoid this threshold effect, the A.W. Valve Co suggested in *Radiotronics* No.70 (November 1936) that the tuning indicator be fed from the detector diode — taking care to minimise the loading by using a 2M feed resistor, as shown.

Potentially flawed

They warned, however, that with the indicator cathode simply earthed, there was a potential path for electron migration from the indicator cathode, by emission to the grid and thence through the isolating resistor and detector diode load, to the positively charged cathode of the detector/audio stage. Thus, instead of the detector diode being simply referenced to its own cathode, it could be exposed to an external bias current. This could prejudice its behaviour in the troughs of weak or heavily modulated signals, where the instantaneous carrier level fell to near zero.

As a precautionary measure, it was suggested that the indicator cathode be biased to a similar voltage to that of the detector cathode. Fig.4 notwithstanding, simple self-bias was not recommended because of variations in target (therefore cathode) current between individual indicators. AWV's preferred approach was to derive the requisite voltage from a relatively stable source — for example, the cathode circuit of the output valve.

One other difficulty had arisen with the 6E5, in that the shadow angle reached 0° with a grid bias of -8 volts. A further increase in signal strength (and AGC voltage) could have little further effect, beyond causing the illuminated edges to overlap. Efforts to overcome this limitation by using only portion of the AGC voltage were compromised by the fact that such measures also affected the sensitivity to weak signals.

The problem was overcome by releasing the 6G5 with a remote cut-off characteristic, being otherwise a plug-in replacement for the 6E5. It retained essentially the same low-level sensitivity, but extended the cut-off voltage by about three times.

Audio system

Now equipped with its own in-built volume control, the audio system shown in Fig.5 was ready for operation from a phono pickup. This involved the provision of a suitable 2-pin socket or twin terminals at the rear of the chassis, plus a 2-way 'radio/PU' switch on the front panel. This was so wired that it would transfer the active end of the volume control from the 50k filter resistor to the live PU connection, the other PU connection being earthed. Some makers included the phono facility, others didn't. For the rest, the 6B6-G triode amplifier and the 6F6-G output pentode are straightforward, with a top-cut tone control and a treble limiting capacitor across the loudspeaker output transformer — fitted for the reasons outlined in earlier articles.

The need to provide a stable cathode bias for the magic eye tube provided sufficient reason to favour full cathode bias for the output valve and this is depicted in Fig.5, as distinct from back-bias shown in the earlier circuit.

Built along these lines, receivers in the mid-1930's were eminently satisfactory for listeners in urban or other well served areas. Servicemen had access to service data for individual models, but the designs were sufficiently consistent from one model to the next for a good servicemen not to rely overmuch on the literature. But the process of evolution was not by any means complete. With the success of the 4/5-valve configuration came the challenge to shed yet another valve — with the idea of offering a 'second set' in every home. One that would be cheaper, smaller and more portable than the existing console.

On the other hand, the shortwave fad was just around the corner, along with the hi-fi revolution, which was to have a significant impact on the audio systems of ordinary receivers. These matters will be the subject of future articles.

(To be continued) ❖

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FORUM

Conducted by Jim Rowe

More about compact fluorescent lamps — and a parting shot about B-MAC and DBS

To welcome in the New Year we have some interesting comments from a number of people who responded to my piece in last September's issue, about compact fluorescent lamps. There's also a letter which helps explain some of the background to Australia's choice of the B-MAC system, last discussed in the October issue...

The subject of compact fluorescent lamps was quite a timely one, it seems, from the number of letters and faxes that have turned up in response to the September column. We'll look at these shortly; but first I'd like to present one last letter on B-MAC.

Yes, I know I wrote in the October issue that this subject was more or less closed for the time being, but like Mr Keith Walters' letter in that issue, this one also seems to need publication in the interests of fairness. It is in fact largely in response to Mr Walters' own letter, and seeks not to prolong any arguments, but simply to clarify a number of the points he raised concerning the reasons for Australia's choice of the B-MAC system for satellite TV broadcasting. As the letter is fairly short and concise, I therefore believe it only reasonable to 'open the gate' and present it as one last contribution to our understanding...

Writes from experience

The letter comes from Mr Carl Wilhelm, who was for many years a high-ranking engineer in the ABC, where he was responsible for the introduction of colour TV and was also heavily involved in the introduction of satellite distribution of programmes. He certainly seems to know what he's writing about:

In publishing Mr Keith Walters' rather vehement letter in full, in 'Forum' (EA October '91), you inevitably must expect to receive further correspondence on the MAC/composite issue, before you can close the debate.

I do not want to comment on the technical pros and cons — these have had more than enough airing. I would, however, like to address some of the issues which led Australia to adopt the B-MAC system — which, with nearly 10 years of hindsight, was an unfortunate choice. To be as concise as possible, I have omitted much detail from the comments below.

1. Mr Walters says that the 'C' band PAL HACBSS network was working quite well. It was, and it was infinitely better as a service than the originally proposed U-MATIC tape replay network. However the RATS (Remote Area Television Service) service to which Mr Walters refers, and which became operational in 1979, suffered a low S/N ratio and breakup on sharp edges such as titles and sub-titles programs. These deficiencies, coupled with the large antenna dish, clearly made the RATS service format unsuitable to adopt for a DBS service.

2. It was the Government of the day who insisted that the replacement service, to be carried by the AUSSAT satellite and now known as HACBSS, should provide at least two radio programs as well as TV. This posed a major technical hurdle, for there were no operational radio satellite delivery systems anywhere in the world at that time.

I can assure Mr Walters that a tremendous effort was made at the time (early 1980s) to find a cost-effective conventional technology solution. These efforts went as far as laboratory trialling SCPC (separate carrier per channel) systems to carry the radio channels with the TV channel. This had to be rejected because of poor S/N performance and the high cost of manufacturing low volume quantities of receivers specifically for the local market.

MAC system design and development was also being conducted during the late seventies and a laboratory prototype of the B system was demonstrated in Australia.

3. AUSSAT tender schedules sought TV and radio systems for the HACBSS service with no exclusions, so long as the systems achieved the basic technical parameters for the TV and radio services at moderate cost to the consumer.

Unfortunately, the only proposal which met the time scale to allow the Intelsat transponder then used for the RATS service to be released, and had the potential of low cost chip sets, used the B-MAC system. It was also the only proposal where sample chip sets for the receiver decoders could be obtained prior to placing contracts.

Yes, Australia was the first country to use B-MAC operationally and yes, the cost of chip sets and therefore the cost of decoders has remained high due to other countries choosing to use satellite delivery systems other than B-MAC. But it was the only choice to fulfil the requirement of the Government of the day. There will always be a risk when a country becomes the first to use a new technical development.

I do not consider Mr Walters' penultimate paragraph suitable for publishing in a quality magazine like 'Electronics Australia'.

Thank you for your information and comments, Mr Wilhelm. In response to your last comment, when I was preparing the October column I did indeed ponder whether or not to include Mr Walters' second-last paragraph with its rather derogatory comments. What finally made me decide to do so was the realisation that various other writers had also made some pretty derogatory remarks about Mr Walters' own earlier letters. Having already reproduced *those* uncensored, I decided that I'd have to be consistent and leave his in as well.

With the benefit of hindsight, perhaps I should have chopped all such remarks out of ALL of the letters concerned. But then the discussion might easily have become rather bland...

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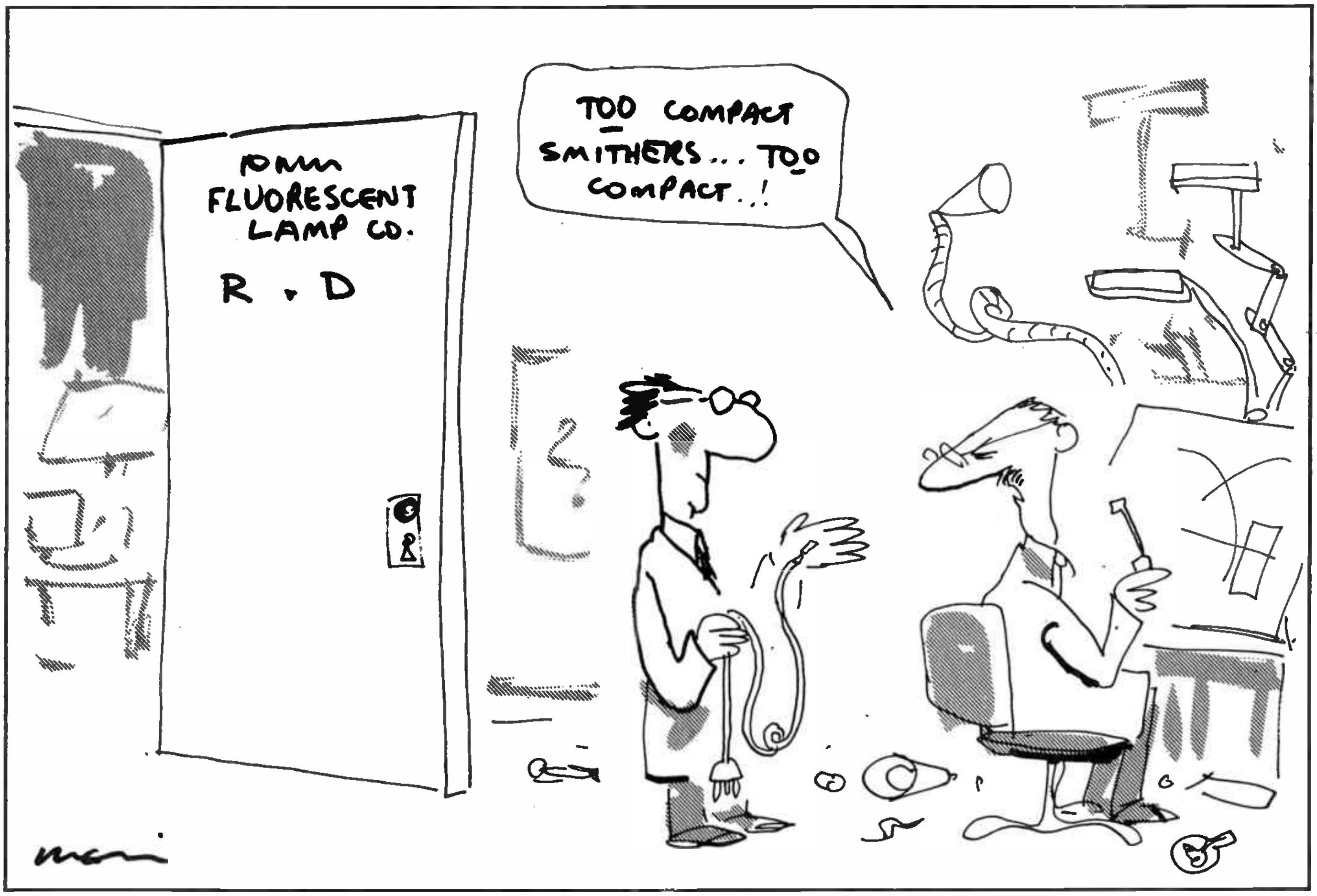

Getting back to the subject of DBS, I for one found your comments gave more insight into the reasons for the original decision to go with B-MAC. However perhaps I'm an old skeptic, but it does seem a little too facile to blame it all on 'the Government of the day'.

Whose plan?

It seems to me that Governments, being formed from elected politicians, as such rarely ever come up with specific technical plans. If these are adopted as part of legislation, my impression is that they are usually formulated by the 'experts' in the appropriate Government *departments* — i.e., the bureaucrats, technical and otherwise. These people generally have much more technical knowledge than our elected representatives, and as a result the latter probably have little option but to take their advice and legislate accordingly.

If the plan later turns out to be flawed, it therefore seems hardly fair to blame the poor pollies. Surely this would be more a sign that the advice they'd been given was itself flawed...

In this case, it seems unlikely that the politicians themselves would have 'insisted' that a replacement satellite TV system had to provide for two radio channels as well. Particularly as you say that such a system was not at that stage operational anywhere in the world, and the need to provide such a system presented a 'major technical hurdle'.

Frankly, it sounds to me like the idea would have come from the technical bureaucrats — who were perhaps merely trying to make sure that Australia got the most advanced and 'up to date' system, so that they wouldn't be blamed later for saddling us with an outmoded and inflexible one. Fair enough, too, but as you say it's always a bit risky trying to be too much of a pioneer.

Need for caution

Anyway, I guess it's all 'water under the bridge' now. We did try to pioneer, and many other countries picked a different system. But before pay-TV begins in earnest around the end of this year or early next, we will have the opportunity to change from B-MAC to a more widely adopted system like D2-MAC — while it's still economically and technically feasible. I suspect I'm not alone in believing this is well worth considering.

And with that final comment, let's put the subject back into cold storage for a while and get started again on this month's main topic:

Compact fluoro's

As I noted earlier, quite a few readers responded to the September piece discussing compact fluorescent lamps. And not surprisingly, some interesting further information has come to light in their comments.

Mr Stanley Ash, a chartered professional engineer from Forestville in NSW, offered these interesting comments on the problems caused by high harmonic currents:

I have just read, rather belatedly, your interesting article in the September issue on the subject of waveform distortion in the current drawn by fluorescent lamps.

An aspect of this subject which might be of interest to your readers is that in a three phase four-wire 415/240 volt distribution system, if the loads on the three phase wires are balanced, no current flows in the neutral and the neutral conductor may thus be of smaller cross-section or even be omitted.

However in the case of fluorescent lighting installations, because the current drawn by each fluorescent light has a third harmonic component, the harmonic current components from each phase add numerically in the neutral, with the result that the third harmonic

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current in the neutral is three times the harmonic current in each phase (for balanced loading).

The neutral conductor may easily be overloaded by the third harmonic current, and this is one reason why it is necessary to fit power factor correction equipment to fluorescent lights.

Thanks for your contribution, Mr Ash. I guess I for one *should* have remembered that tendency for certain odd harmonics to add in the neutral conductor, because I'm sure I must have learned it years ago in the 'power' subjects of my uni course. But that was a good 30 years or so ago, and I haven't had much occasion to think about it since then!

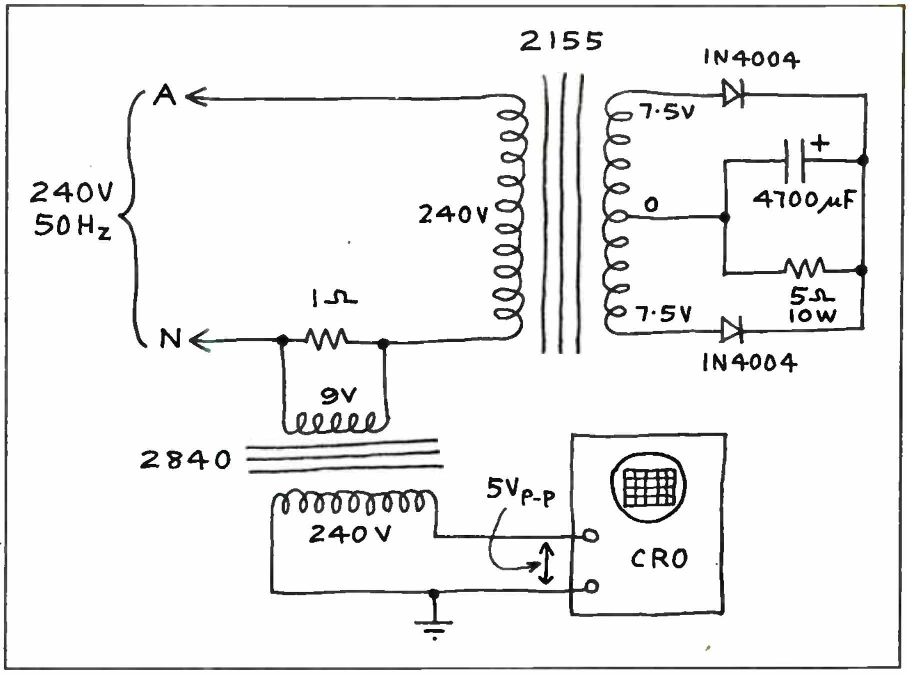
Other harmonics, too

It certainly makes clear another problem caused by harmonic currents, though, as far as the power authorities are concerned. And although you refer specifically to third harmonic components, I imagine the same would apply to any other higher-order harmonics whose period was an integral sub-multiple of 6.666ms (one third, or a 120° segment of the 50Hz period). In other words the sixth harmonic, ninth, twelfth and so on. These would all tend to be additive in the neutral line, by my reckoning, although the magnitude would no doubt become smaller and smaller for higher harmonics — so I expect that the third harmonic presents the largest potential problem.

Moving on, another interesting letter came from Mr Frank Choate, who is a director of the firm Amalgen Control Systems, in Mortdale NSW. Here's what Mr Choate had to say:

I liked your article on compact fluoros, power factor, PCs and TVs. The article does highlight what has become a considerable problem, and is likely to become worse in the future.

Fluoros, PCs and TVs can cause problems because of their large numbers in one installation; but worse, many installations have large rectifier systems for DC motor drives, variable speed AC motor drives, soft-starting motor drives, SCR controlled heating, plating baths etc. These loads are not necessarily small — 200kW to 300kW drives are quite common, and one installation could contain say 10 such drives plus other non-linear loads. Probably by the turn of the century half of the electric power generated will be controlled by rectifiers. The Americans are predicting more, but their predictions are often a bit on the wild side.



The experimental circuit used by correspondent Andrew Pierson, to confirm that mains current distortion is also caused by conventional 'linear' power supplies using a capacitor-input rectifier, as well as switch-mode supplies.

The problems multiply when power factor correction is considered. Sure a capacitor will solve some of the problems. It provides a store of energy to supply large peak currents, and can eliminate the 'cos ϕ' or displacement part of the low power factor. However the mains reticulation system is largely inductive; the loads are usually inductive, the supply transformers have both magnetising and leakage inductance, and the wiring from the substation and at the installation itself is inductive.

Inductance and capacitance equals resonance. If these possible resonances are not taken into account during the design of power factor control equipment, the non-linear loads can cause regular blown fuses (at perhaps $200 per fuse); catastrophic failure of the capacitors; a possible increase in harmonic voltages and currents in other parts of the system; or perhaps an excessive power bill.

It should be realised that although the resonances that most electronic engineers might come across only involve milliwatts or watts (big transmitters and such things aside), the power system may be handling a megawatt or more. The consequences of getting it wrong can be a lot more spectacular.

Another problem is that the power authorities generate ripple signals on their own systems, to control 'off peak' loading. These signals vary from 400Hz to 1050Hz, with the lower frequencies often used because they will work over longer distances. These signals must not be bypassed by the power factor correction equipment — but the recommended circuit to achieve this resonates at about 320Hz, which is close to 350Hz (the dreaded 7th harmonic). At these power levels it is not possible to achieve the Q factors needed for sharp filters, and hence where ripple signals are used careless design may well result in 'the smoke escaping', complete with sound effects!

The manufacturers who you mention as not providing correcting capacitors at the terminals of their lamps, etc., may be saving money. However they may also realise that these distributed capacitances can cause problems. While each capacitor may be small and only store a small amount of energy, the cumulative effect can be large. The problem here is that trying to analyse such a system for resonances over all possibilities of load can be impossible.

The further problems of radiated noise, excessive neutral currents and problems associated with the design of mains filters will, with the above, ensure that many of us who spend the next decade in the electrical and electronic industry will be able to say 'we lived in interesting times'.

Thanks again for a stimulating article.

And thank you too, Mr Choate, for your own comments. As you point out, the problem of current waveform distortion and the resulting harmonic components is by no means restricted to

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compact fluoro's, or even to switch-mode power supplies. It has been growing steadily over quite a few years in all sorts of areas, and looks like assuming major significance.

I'm not sure if I understand your reference to resonance problems caused by interaction between capacitors used for power factor correction and assorted system inductances, though. My understanding is that a power factor correction capacitor is deliberately designed to draw a 90° 'leading' current component equal in value to the 90° 'lagging' current component drawn by an inherently inductive load, such as a conventional fluorescent tube and electromagnetic ballast combination.

Already resonating...

If this is the case, surely that means that the capacitor and its own particular inductive load are *already* effectively resonating at 50Hz. And because this resonance is a parallel one, this should mean that the nett impedance presented to the mains will be close to a pure resistance, equal to the 'real' part of the load — the fluorescent lamp, or whatever.

Assuming I'm right, though, I can't see how all the little power factor correction capacitors could effectively add together to create a large and troublesome one, able to resonate with transformer and line inductances. But perhaps I'm missing something here.

Perhaps you're implying that such capacitors are commonly made too large, and as a result produce a resultant load that is capacitive? Or perhaps the capacitors are left in circuit even when their inductive loads are disconnected? I don't know; you might like to clarify this point.

By the way I notice in your discussion of ripple control tones that you refer to 'the dreaded seventh harmonic'. I've seen such a reference before, and have to confess that I for one have no idea what it means. Sorry to reveal my ignorance, but what's so especially worrying about the seventh harmonic?

More experiments

Moving on again, another interesting letter came from our old friend and contributor Andrew Pierson, of Salisbury Park in SA, who had this to contribute:

Your comments in 'Forum' about peak currents with high harmonic content being drawn from the mains, particularly by switchmode supplies, rang a few alarm bells. The fact is that this mounting problem has been with us for many years, and it's not caused by switchmode supplies, per se. It's probably not been recognised by most people involved in electronics, because they just didn't have the inclination to look at the mains current waveform of the equipment they were using!

It makes little difference whether a rectifier/filter system is connected directly across the mains (as in switchmode supplies) or via a transformer. The real culprit is the rectifier/filter system itself; if it pulls a peaky waveform from the secondary of a transformer, then the primary current waveform is going to be peaky also! It's true that the transformer will not pass the very high order harmonics, but it has more than enough bandwidth to pass severe waveform distortion.

To illustrate this, I set up the test circuit shown, which used a commonly available transformer feeding a capacitor-input 'full wave' rectifier. The primary current was measured by means of a small series resistor in the neutral leg, together with an isolating transformer which fed a CRO. The result was (after ignoring a small sine wave component 90° out of phase, due to the inductive current of the transformer) very similar to the current waveform of the AT computer you showed us. And we've been using power supplies like this ever since the evolution of the silicon power diode!

Under heavy loading conditions, the value of peak current is limited by the effective impedances of the transformer and the storage capacitor, together with the resistance of the rectifier diodes and associated wiring. You don't need a very large storage capacitor to produce nasty current peaks; with the modest transformer shown, the peak-to-peak primary current was within 75% of the maximum possible value with a storage capacitor of only 500uF, which was obviously far too small as it produced a ripple voltage of 6V p-p.

The old valve rectifier systems were probably very 'friendly' to the power grid, with their high impedance vacuum tube rectifiers and limited value of storage capacitance. Since the advent of good silicon diodes and electrolytic capacitors, we've been murdering the system and most of us didn't know it! Overcoming these problems will involve us changing some very fundamental power supply principles.

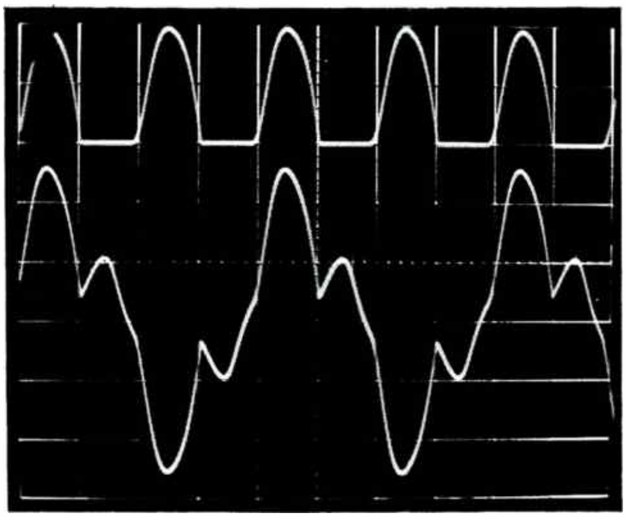
Thanks for your comments also, Andrew. Actually I didn't suggest that the problem of peaky and distorted currents was new, or restricted to switch-mode power supplies. All I said was that it was characteristic of many electronic power supplies, and *in particular* switch-mode supplies. And I stick by that, because it does seem fairly clear that currently these are the worst offenders.

'Linear' supplies too

You're quite right in pointing out that conventional transformer-fed rectifiers with capacitor-input filters are also guilty of drawing quite distorted current waveforms. But as your own scope photo shows, the resulting mains current doesn't tend to be nearly as peaky as that drawn by a compact fluoro or switch-mode supply. Presumably this is because of the 'filtering' effects of transformer core saturation, leakage inductance and so on.

It's true that the old valve rectifiers were probably much better again, because of the relatively high impedance of the rectifier valves and the fairly small reservoir capacitors available at the time. But by the same token, the high rectifier impedance also made such circuits quite

(Continued on page 128)



Here are the waveforms found by Andrew Pierson for the circuit at upper left. The upper trace shows the 100Hz pulses in the CT leg of the transformer secondary, while the lower trace is the primary current...

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THE SERVICEMAN

The volume control that also acted as an adjustable heating control!

This month we have an intriguing story from a contributor, regarding a National CTV with a puzzling problem: turn down the volume control, and a resistor would overheat to the point of smoking. Meanwhile, in between my own jobs I've been looking back through some old issues of this magazine from the 1950's, when things were in many ways rather simpler.

Readers have probably noticed by now that I am strong on nostalgia; that I never hesitate to go into a reverie about how things were 'way back then'. Nostalgia often amounts to a sentimental look at history, and I have recently spent some time having a sentimental look at the history of modern electronics. It came about this way...

A few weeks ago I was asked if I would like to take over a collection of 'old' electronics magazines. I was told that there were a number of issues of *Radio, Television and Hobbies* among them, and as *R, TV & H* was an earlier name for this magazine, I accepted the offer in the hope that they might help to fill in some of the gaps in my own collection of early editions.

To my surprise and pleasure, the acquisition predated my earliest copies by nearly 10 years. Right back to February 1957, in fact. And what a revelation that issue is!

To begin with, it was edited by the legendary John Moyle. Neville Williams was the Technical Editor, and Jim Rowe hadn't yet got a guernsey. (Jim didn't appear in the credits for the first time until early in 1960!)

The first article in the February '57 edition was about an Earth Satellite, expected to be launched by the US in the following year. As we now know, the USSR beat them to it, and, if I remember rightly, 1957 was the year of the Sputnik.

One of the technical articles in the same edition was about a UK design for a flat tube TV display. It was a most complicated device, 12" (300mm) across the diagonal and 3-1/2" (90mm) thick. It's not available today, so obviously it was not a commercial success.

Two construction projects featured in the issue were a 'Five Channel TV Tuner' and a 'Wide Band CRO'.

Five channels were considered to be all the tuner needed at that time, because there were only three channels on air in Sydney and Melbourne, and none anywhere else.

The 'wide band' CRO turned out to have a bandwidth of '3 megacycles', or 3MHz as we would say today. Being designed for home construction, 3MHz was probably about as wide as one would wish to go. But imagine trying to do any serious work today with that kind of 'wide band' performance.

The advertisements in the old magazine were also fascinating. Open reel tape recorders were the IN thing, although the Royce company in Melbourne were still offering their disc cutting lathes, cutting heads and stylii, and blank discs 'for the discerning recordist'.

On the subject of recording and recordings, stereo sound had not then arrived, but the magazine carried many references to its imminent release. It was also noted that production of 78rpm shellac discs had just ceased in England, and it was suggested that monophonic records would soon follow them. (It's taken until now to see the end of vinyls — I wonder what will replace CD's?)

Reference was made to the happy coincidence that two-channel amplifiers were to be required just at the time that transistors appeared. Nevertheless, all the early stereo amplifiers were valve types, both commercial and home-built projects. Another advertisement that attracted my attention (and one that would be hard pressed to find a place today) was one for TV antennas and a booklet of installation advice.

The gimmick was the cover photograph of a girl in a swimsuit, standing on a tiled roof adjusting an antenna. Quite apart from the inappropriate dress for such a job, I can't imagine the feminists allowing that kind of '(S)exploitation' these days!

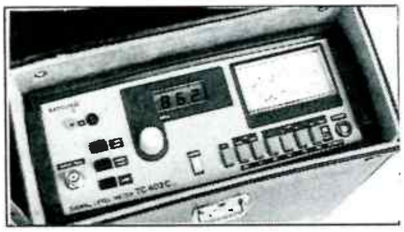
But of all the material in the February '57 edition, I was most interested in 'From the Serviceman Who Tells', the forerunner of this very column. The whole article was given over to describing faults in a five-valve mantel radio.

Such a prosaic subject is probably not surprising, since television had only started a few months earlier, in 1956, and not many faults would have been noted by the time this issue came out.

Still, it was quite a thrill to read the early story, and to realise that now, nearly 35 years later, I am carrying on the tradition of one of the longest-running columns in any journal anywhere. I hope I can maintain the tradition for many years to come.

DIGITAL!

Sadelta's new TC402C. A calibrated field strength meter for 40 to 870 Mhz., with L.C.D. frequency indicator and larger level meter: $750 +20% Tax.



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READER INFO NO. 9

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Modern puzzler

Now, we come back to the present time and to one of our new contributors. He is Mr T.G., of Alberton West in Victoria. And he has an interesting story to tell, about a most unusual fault. He tells it this way:

How often in the pages of 'The Serviceman' have we read of perplexing tales from the service bench that have been difficult if not impossible to fully explain? Well, the following story left me with a few unanswered questions.

A customer arrived at my workshop recently with a National TC-2233 colour TV, fitted with a Panasonic V1 chassis. The reported fault appeared to be partial frame collapse, with a picture only about 3cm high at the centre of the screen.

The customer told me that everything was OK before the picture collapsed; indeed there seemed to be colour present and the sound seemed normal. So I told him that I'd get to work on the set as soon as possible.

Later that day I removed the back cover and switched the set on to make a few checks around the vertical scan circuit. The culprit turned out to be Q403, one of the vertical output transistors, which had an open circuit b-e junction.

After replacing the transistor and restoring a normal picture, I put the set aside and let it run to confirm that all was well. But I soon discovered another problem — not with the picture, but with the sound.

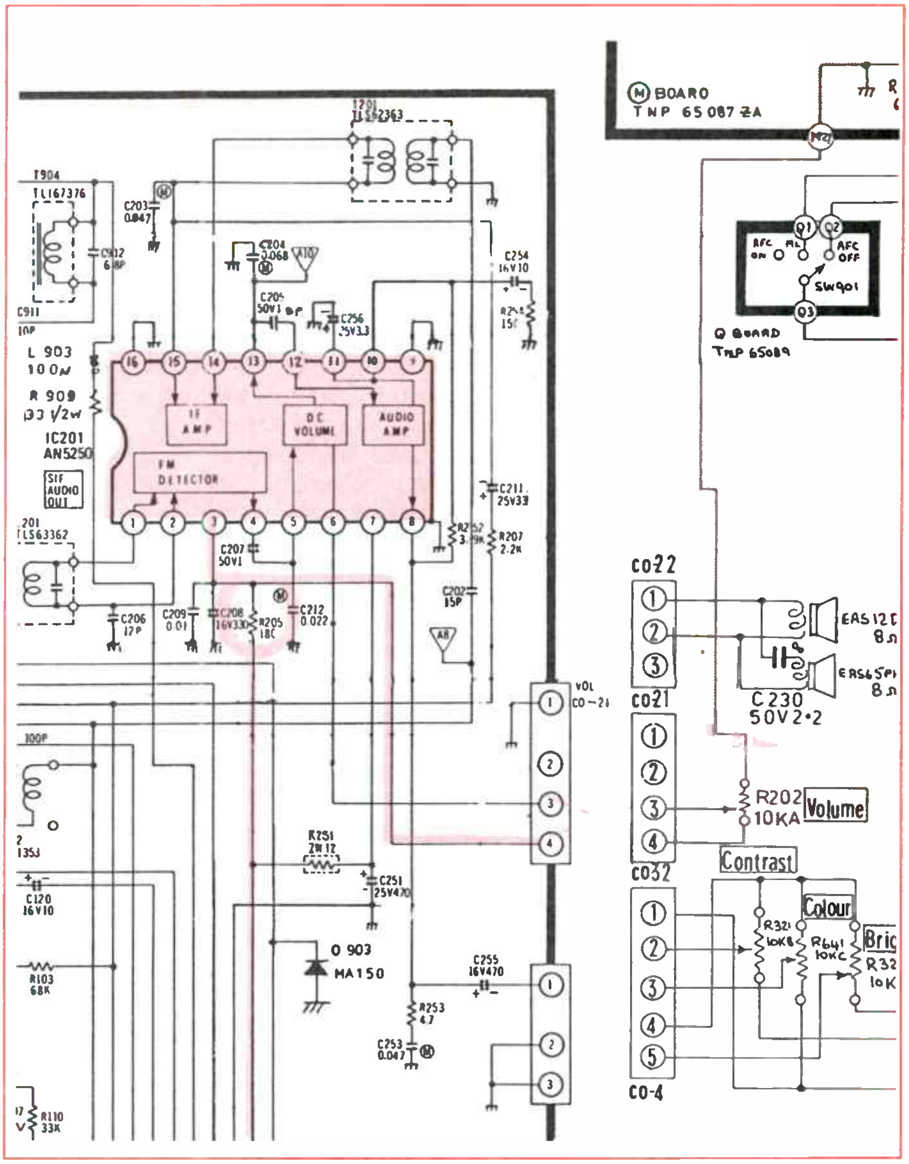
I decided to turn the volume down and let the set run quietly, but as I did so (starting with the slider about 1/4-on, from the minimum volume position) the sound became very scratchy and rumbled badly. It then became very distorted as the control approached the bottom. Then as the volume control hit zero there was a mild thump from the speaker before it went silent!

Now I've heard the effects of noisy volume controls before, but this sounded as though the audio amplifier was being throttled, rather than merely being deprived of any input signal. At the time, I didn't know how close that was to the truth.

While deciding what to do next, I suddenly realised that something, somewhere, was getting very hot. The smell warned me at first, then I saw a thin wisp of smoke curling up from a resistor marked R205 on the main PCB. As I hurriedly switched the set off, I wondered whether another fault had suddenly developed. Why else would a resistor spontaneously burn out?

This latest development concentrated my thoughts on the volume control itself. I wondered how the function of R205 tied in with the control, but my musing was complicated by the fact that I didn't have a circuit diagram for the set. After studying the PCB pattern for a few minutes, I was able to draw out the circuit around R205, which turned out to be associated with the audio amplifier IC201, an AN5250.

(We are luckier than T.G. We have the official diagram, and reproduce it here — Ed.)



Here is the relevant audio circuitry of a National TC-2233 colour TV, as discussed in the story contributed by T.G. The nominal plus 12V DC supply line to pin 3 of IC201 is highlighted, along with the wiring to the DC volume control R202.

As can be seen from the diagram, power for IC201 is derived directly from the chopper transformer via the now-cooked R205. The speaker connects at socket CO-22, while the volume potentiometer connects via plug and socket CO-21 to pin 6 of IC201.

My next step was to remove R205 and try to find out why it had failed. The problem was that without a circuit diagram and no colour code left on the original resistor, what value would I replace it with?

Without really expecting to learn anything, I put the resistor across the ohmmeter and was quite surprised to get a reading — about 240 ohms — which didn't help very much. It could have been stressed badly enough to raise its resistance many times.

As it appeared to be a 1/2-watt type, and considering that most audio amps call for a Vcc of around 9 to 12 volts, R205 must have started out somewhere between 47 and 150 ohms.

So I temporarily soldered a 100 ohm resistor in place, in order that I might make some voltage measurements around IC201. I started with the voltage drop across the new R205, on the basis that if

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the drop exceeded about 7 volts, I would know that I still had troubles.

With one eye on the meter, I switched the set on and after a few seconds the meter's display settled at about 16 volts — the full supply voltage! Not surprisingly, the new resistor was again quickly heating up. I couldn't imagine what was going on. About the only thing I could think of was an internal short circuit at the supply pin of IC201. I quickly tested this by increasing the volume setting, to see (er — hear) if there was any response from the speaker.

To my surprise, things were exactly as when I started. The volume control seemed to be doing its job in a very noisy fashion. But when I happened to glance at the meter, surprise turned to sheer disbelief as I watched the voltage across R205 drop, as I raised the volume.

I moved the meter leads to pin 3 of IC201 and sure enough, as I moved the volume up, up went the voltage. At this point I sensed an improvement in the sound quality too. Then as I moved the volume control down again, the voltage dropped to zero and R205 was once again getting hot.

At this point I thought I could go no further without a proper circuit diagram. But before admitting defeat, I decided to check the wiring from the PCB to the volume control for any shorts to ground and to confirm the resistance and condition of the volume pot itself. And here I finally struck oil.

I switched the set off and pulled plug CO-21, which has two wires that connect to the volume pot. The resistance between pin 3 of plug CO-21 and ground varied from approximately 10k ohms at maximum volume, to zero ohms at minimum volume.

It was a while before I noticed the ground connection at the volume pot, because it was situated at the channel selector PCB. Transforming my measurements into a rough circuit diagram confirmed, after double checking, that the wiper of the volume pot connected via pin 4 of CO-21 to the supply pin of IC201.

The minimum end of the volume pot was connected to ground, so when the volume pot was set to minimum the supply to IC201 was short circuited! No wonder R205 burnt out.

Now, assuming that the volume was varied by a control voltage fed to pin 6 of IC201 (via pin 3 of CO-21), I felt sure that that was where the wiper of the volume control should be. And to achieve a varying voltage there, the maximum end of the volume pot should connect to the supplyrail.

Well, you may have already worked it out, but in the end the solution was simple — swap the connections from plug CO-21, on the volume control side. I changed the leads over by the simple expedient of pulling the tiny connectors out of the plug and reinserting them in the opposite holes. I plugged CO-21 back in, put the volume at minimum, and switched on. There was no smoke. There was 11.5 volts at pin 3 of IC201. The volume control worked perfectly, with no noise and no distortion over its full range.

After breathing a heavy sigh of relief, I fitted a new 100-ohm resistor, tidied things up and put the set back on test. Needless to say, it performed perfectly. With the problems out of the way, it seemed that a post mortem might be in order.

Firstly, how and when did this fault occur? As far as I could see, the set had not been worked on before. All the soldering, including the wires at the volume control, looked original. The PCB was clean on the copper side, and the wiring was dressed as though it had never been disturbed. So had it been wired incorrectly since the set was new?

Remember that when I first switched the set on, the volume control was sitting at about 1/4 on, and the sound seemed to be normal. But was it? I may have been too concerned with the picture fault to have noticed any subtle distortion. Besides, the customer had made no comment that there was any problem with the sound. As I was preparing these notes, I marvelled at how the circuit, as originally wired, both worked and didn't work, so to speak.

With the control set at a position which would give moderate volume, the resistance between the wiper and ground would be high enough not to load the supply.

But as the wiper moved towards minimum, the supply voltage to the amplifier IC would quickly drop, resulting in reduced output drive, more distortion, and the near demise of R205.

This also explains why the volume control appeared to be noisy, but turned out to be perfectly OK. Luckily it had not burnt out over its minimum end.

The set ran perfectly for several days and when the customer called to collect it, I asked him if he had ever noticed anything unusual about the sound. He was quite sure that it had always been fine, but agreed that he rarely touched the set as it was their second set and was used mostly by the children. He also confirmed that the set had never been serviced, and was sure that no one had ever tampered with it. So I left it at that. I guess I'll never know how the fault in the wiring originated — perhaps a missed test at the factory? I wonder if there are any other sets from the same batch with the same fault. I would be interested to hear if any other serviceman has come across this one.

And finally, another odd fact. It would seem that the set has never had its volume turned right down in all the years since new. If the sound had ever been muted for more than a few seconds at any time, R205 would have burnt out and the owner could not have made his 'never serviced' statement with any degree of honesty.

Well, T.G., that was a most interesting story — thanks! It's another of those mysterious tales about factory faults that should never have happened, but did. This one is even more surprising, because it remained undetected for so many years.

And how fortunate that T.G. decided to work in silence, while soak testing the set after repairing the vertical fault. If he had left the sound running the fault would have been still there today, and we would not have had the benefit of his story.

Closer to home

Now we come back to my own parish. There hasn't been much unusual activity around the pump lately. At least, not unusual enough to make material for these pages.

However, I did have one very puzzling experience recently. I still don't know if there was a fault in the equipment, or if it was that the customer and I both had a simultaneous but temporary malfunction in our critical faculties.

I was called on to look at a TV/VCR setup that was reported to be out of order. It seemed that neither the TV nor the

Fault of the Month

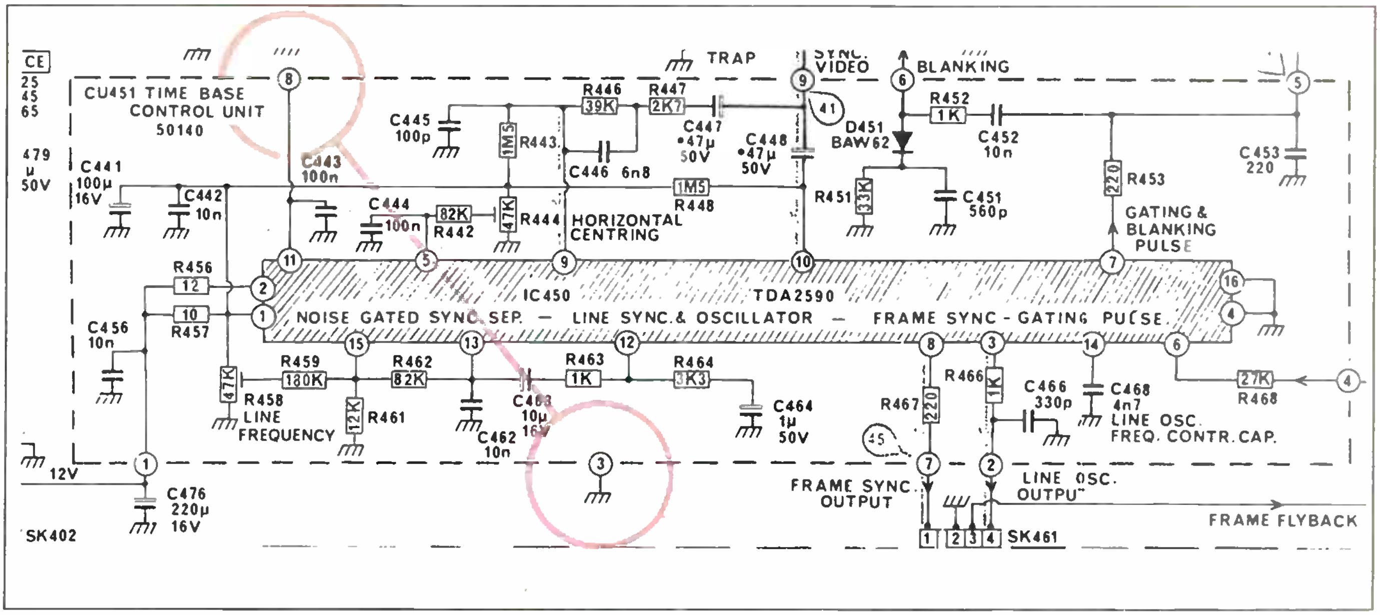
Kreisler 59-04 CTV

SYMPTOM: No sound or picture. The line output transistor and tripler were OK. The main 35V rail was down to only a few hundred millivolts, but there was no short circuit discernable on the rail.

CURE: IC290, a TDA2611A audio amplifier, was shorted. The Vcc for this chip is supplied from the main rail via a dropping resistor. The resistor was enough to mask the presence of the shorted chip during resistance measurements, but not enough to prevent the power supply from shutting down.

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.

World Radio History



Here's the sync circuitry of a Kriesler 59-04 TV, as discussed in this month's second story. The highlighted connections are those which need to be joined for correct picture sync when the set is used with a VCR.

VCR could be fine tuned, and the picture(?) on screen was all broken up with lines and dots and splashes of colour. The set had been playing up for a week or more before I was called in, and the owner had reached the end of her tether with it.

When I arrived I found an old Kriesler 59-04 model TV, and a newish NEC video. I confirmed the customer's complaint — the TV *could* actually be fine tuned, but would not hold any setting.

The tuning was very critical, and was lost as soon as I took my fingers off the tuning spindle. I felt that the fault had to be in the TV's tuning circuits, and mentally absolved the video from any blame for the trouble.

It was not the sort of job that I would like to tackle in the customer's home, especially as it was late in the afternoon and the household was busy with preparing dinner, doing homework and so on.

So I packed the set into the van, meanwhile leaving one of my 'lenders' to keep the folks happy while I worked on their set without pressure. Before leaving, I tuned my loan TV to their video and thereupon proved that the fault must be in their Kriesler. The VCR worked perfectly through my old set.

Next day I set the Kriesler up on the bench, connected an antenna, and switched on. It not only came up with a perfect picture, but one so stable that I could rotate the fine tuning pots over quite a few degrees without any sign of losing the channels. Compared with the performance the day before, it didn't look like the same set.

I opened it up and had a close look for loose connections or dry joints, but could find nothing. I poked and prodded and bumped and thumped, but found not the slightest trace of instability.

I even connected up a VCR that I had just finished repairing — and that, too, played perfectly. I had to fall back on the idea that the customer's video must be faulty in some way, even though it was working perfectly with my TV.

So the next chance I got, I picked up their VCR and brought it back to the workshop, to run it with its own TV and so to see if indeed there was some connection between the fault and the two units together.

Back in the workshop, I found that the fine tuning problem had indeed vanished. The off-air picture through the recorder was as steady as a rock, and all traces of the instabilty had gone.

The only problem left was a severe dose of flagwaving on video playback. The distortion was as bad as any I have ever seen, and extended half way down the screen. The reason for this was another mystery, because there had been

Continued on page 87

The WindowLite™ From MMT Australia

WINDOWLITE from MMT Australia Pty Ltd and CommSonics Inc, is the first full function hand held signal level meter for use by field technicians and MATV/CATV installers in trouble shooting, tuning and alignment of antennas, headend and broadband systems.

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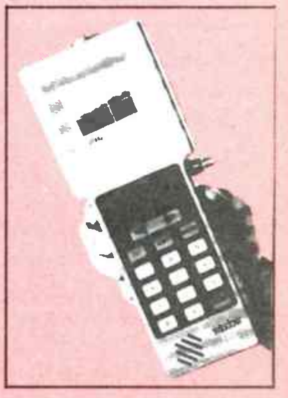


READER INFO NO. 10

World Radio History

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.

1-99V DVM

This circuit was designed to give a high impedance (10M) 1-99V meter to monitor a high tension power supply, with a digital display. It consists of three main stages: a voltage dependent oscillator (based around Q1 and IC1); a counter and display (IC2, IC3 and the two 7-segment displays); and a timebase oscillator (IC4).

The voltage-dependent oscillator uses transistor Q1 to transform the tiny current through R1 into a larger current flow into C1. IC1 is configured as a relaxation oscillator that detects when 2/3 supply voltage is present on C1. Hence the input voltage is changed to a proportional output frequency to be measured by counters IC3 and IC2.

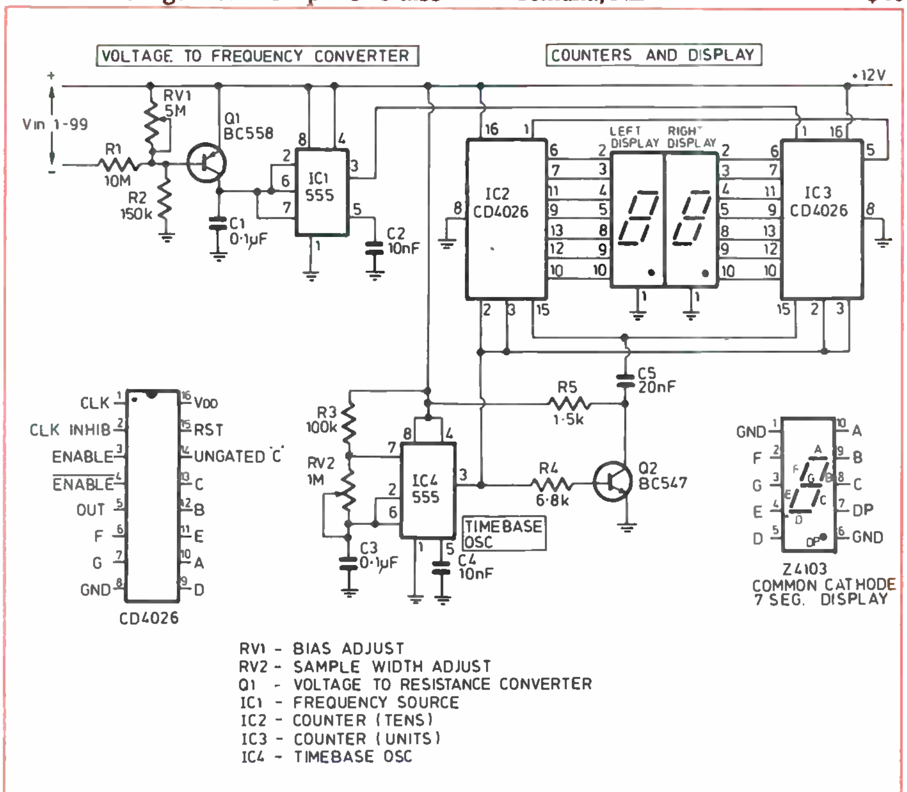
The second 555, IC4, is used as a timebase oscillator with a cycle determined by C3, R3 and RV2. This cycle starts when the threshold voltage is reached at pin 6. Pin 3 goes low, turning off transistor Q2, which sends a positive pulse to reset both counters (pins 15). The low voltage from IC4 pin 3 is also applied to pins 2 and 3 of both IC2 and IC3, blanking the display and removing the clock inhibit. So, while the output of pin 3 remains low, and this time is determined by RV2 and C3, the counters record the number of pulses sent by IC1.

When the 555 is triggered by pin 2 voltage dropping low enough, pin 3 again goes high, and C3 recharges through R3 and RV2. Transistor Q2 is turned back on, the clock inhibit prevents further counting and the display is enabled to show the result.

The setup procedure: first set RV1 so that the display indicates '01' — the transistor bias voltage is invariably detected. Then apply a reasonably high, known voltage and adjust RV2 until this figure is displayed.

There is no reason why other common cathode displays might not be used, or even 4017 counters driving single LEDs. But in this case current-limiting resistors would be needed, as the 4017 does not have internal current-limiting like the 4026.

Julian Phillips,
Temuka, NZ $40



Tristate buffer as OR gate

If you need and haven't got , an OR gate for a project, then you can make adapt a spare gate on a 74LS125 quad tri-state buffer to take its place.

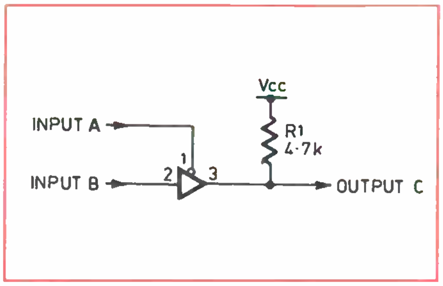


Fig.1.

When input A is low the gate is enabled, and its output C will be the same as input B. When input A is high, the gate is disabled and output C goes to tri-state. Because C is pulled high by resistor R1, it will remain high no matter whether input B is 0 or 1.

TRUTH TABLE

INPUTS		OUTPUT	REMARKS
A	B	C	
0	0	0	C=B
0	1	1	
1	0	1	C=1
1	1	1	

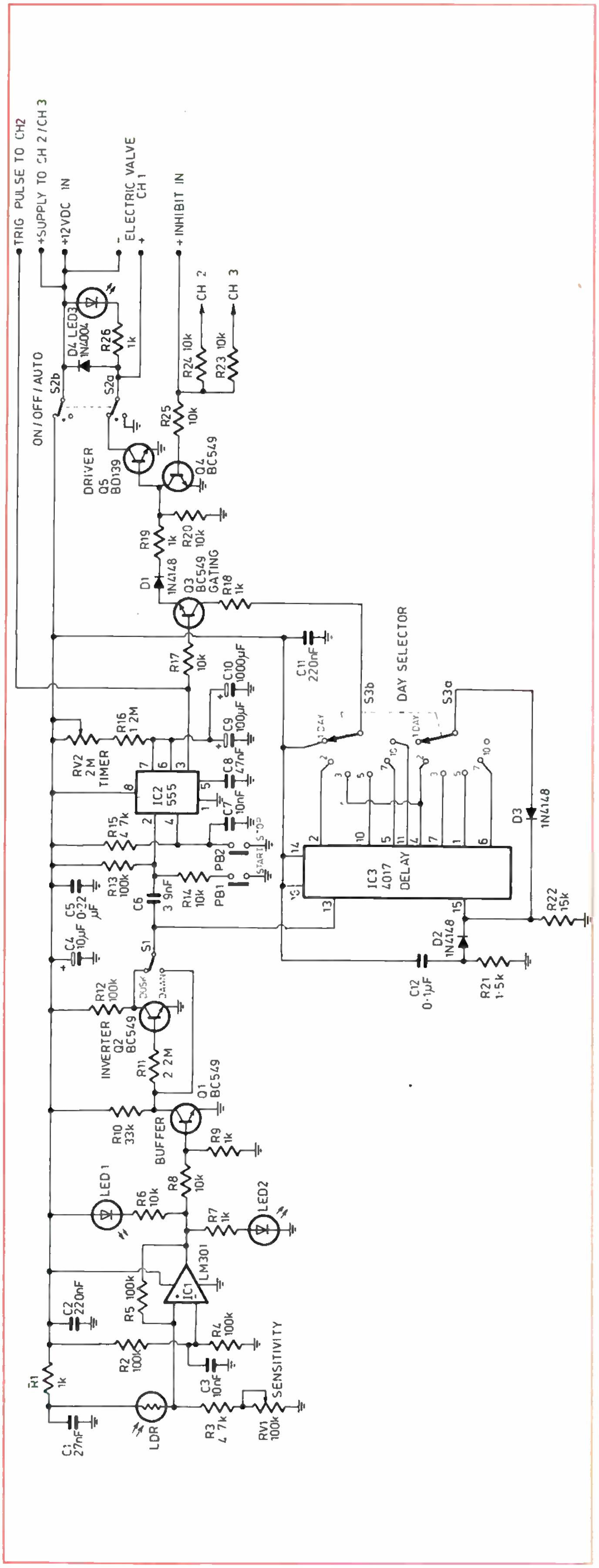
Fig.2.

The truth table for this arrangement is the same as that for an OR gate.

C. Shankar,
Bangalore, India $35

World Radio History

Automatic watering system



I wanted a system with the following requirements: automatic watering every day, or delayed watering either at dawn in winter or at dusk in summer; and a need for more than one line, as my gardens are on a slope. (In fact, I use three lines, each controlled by its own electric valve.)

For these electric valves, I used Hardie Irrigation ones with 3/4" fittings and apparently made for 24V AC. As a pleasant surprise, they worked well on 10V DC without staying magnetised or overheating. My system is powered by a 12V solar supply.

IC1 works as a comparator. In the daytime the LDR's resistance is low, so the voltage at the + input is high; the output of the IC1 is high, so the yellow LED2 is lit, indicating the status of the comparator.

In the dark, the high resistance of the LDR means IC1's output voltage is low, so the red LED1 is lit. RV1 adjusts the sensitivity by controlling the light level at which the comparator switches over.

Transistor Q1 acts as a buffer and pulse shaper. Q2 is an inverter which is used for dusk watering. This section of the circuit is common to all three channels — the rest is duplicated for each additional channel.

The negative edge of the trigger pulse activates both the timer IC2 and the delay circuit IC3. The timer is a 555 wired as a monostable. It can be started and stopped manually via pushbuttons PB1 and PB2, but only if switch S3 is in the 1-day (every day) position.

RV2 adjusts the length of watering — it varies from 30-90 minutes with C9 and C10 having a combined capacitance of 1100uF. The output of IC2 switches on the gating transistor Q3. Capacitors C7 (connected to pin 4) and C8 (pin 5) act during switch-on and reset. The other branch of the trigger pulse activates the counter IC3.

Selector switch S3 can be set from every day to every 10th day, in six steps. D1 provides reset when the power is turned on, with D3 passing the reset pulse coming via switch S3a. (The reset occurs one 'count' after the selected output is activated.) This output from IC3 provides power via switch S3b for the gating transistor Q3.

With both conditions satisfied, outputs from IC2 and IC3 provide switch-on and power for transistor Q3, which then turns on driver transistor Q5 via D1. Q5 switches on the channel 1 electric valve and lights green LED3.

Diode D5 protects transistor Q5 from the back-EMF of the collapsing magnetic field in the valve coil. In order to turn on channel 2, the timer IC2 works even if the delay IC3 chip is still counting.

After the 'blind' timing period is over, the off-pulse turns on the next timer and delay (IC4 and IC5); they in turn pass on the pulse to channel 3.

The trigger pulse for channel 2 comes from pin 3 of IC2, and for channel 3 from pin 3 of IC4. The chain can of course be extended beyond three channels.

The last feature is the 'inhibit' transistor Q4. A small positive voltage through the 10k resistor R25 to the transistor's base will disable Q5 and prevent it turning on the valve.

A comparator with a humidity probe could provide an inhibit voltage when extremely wet weather occurs. This could be similar to the circuit around IC1. The main switch S2a and S2b has a centre OFF, manually ON and AUTO positions. You can build the unit free-standing with a gel lead-acid battery, a small solar panel and a shunt regulator to protect the battery.

Rolf Sommerhalder,
Rylstone,NSW $40

World Radio History

Construction Project:

DOLBY SURROUND SOUND DECODER

Build this new Dolby surround sound processor and envelope yourself with the stunning realism and dramatic sound impact available from Dolby surround-encoded videos or TV transmissions. It can also enhance conventional stereo, by providing a rear or 'ambiance' channel.

by ROBERT PRIESTLY

The Dolby 'surround sound' process increases the sensation of 'being there', by producing an effects channel to create surround sounds which a conventional stereo system cannot produce. Movie buffs have all experienced the spectacular sound effects at the cinema. Planes that fly in from behind, then pass over the audience to land at the front of the cinema; explosions that envelope everyone. Impressive stuff!

Now you can have it all at home, with the Dolby surround sound processor described in this article.

Surround sound

According to one source, Dolby surround sound, or more correctly, the Dolby *Pro Logic* system is a standard developed as long ago as 1974. Certainly it's been in general use since the late 1970's, and most movie theatres have the required sound system to reproduce the effects the system is capable of. There is a degree of confusion as to what the standard is, but our research indicates that the full Dolby Pro Logic system incorporates front left, front right, front centre and a surround (or effects) channel. That is, it has four channels.

A recent update of the standard is to incorporate a stereo effects channel, giving *five* independent channels. The effects speakers are generally located behind the audience, although parallel-connected speakers are sometimes placed at the side as well as the rear.

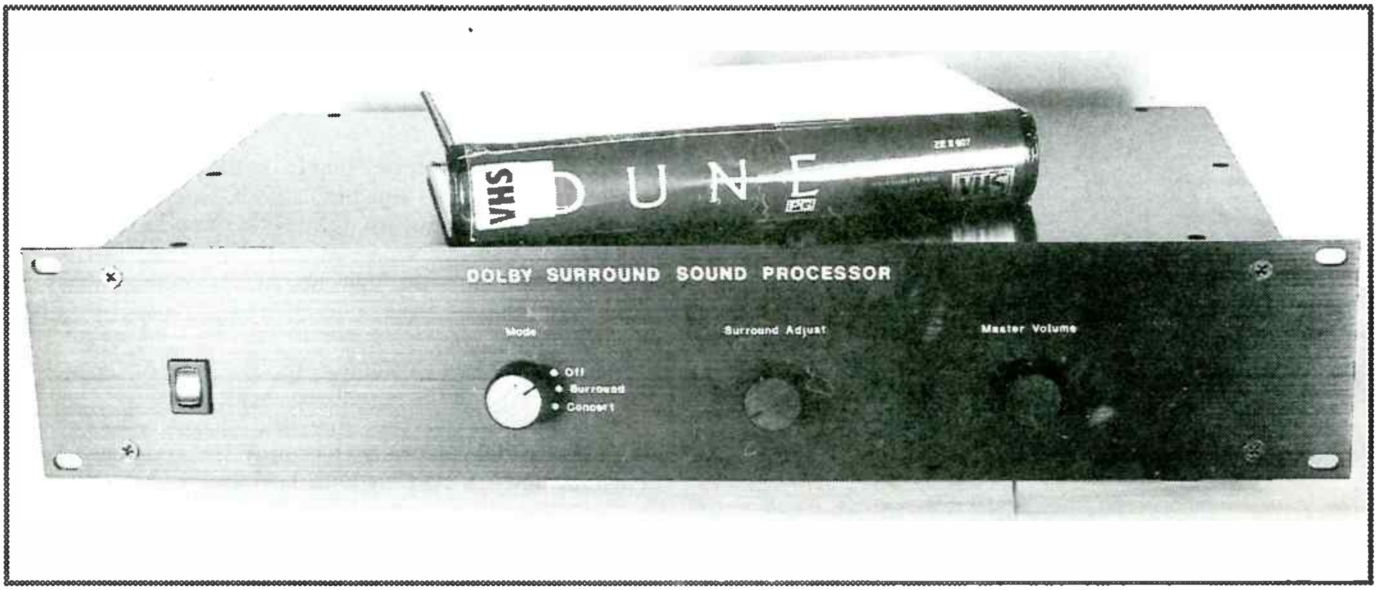
How the system works is Mr Dolby's little secret, and movie makers who use the encoding pay a licence fee.

Similarly, the decoding system is licensed and commercial sound systems that incorporate the Dolby 'box' also pay a licence fee. However, in the absence of a cheaper system, most videos and movies have their sound track recorded with the Dolby Pro Logic system.

The system uses 'steering logic' to create the various channels, and the electronics is therefore probably rather complex. Regular readers may have noticed that a Dolby Pro Logic decoder IC is now available, although a hefty licence fee is required in addition to the cost of the IC itself.

These days it's possible to buy sound systems that include a Dolby Pro Logic decoder, and some manufacturers extend the system with proprietary extras to give up to seven channels. As well, these systems usually incorporate a delay between the front and rear channels to give 'ambiance' to the sound.

There's no shortage of films or videos with the encoding, although surprisingly



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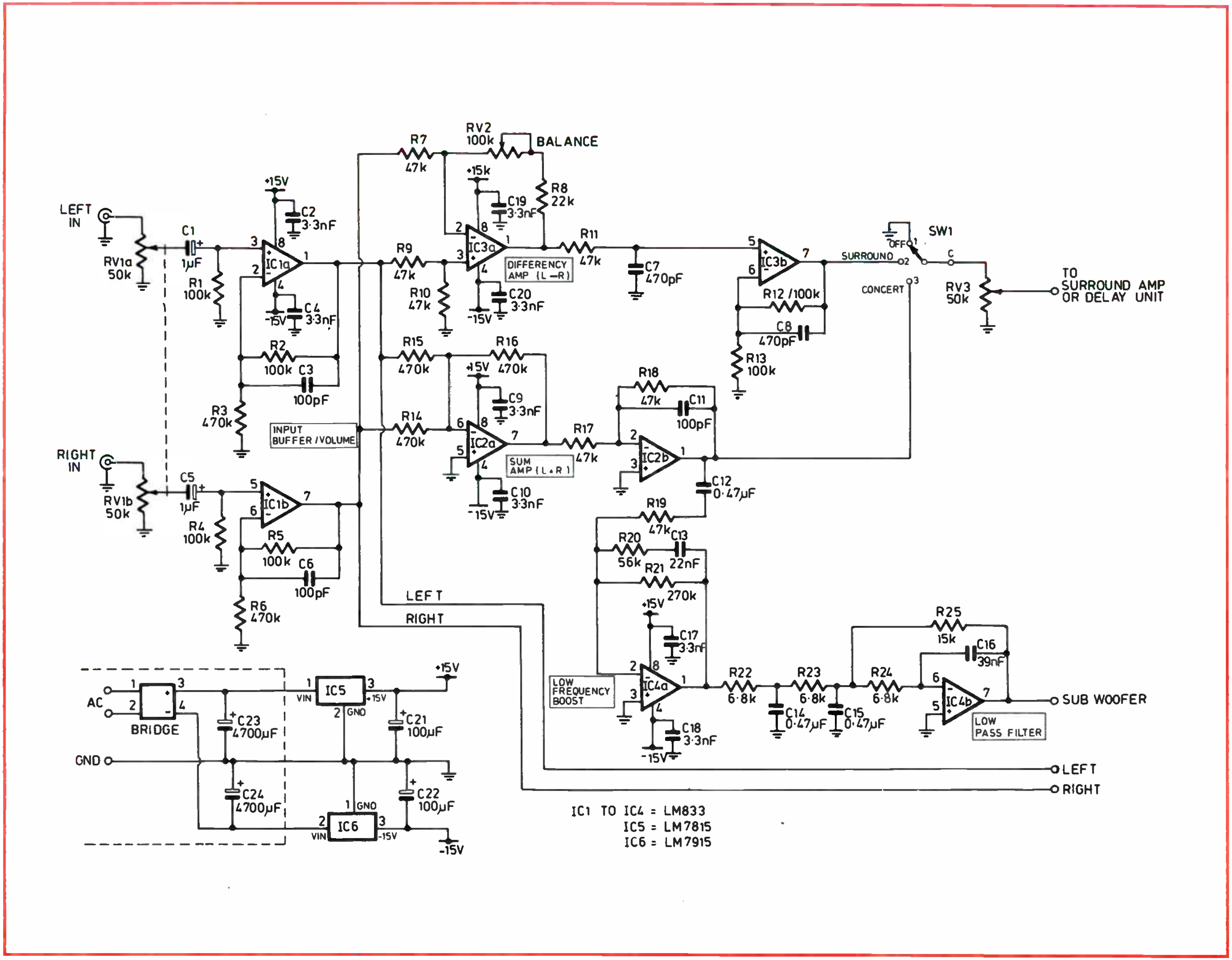


The circuit diagram of the decoder PCB. The stereo input signal is buffered by IC1, and IC3a subtracts the L and R signals to produce the effects information. This signal is filtered by IC3b, a 7kHz low-pass filter. A mono sum signal is produced by IC2a, inverted by IC2b then fed to the sub-woofer channel via IC4.

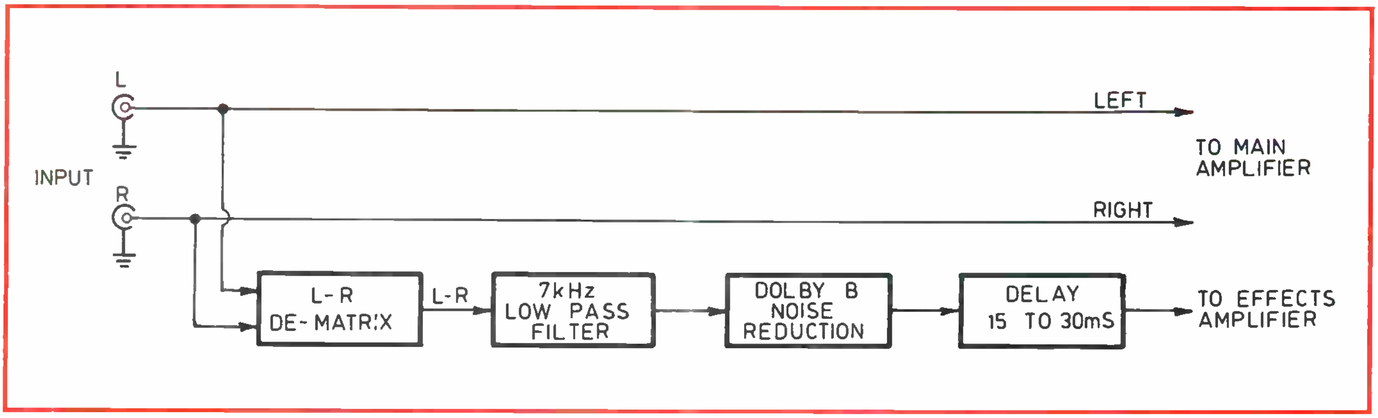


Fig.1: The block diagram of a passive type Dolby surround decoder. The Dolby encoding creates the effects channel by recording phase shifted information in the L and R channels. This information is subtracting one channel from the other.

few videos highlight the fact. As a general rule, if the video has a hi-fi stereo sound track, it's likely the Pro Logic encoding is on the recording. The credits at the end generally show the Dolby logo if the system was used in the original film, although there's no guarantee the video version includes it. However, according to sources in the industry, the dubbing process doesn't modify the encoding and it's rarely removed if the original film version was Dolby encoded. As well, TV transmissions include the encoding, although a stereo TV or video recorder is required to get access to the sound channels.

There are also a few CD's with Pro Logic encoding, usually sound tracks of musicals taken from the film that was originally recorded with the encoding. Naturally, video discs include the encoding, although people with a video disc player usually have a Pro Logic decoder anyway.

So there's plenty of program material. But you may be wondering how we are able to offer a surround decoder when the encoding is a secret and licensed to the hilt. As it turns out, this decoder is extremely simple and no copyright has been infringed.

Simple approach

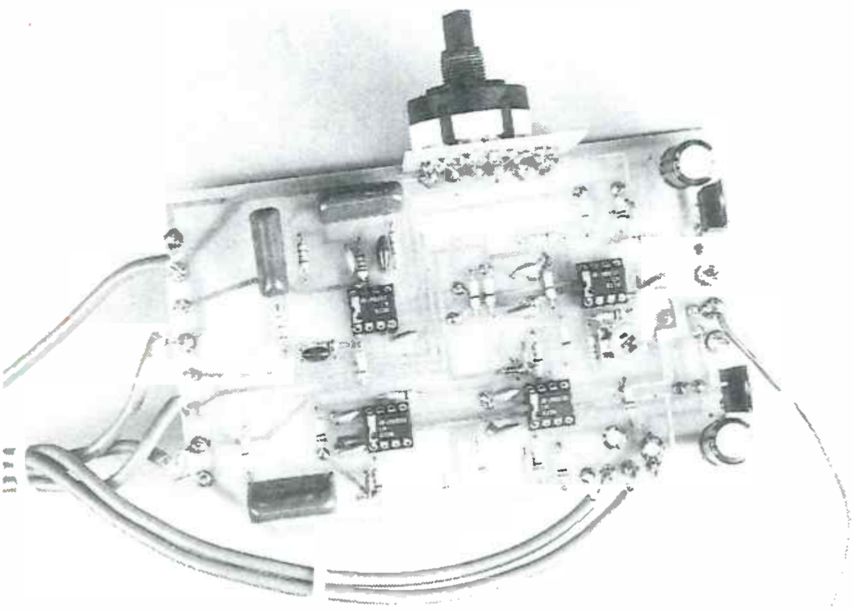
There are two ways of decoding Dolby surround encoding. The simplest way is shown in the block diagram of Fig.1. This system is a passive one and is not the licensed Pro Logic system.

The two stereo sound tracks are first de-matrixed to produce an L-R signal. The phasing of the L and R signals is a part of the original encoding and subtracting one from the other gives the third (effects) channel, for those signals appropriately phased during recording.

The resulting signal is then passed through a 7kHz low-pass filter, a Dolby B noise reduction unit and then an audio delay of around 20 to 30ms. The output of the delay circuit is then fed to a power amplifier which drives a pair of rear speakers.

A single rear (effects) speaker can be used, as the surround information is monaural, but two speakers reproduce a more 'spacious' effect. Sometimes a centre channel (mono or L+R) and a sub-woofer channel are added to heighten the sound impact, but this has nothing to do with the Dolby process.

The true Dolby Pro Logic surround sound decoding is an active process. The stereo channel is de-matrixed, delayed and bandwidth limited as with Dolby surround sound, but additional complex circuits are added to provide enhanced separation between the front and rear speakers. This process significantly improves the front to rear channel separation, and allows special surround effects to be better placed.



This shot shows the decoder PCB. The switch PCB connects to the main board with wire links. Set the tab ring of the switch to give three positions, rather than four.

The project

The processor described here uses the passive decoding system, but with a few additional features such as a sub-woofer channel and a 'concert' mode. The block diagram of the circuit is shown in Fig.2. As already described, the effects information is recovered using the difference (L-R) signal originally encoded into the

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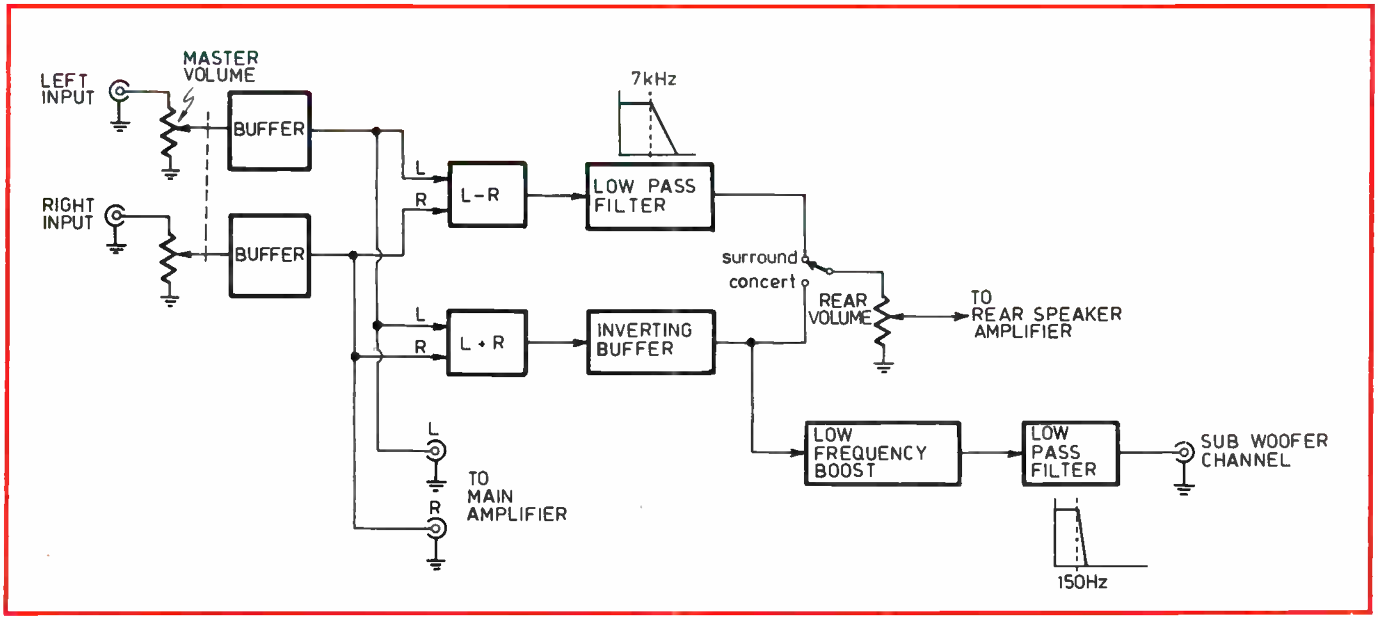

Fig.2: This block diagram shows the various sections of the decoder PCB. As well as surround sound decoding, it includes sections to give a mono rear channel and a sub-woofer channel.

left and right sound channels of the movie sound track. The L-R information is then fed to a low-pass filter with a cutoff frequency of 7kHz. This filter reduces signal leakage and crosstalk from the surround channel.

An offshoot is that you don't need a high fidelity amplifier for the surround signal. As well, in the original sound mix, frequencies below 120Hz are recorded as conventional stereo signals, as the ear can't determine the origin of these frequencies.

These frequencies can therefore be reproduced from low frequency speakers located anywhere in the room, as the visual content of the film 'locates' the origin of the sound.

Normally the bandwidth-limited surround sound signal is Dolby B encoded as well. This is a form of noise reduction, commonly found in tape recorders. In practice the corresponding Dolby B decoder can be left out with little noticeable effect, and at this stage is not included in the project.

Ideally, as already described, a delay network to give around 15 to 30ms delay time for the rear channel should be included. But depending on the speaker arrangement, the delay unit can also be left out, giving a considerable saving in cost and complexity.

If the rear surround speakers can be placed well behind the listener, the Dolby surround effect is still very effective, although a more spacious effect is perceived with the delay unit.

During development, a BBD (bucket brigade device) was initially included as a delay unit. The reason for delaying the surround channel is to minimise sound leakage between the front and rear surround channels, by taking advantage of a phenomenon known as the Haas effect.

The Haas effect causes the ear to identify the source of a sound as that from which it is first heard, and to ignore the same sound from another point that arrives after the first. The first arrival effect ensures that the front channel sounds are clearly identified as coming in front of the audience, even if they also come from behind. However, given suitable placement of the rear speakers, sufficient delay is provided. To keep the cost and complexity to a minimum, we've eliminated the delay section, although you can always add one later if required. For this reason, pads are included on the PCB for the power supply to a delay unit.

On the other hand, a sub-woofer channel *has* been included in the circuit. This channel is created by summing the left and right channels to produce a

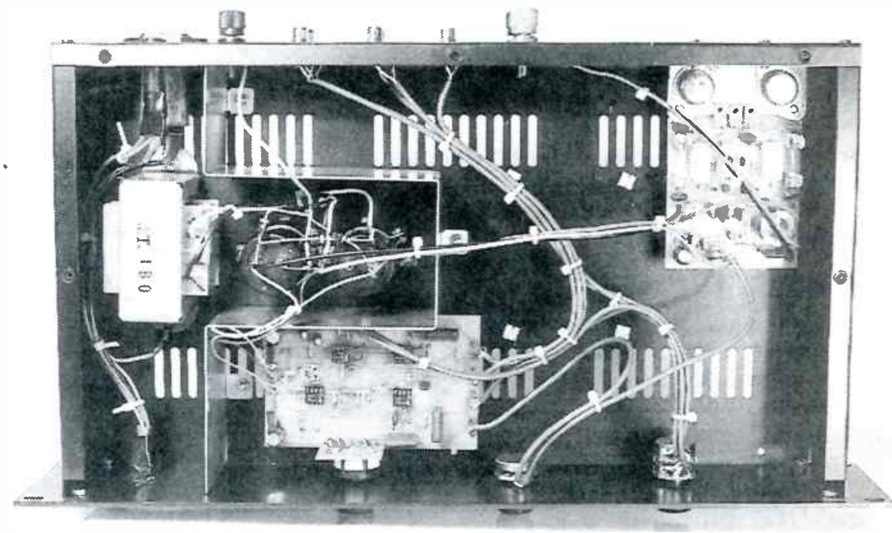

Fig.3: As shown in this photo of the prototype, the power amplifier module is mounted on the rear of the case, at the right. The power supply diodes are mounted on the tags of the main filter capacitors.

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monaural signal. This signal is then passed through a 30Hz low frequency boost stage and then through a 150Hz low-pass filter.

Very low frequencies are often used in cinemas to create eerie or dramatic effects, and can have considerable impact. It is preferable to place the sub-woofer enclosure towards the front of the sound stage, but its location is not critical as the ear cannot place low frequency sounds. A relatively high power amplifier and a suitable sub-woofer speaker are required, if you want to fill your room with earth-shaking bass that's beyond the capabilities of most speaker systems.

The 'concert mode' setting in the circuit produces the effect of ambiance by suggesting the size of a live concert hall. For best effect, this mode should have a delay for the rear signal, but a degree of ambiance is still provided without the delay.

There are three controls associated with the circuit — the master volume, surround adjust control and mode selector switch. The master volume control is used to adjust the sound level of *all* channels (front and rear).

Naturally the volume control of the main amplifier will determine the maximum volume of the front speakers, and needs to be set accordingly. The 'surround adjust' volume control is used to adjust the balance between the front and rear speakers.

The mode selector switch has three positions — off, surround and concert. The surround position is used when Dolby encoded material is being reproduced. Concert mode is selected if you want to add rear speaker sound to conventional stereo music, while the off position disables the rear channel.

Now to the circuit details of our decoder/processor.

The circuit

The stereo audio signal is applied to the input sockets, which connect directly to a dual-gang, 50k potentiometer. This is the master volume control for all channels, and adjusts the signal level applied to the buffer stages of IC1a and IC1b. These stages have an overall gain of around 1.2 and provide a low impedance signal for the rest of the circuit. Capacitors C3, C6 and C11 (around IC2b) limit the bandwidth of the op-amps to around 20kHz, and reduce noise and other extraneous signals.

The stage around IC3a is used to dematrix the input signals. This stage is a differential amplifier and its balance is adjusted with RV2. When correctly adjusted, there should be no output from this stage for common mode (mono) input signals.

The output signal from IC3a is the 'effects' channel, which is then connected to the low-pass filter around IC3b. The network of R11 and C7 form part of this filter, which has a cut-off frequency of around 7kHz.

The output of IC3b is a low impedance source and connects to the selector switch SW1. The wiper of SW1 is connected to RV3, the 'surround adjust' control, which is used to control the volume level of the surround signal power amplifier.

The summing amplifier of IC2a combines the L and R input signals to produce a mono output signal (L+R). This stage has a gain of unity and connects to the inverting amplifier around IC2b. This stage also has a gain of unity and C11 again limits the bandwidth as already described. This stage is included so that the mono output signal has the same phase relationship as the original L and R input signals. The output of IC2b is fed to the mode select switch SW1, and provides the 'concert mode' signal.

The output of IC2b is also fed to the low frequency boost circuit formed by IC4a and its associated components R20, R21 and C13.

This stage boosts frequencies of around 30Hz and provides frequency

Fig.4: For the prototype, the input and output sockets were mounted on the rear panel of the case, with RCA sockets for signals and terminal posts for the speaker. The sockets needn't be insulated from the panel, but all terminals are.

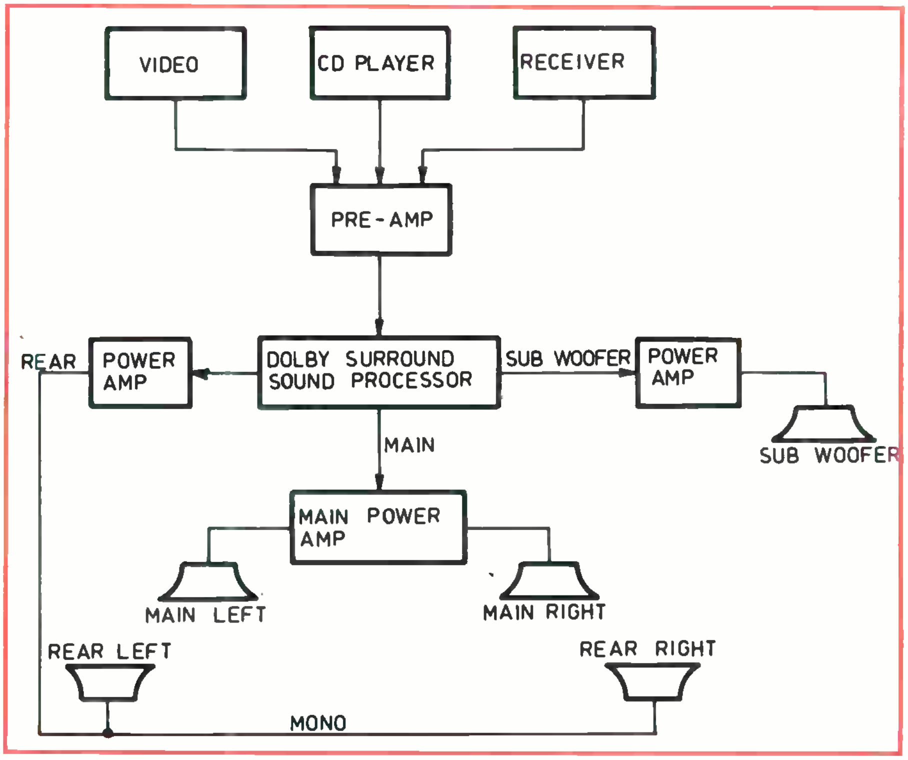

Fig.5: This block diagram shows how the Dolby surround processor can be connected into an existing system. If you intend using it with a single sound source, such as a VCR, plug the audio output of the VCR into the processor and the output of the processor directly to the main amplifier.

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emphasis for the low end frequencies that most speaker systems are unable to reproduce.

The output of IC4a then connects to the third order low-pass filter around IC4b. This filter comprises R22 to R25 and C14 to C16. The output of this stage is then connected to a rear panel socket for connection to a sub-woofer amplifier.

The circuit requires a dual polarity +/-15V supply, provided by regulators IC5 and IC6, with capacitors C21 and C22. The dual polarity DC input voltage comes from an external power supply that can also be used to power a surround sound power amplifier.

In the prototype, a 28V-0-28V centre-tapped transformer was used to power both the decoder PCB and a power amplifier module for the rear speakers. The power amplifier module used in the prototype was described in *EA* for January 1989 and is ideal for the purpose. As shown on the circuit diagram, 4700uF filter capacitors connected to the output of a bridge rectifier were used in the decoder power supply. However the choice of power amplifier and power supply design is up to you, depending on your needs. Each of the four op-amps in the circuit has a 3.3nF bypass capacitor connected at its power supply terminals, to reduce any interaction cause by the power supply.

Construction

The electronic components are mounted on a double-sided PCB, while the 'mode' switch is mounted on a small single-sided PCB which is mounted vertically at the front of the first board. The power supply transformer, bridge rectifier and main filter capacitors are mounted separately.

As shown on the layout diagram, there are six points on the PCB that require solder-through connections — made by threading a small length of tinned copper wire (such as a component pigtail offcut) through the PCB hole and then soldering it to the pads on both sides. The remaining solder-through points are made by means of component terminals.

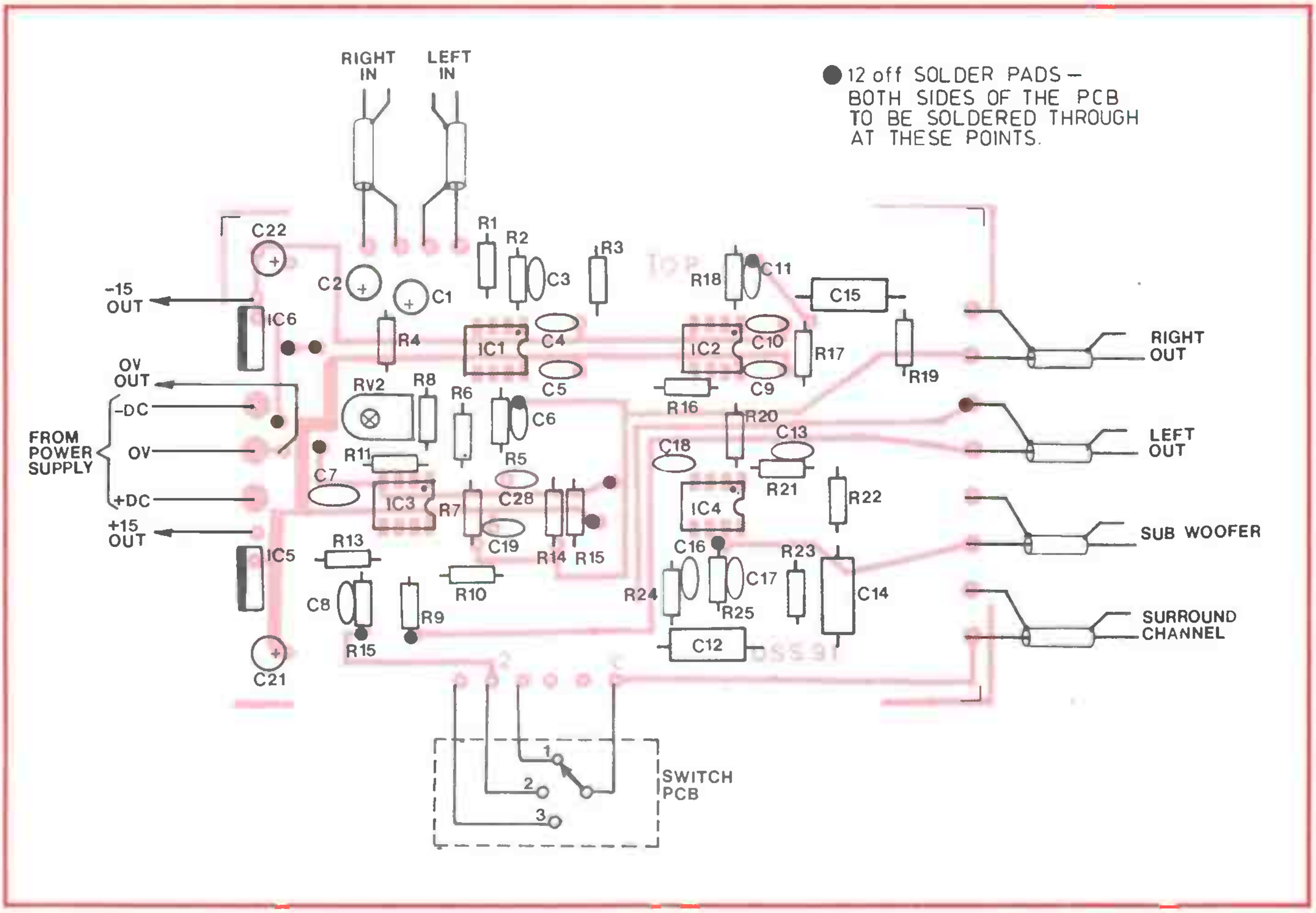
Fit the separate solder-through points first, then install the resistors. Follow this with the larger components, such as the IC sockets, then the capacitors and the trimpot. It is best to mount the two voltage regulators last, as their terminals can break during the construction process. Check particularly that component leads used to connect tracks on both sides of the board are soldered both sides. These are marked on the layout diagram.

Next solder the switch to its board. The recommended switch (a Jaycar type SR-1214) will need to be set to the three-pole position by setting the tab ring located under the fixing nut.

The switch PCB will simplify wiring, but if you cannot obtain the correct switch any suitable wafer switch can be hardwired to the main PCB using ordinary hookup wire. In this case, make sure the wiring is kept as short as possible.

The switch PCB connects to the main board with PCB pins or short lengths of tinned copper wire. Solder the pins (or lengths of wire) to the main PCB so they project above the component side of the board. Then solder the switch PCB to these pins so that the two boards mount at right angles to each other.

The various leads can be soldered



The layout diagram of the decoder PCB. As indicated, there are several points on the board where the top and bottom tracks need to be linked. The switch mounts on its own PCB, or it can be hardwired as shown.

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Sound Processor

directly to the main PCB or soldered to PCB pins fitted to the board.

All leads other than the three power supply leads should be run with shielded cable. As noted earlier pads are included on the main PCB to allow a delay unit to be powered by the power supply, and if needed wires for this unit should be fitted as shown in the layout diagram.

Once the board has been constructed, the balance of the differential amplifier IC3a needs to be adjusted. Ideally this should be done with a signal generator and a 'scope. However it can also be done by connecting the output of the board to an amplifier and listening to the output level of the rear speaker.

Apply power to the board and connect a signal to both input channels. To ensure the signal is the same, link the L and R input sockets and apply the test signal to either of the input sockets. Then adjust RV2 until the output of IC3a is as close to zero as possible.

In the final installation, this adjustment can be made by selecting a mono signal (such as ABC TV) and setting RV2 to give a null in the output level of the rear speakers.

A stereo input signal without Dolby encoding will give an output level that depends on how much phase difference exists between the L and R signals.

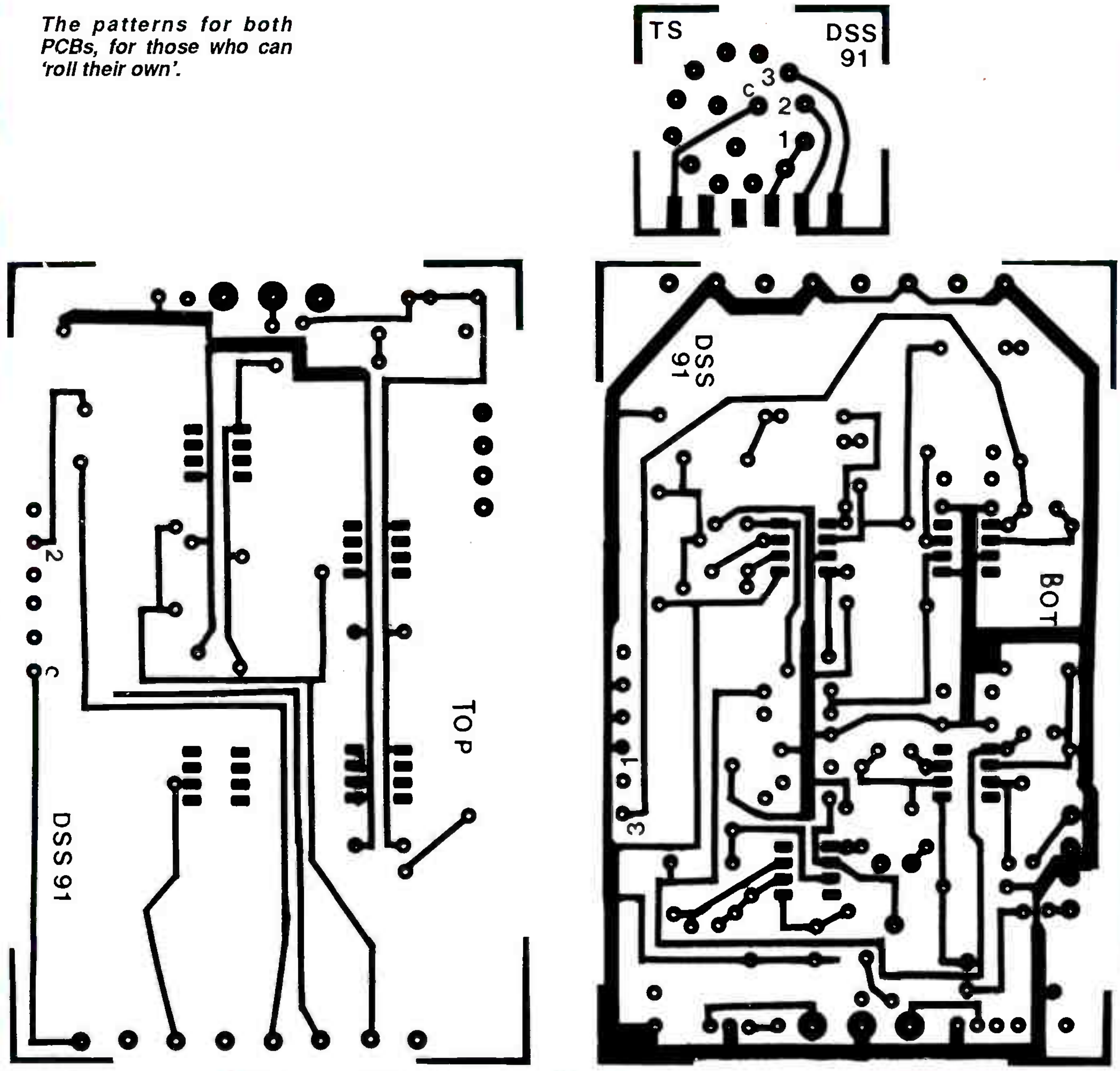
A complete unit

To make the unit complete, a power amplifier and a power supply are required. As well, everything needs to be fitted inside a suitable case. There are numerous options as to how this can be achieved.

For example, if you have a spare power amplifier, it can be used as the surround channel power amplifier. In this case, a separate power supply for the decoder PCB will be required.

The power supply requirements for the board are not critical, as its current consumption is relatively low. A dual polarity DC supply of around 20V to 30V is required. To allow the regulators to function correctly, locate the external-

The patterns for both PCBs, for those who can 'roll their own'.



World Radio History

ly mounted filter capacitors as close to the PCB as possible. Their size is not critical and a value of between 470uF to 1000uF will be adequate.

The case can vary from a basic box to the rack mounted style used in the prototype. A metal case is recommended for best shielding, and obviously it should be large enough to take the various signal sockets and front-panel controls.

The prototype

The photo of Fig.3 shows the arrangement used in the prototype. As mentioned earlier, the power amplifier module published in *EA* for January 1989 has been used for the surround channel power amplifier. Refer to this edition for constructional details.

As shown in the photo the power amp is mounted on the right-hand rear panel of the case.

The rear panel is used as a heatsink and heatsink compound should be applied when fixing the module to the panel. The power supply in the prototype is used to power both the amplifier module and the decoder board. As already described, a 28V-0-28V transformer is connected to a bridge rectifier which connects to two 4700uF filter capacitors. The diodes for the bridge rectifier are mounted on the filter capacitors.

The mains power is connected via an IEC socket fitted with a mains filter. This helps reduce clicks and pops caused by nearby appliances switching on and off. A fuse and a switch with an integral neon indicator light connect in series with the incoming active.

All the input and output sockets and terminal posts can be fitted to the rear panel of the case, as the photo of Fig.4 shows. Use RCA sockets for all signal sockets and terminals for the speakers.

The sockets don't need to be insulated from the panel, but the terminals do. The terminal for an external earth connection connects to the common rail of the power supply at the filter capacitors.

The prototype was built into a standard size black anodised rack mounting case. The front and rear panels have been silk screened to give a professional look. There is enough room inside this case to include a delay unit and a subwoofer power amplifier as well.

System connections

The processor can be connected into an existing sound system in various ways. The unit requires a stereo input signal from a sound source, such as a hi-fi stereo video recorder, a CD player or a stereo TV set. The relatively poor response of a conventional VCR (stereo or mono) will usually prevent the Dolby surround encoding from operating effectively. A complete system is shown in Fig.5 in which the unit is connected between the pre-amp/power amplifier stages of an existing stereo amplifier.

Some amplifiers have links on the back panel to allow this connection. If the pre-amp and the power amplifier are separate, simply connect the surround sound processor between them.

If you intend using a single sound source such as a VCR, it is easiest to connect its audio output directly to the input of the processor. The L and R outputs of the processor then connect to suitable inputs on the main power amplifier.

Alternatively, if you're not using it with a tape deck, the tape monitor connections of an existing sound system can be used. When the tape monitor switch is operated, the selected audio signal is connected to the record-out sockets.

These sockets can be connected to the inputs of the processor, and the processor's stereo outputs connected to the record-in sockets on the main amplifier.

The master volume on the processor unit will control the level of the signal, giving an overriding control of the volume of the main stereo speakers. There is no need to use high quality rear speakers if these are only used to reproduce the effects channel. However for concert mode, the higher the quality the better. In some cases, cheap speakers such as car 'rear' speakers can be quite effective.

Because they generally come in some sort of enclosure, these speakers can be cost effective. However, don't expect great sound when used in concert mode.

In some cases, using high quality rear speakers can cause sensitivity problems, in that the output sound level cannot be made loud enough.

To obtain more gain from the decoder, the value of R12 can be increased. However, the volume level of the rear speakers should be adjusted carefully. If they are too loud, you'll prevent the effects from being heard as all the sound will appear to come from the rear.

The rear speakers should be mounted in back corners of the room, usually on the rear wall above the listener.

Sound sources

As already mentioned, most hi-fi videos have Dolby encoding. Some that we know to give great effects are *Back to the Future III*, *Mad Max — Return to Thunderdome*, *Dune*, *Star Trek — the Wrath of Khan*, *Last Starfighter*, and so on. In fact, most action and sci-fi movies made since 1980 have Dolby encoding. However don't expect much if it's not recorded in hi-fi.

If you have a stereo TV, but don't own a hi-fi VCR, you can still use the processor. In this case connect the audio outputs of the TV to the input of the processor as already described. The transmission process doesn't seem to affect the Dolby encoding and the results can be just as good as from a VCR01.So there it is, a simple project that can enhance your viewing pleasure by adding the third dimension. You won't be disappointed! ■

PARTS LIST

Resistors

All 1/4W, 5% unless otherwise stated:

R1,2,4,5,12,13	100k
R3,6,14,15,16	470k
R7,9,10,11,R17,18,19	47k
R8	22k
R20	56k
R21	270k
R22,23,24	6.8k
R25	15k

Variable resistors

RV1	50k dual gang, linear
RV2	100k trimpot
RV3	50k linear

Capacitors

C1,51	1uF electrolytic
C2,4,9,10,17,18,19,20	3.3nF ceramic
C3,6,11	100pF ceramic
C7,8	470pF ceramic
C12,14,15	0.47uF polyester
C132	22nF polyester
C16	39nF polyester
C21,22,23,24	100uF 25V electrolytic to suit (see text)

Semiconductors

IC1-4	LM833 dual op-amp
BRIDGE	4A diode bridge (see text)
IC5	LM7815 voltage regulator
IC6	LM7915 voltage regulator

Switches

SW1	3-pole 3-position PCB Mount rotary switch

Miscellaneous

Double-sided PCB, 85mm x 130mm coded DSS 91;
PCB 43mm x 39mm coded TS DSS 91;
transformer to suit (28-0-28V);
mains switch, fuseholder and fuse;
five x RCA sockets;
three x terminal posts;
suitable case, shielded cable, four by 8-pin DIL IC sockets;
PCB supports;
hookup wire.

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Each project, which is designed to be built on a "Verobloc" breadboard, is presented in similar fashion with a brief circuit description, circuit diagram, component layout diagram, components list and notes on construction and use where necessary. Wherever possible the components used are common to several projects.

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Describes fifteen fairly simple projects for use with a car and/or boat. Each project has an explanation of how the circuit works as well as constructional details including a stripboard layout.

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Mains power supplies are an essential part of many electronic projects. This book gives a number of power supply designs, including simple unstabilised types, fixed voltage regulated types, and variable-voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low-voltage types for semiconductor circuits.

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These books are designed to aid electronic enthusiasts who like to experiment with circuits and produce their own projects. The circuits for a number of building blocks are included in each book, and component values and type numbers are provided in each case. Where relevant, details of how to change the parameters of each circuit (voltage gain of amplifiers, cut-off frequencies of filters, etc.) are given so that they can be easily modified to suit individual requirements. No difficult mathematics is involved.

HOW TO DESIGN ELECTRONIC PROJECTS

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The aim of this book is to help the reader to put together projects from standard building blocks with a minimum of trial and error, but without resorting to any advanced mathematics. Hints on designing circuit blocks to meet your special requirements where no "stock" design is available are also provided.

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HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
BP110 **$8.50**
We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

AUDIO AMPLIFIER FAULT-FINDING CHART
BP120 **$4.00**
This chart will help the reader to trace most common faults that might occur in audio amplifiers. Across the top of the chart are two "starting" rectangles, vis Low/Distorted Sound Reproduction and No Sound Reproduction; after selecting the most appropriate one of these, the reader simply follows the arrows and carries out the suggested checks until the fault in located and rectified.

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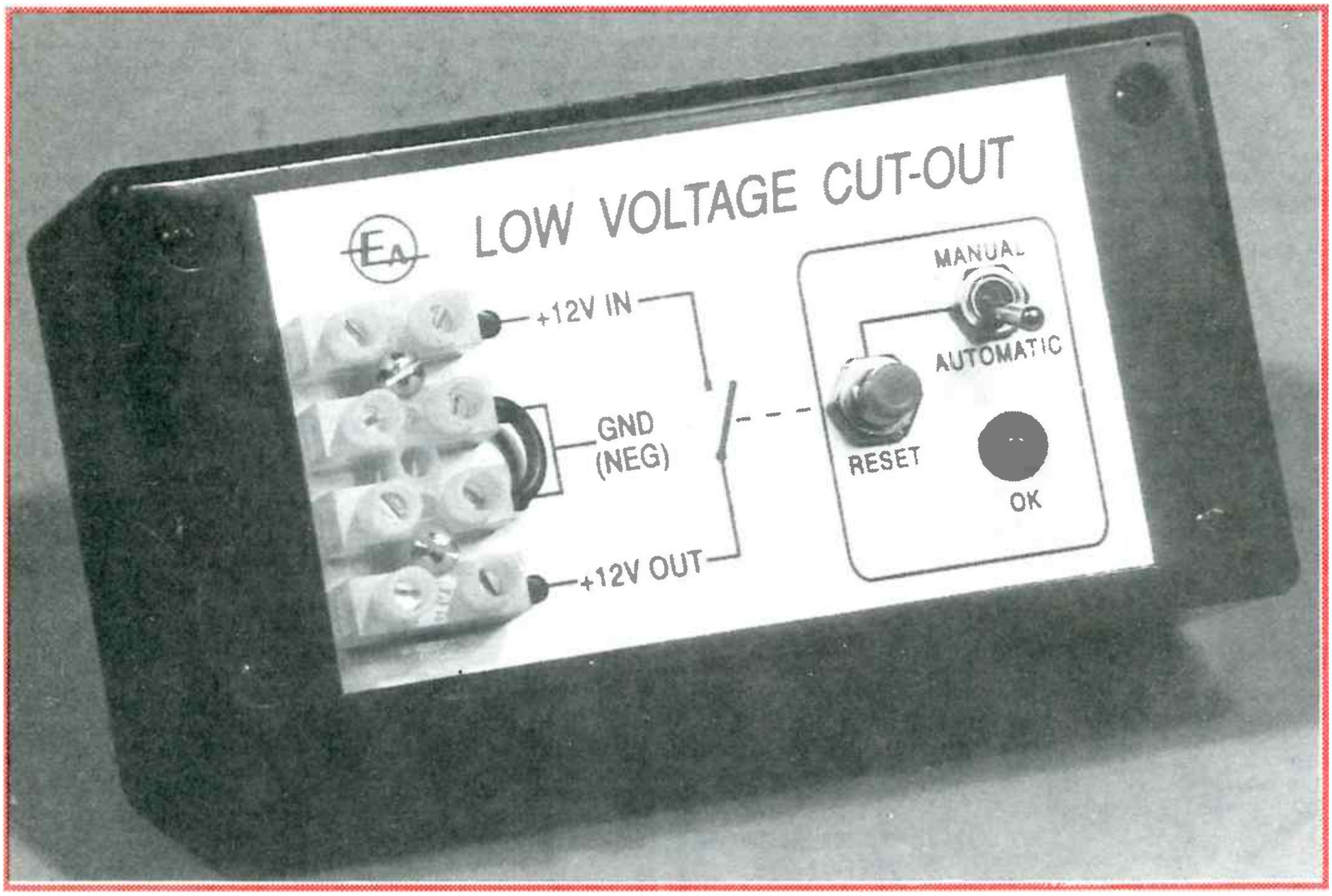
Construction project:

LOW VOLTAGE CUT-OUT FOR CARS AND BOATS

Build this simple little gadget, and avoid getting caught out with a flat battery during your holidays. It simply connects into a 12V accessory's power line, and shuts off the flow if the battery's voltage drops to a dangerously low level.

by ROB EVANS



The scenario may be familiar to many readers: you park your vehicle (or anchor the boat), extract a few cold 'lemonades' from the 12V-powered refrigerator and relax to watch the sun go down.

Unfortunately, the next time that you even consider how the battery may have coped with the five or so amps demanded by the fridge over an extended period, the sun has risen again and it's time to move on. And — you guessed it — there's not enough energy left in the battery to start the engine. So there you stay, until help arrives...

Of course, this is just one possible scenario. There are a whole range of situations where a 12V accessory can surreptitiously exhaust the battery's charge. Some will just cause a minor inconvenience, while others can place you in a dangerous predicament.

Our new low voltage cut-out unit offers a solution to the problem by continuously monitoring the battery's condition, and disconnecting the load *before* there is the potential for 'starting troubles'.

While the most accurate way of determining a car battery's state of charge is

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to test each cell with a specialised device such as a Hydrometer (which derives a good/bad reading from the condition of the cell's acid), the overall terminal voltage can also give quite a reasonable indication. For example, if the voltage is around say 12.5V it's safe to assume that a substantial charge remains, and the battery should have no difficulty in starting an engine.

On the other hand, a battery with terminal voltage of 11.5V would probably have a very restricted current capability and insufficient energy to drive a heavy load.

In the cut-out unit we've elected to make this drop-out voltage adjustable over a nominal range of 10.9V to 11.9V, as set by an internal trimpot. This allows the unit to be fine tuned for each installation, depending upon the minimum acceptable level of battery charge.

We've also arranged the circuit to restore power to the load automatically when the battery voltage has returned to around 12.6V, indicating that the cells have been recharged or high-current charging is taking place from say, a vehicle's alternator.

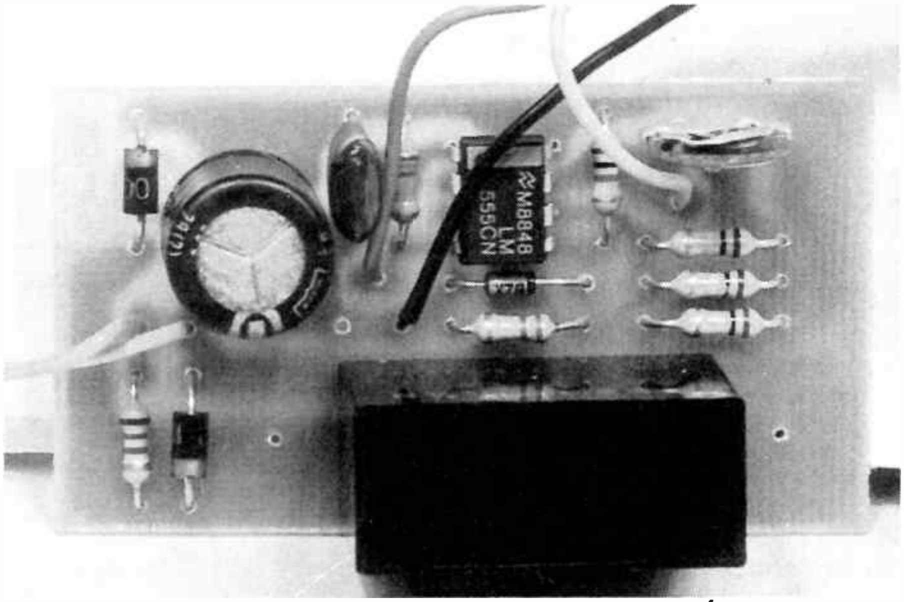
With this feature you can leave the battery management up to the cut-out unit, which both connects and disconnects the accessory in response to the battery's state of charge. By the way, while the 12.6V 'reset' level should suit virtually all circumstances, it can be altered by just changing the value of a couple of the circuit's resistors — see later for more details.

There are circumstances however where the automatic reset feature may not be desirable. Imagine for a moment that the battery in question is near the end of its useful life, and exhibits a relatively high internal resistance. In this case, when the cut-out unit has disconnected the load in the normal manner, the input voltage may immediately rise — causing the unit to reset, and therefore connect the load again. The voltage will then fall, and so on...

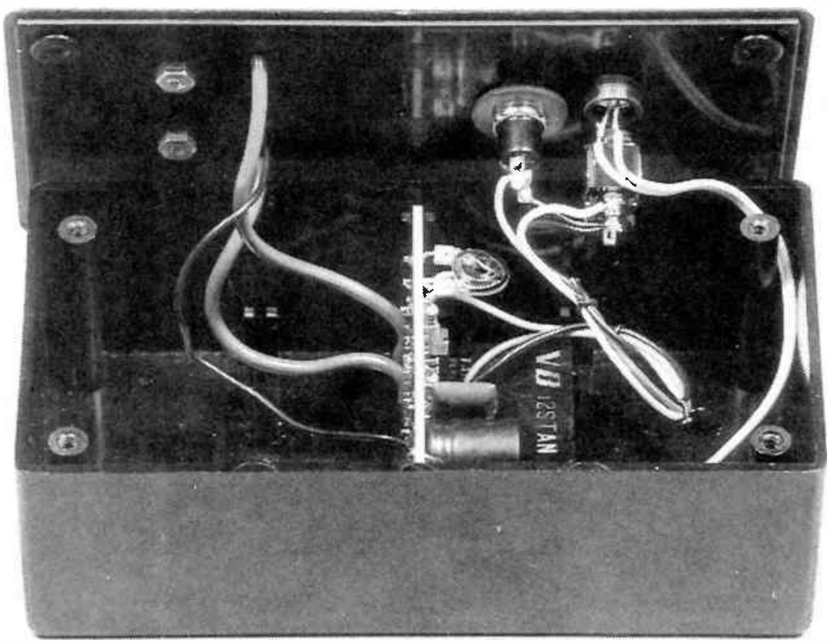
While this is an unlikely event (chances are that the voltage will not return to a greater level than 12.6V), the cut-out unit would continuously drop the load in and out, which may not impress some fridge compressors for example. Also, a similar situation could develop due to resistance in the accessory's wiring and connectors, rather than in the battery itself. In any case, the cut-out unit offers an alternative *manual* reset mode to cope with such complications.

When this mode is selected on the unit's 'automatic/manual' switch, the load is disconnected in response to a low input voltage in the usual way, but is not reconnected as the input rises above the 12.6V 'reset' level. In fact, it will remain in its 'dropped-out' state until the front panel's RESET button is pushed, where the load will be reconnected — if the input voltage is above the current cut-out level. That is, the RESET button will only cause the circuit to 'latch' if the battery has recovered to some degree.

Aside from that, the low voltage cut-out unit offers an 'OK' LED on the front panel to indicate that the load is indeed connected, and a simple terminal strip connector for the input/output wiring to help make the installation a simple process. It's also very reliable, and only draws around 12mA from the supply once it has disconnected the load. And importantly, the unit uses standard low-cost components and is extremely easy to build.



The PCB is really quite small and could be installed inside a 12V accessory itself, rather than in the plastic case as described.



Inside the completed unit. Note that the PCB is held in place by the case's mounting slots, and the 12V in/out wires are soldered to the corner side of the board.

World Radio History

Low voltage cut-out

Circuit description

As you can see from the schematic diagram, the cut-out unit's circuit is based around our old friend the 555 timer IC. The 555 is a logical choice for the job — as in so many other utility-type circuits — since it offers a flipflop with voltage-dependent setting and resetting actions, the ability to switch a relatively high load current, and a stable yet versatile internal circuit design.

In our case the 555 is arranged in a fairly standard configuration, where the threshold and trigger pins (6 and 2 respectively) are tied together and both sense the incoming voltage.

Since the trigger input normally *sets* the 555's internal flipflop as the voltage drops below 1/3Vcc, and the threshold pin *resets* the flipflop as it rises above 2/3Vcc, the circuit behaves as an inverting Schmitt trigger between pins 2 and 6, and the output at pin 3.

In our circuit however, the 555's control voltage (CV) input is held at 5.1 volts by the action of ZD1 and its associated resistor R5, which effectively overrides the chip's internal voltage divider (see Fig.1). This now means that the flipflop will be *set* when the input level falls below 2.55V, and *reset* when the inputs are above 5.1V — regardless of any moderate changes in the voltage at pin 8 (Vcc).

So when the input voltage is above the 'threshold' level (5.1V), the 555's output (pin 3) will fall to energise RLA, which in turn connects the DC supply voltage to the output load.

Conversely, power to the load is removed when the 555 is *set*, as the input level at pins 2 and 6 falls below 2.55V (the 'trigger' level).

The actual input supply rail is applied to this level-detecting scheme (at pins 6 and 2), via isolating diode D1 and the voltage divider formed by R1, R2 and R3. Note however that when the 555 is in its normal *reset* state (relay energised), pin 7 is effectively shorted to ground potential via the chip's internal 'discharge' transistor, thereby connecting RV1 and R6 in parallel with R3.

As a result, if RV1 is adjusted for its minimum value (0 ohms) and the 555 is indeed reset, the 2.55V trigger level at pin 2 is met as the source voltage falls below about 11.9V. On the other hand, if RV1 is set to its maximum resistance, the 555's flipflop will be set as the input voltage drops below around 10.9V. So ultimately, the circuit's relay will drop-out if the input voltage falls below the range of 11.9 to 10.9 volts, depending upon the setting of RV1.

Once the 555's flipflop has been *set* (relay de-energised), the internal discharge transistor at pin 7 will be turned off, disconnecting RV1 and R6 from the input voltage divider circuit.

Since the divider is now composed of just R1, R2 and R3, the 5.1V upper threshold point will be reached only when the input voltage has risen to about 12.6V, where the flipflop will again be *reset* and the relay energised to connect the load. This is in fact the operation of the cut-out unit when in its 'automatic' mode.

When the 'manual' mode is selected on SW1, the 555's discharge pin is grounded continuously through the switch contacts, leaving RV1 and R6 permanently in circuit. This means that while the triggering or low voltage drop-out process will operate in the same manner — since when the flipflop is *reset*, SW1 performs the same function as the discharge transistor at pin 7 — the 555 will not be reset until the input voltage reaches a theoretical figure of about 22V. So in practice, the circuit cannot automatically reset, and the relay will not reconnect power to the load.

This is of course where the manual reset button comes into play. While the 555's master reset function at pin 4 is normally disabled in our circuit by the

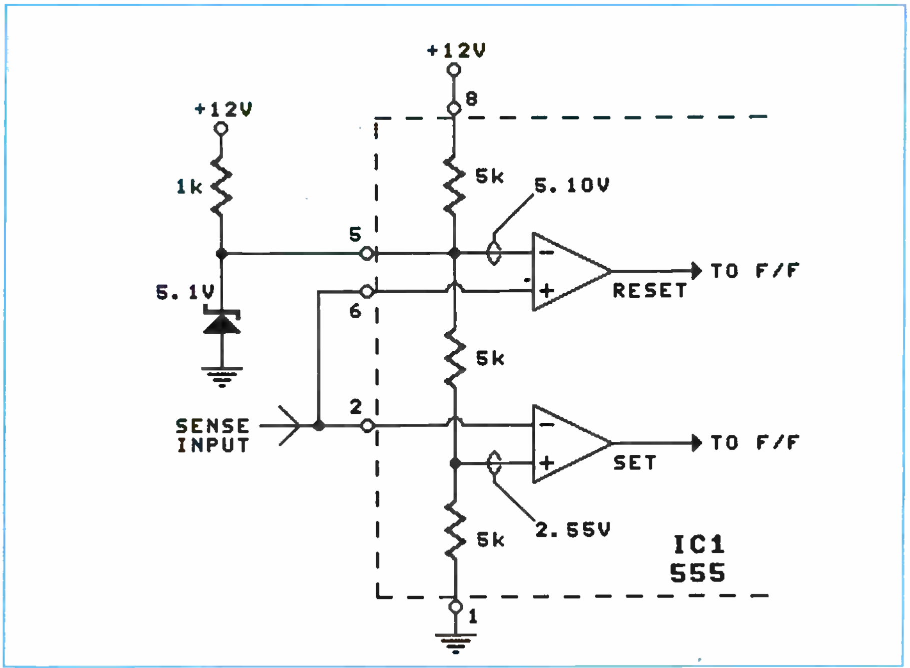
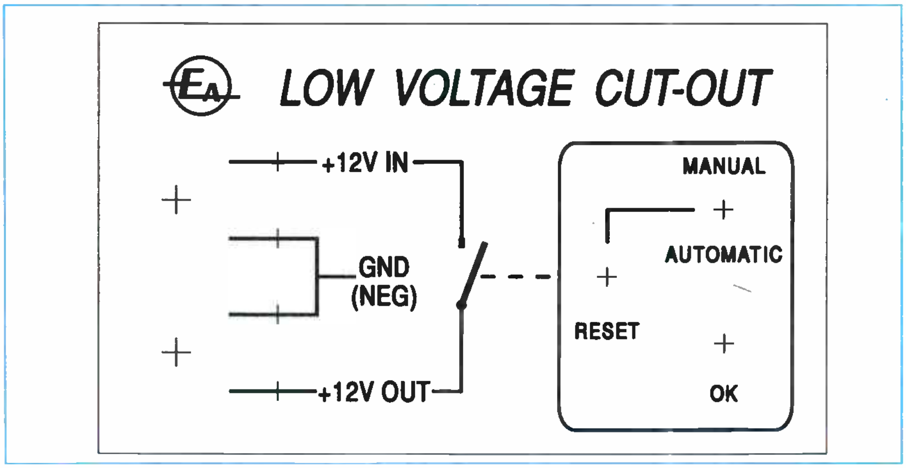


Fig.1: The voltage at which the threshold input (pin 6) resets the 555's internal flipflop is fixed by the 5.1V zener diode at the CV input (pin 5). Due to the 555's internal voltage divider, the trigger input (pin 2) will therefore set the flipflop at 2.55V.



The actual size artwork for the case lid.

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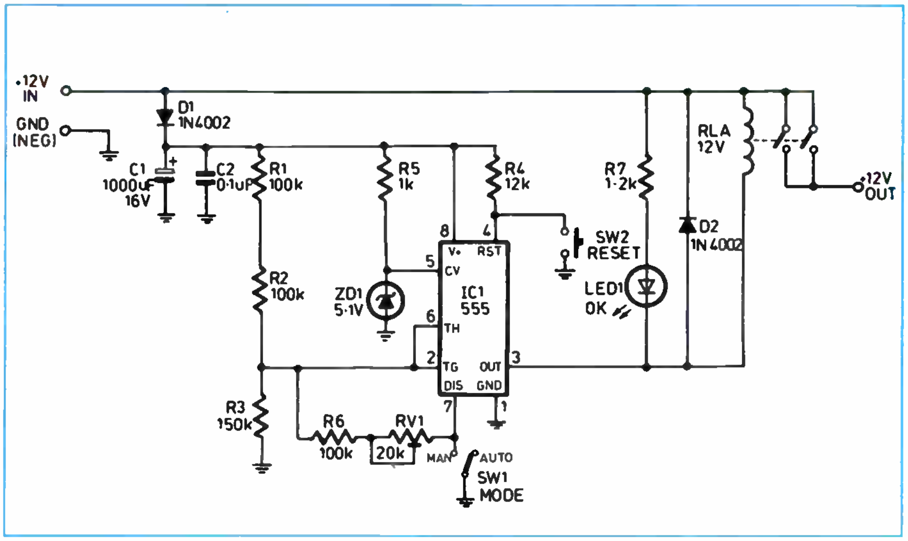


Fig.2: The circuit is very simple thanks to the 555 timer IC. Its trigger and threshold inputs are used to sense the low and high input voltage points, respectively.

pull-up resistor R4, the reset button (SW2) can pull this point to ground potential when required. When this occurs, the 555's flipflop is reset, pin 3 goes low to energise RLA, and power is reapplied to the load.

If however the voltage at pins 2 and 6 is less than the 2.55V trigger point at this time, the 555 will immediately *set* once the button is released, and the load will again drop out. So in effect, the resetting action will only last as long as the reset button is pressed, if the input voltage is below the 'drop-out' level. Normally though, you would only be pushing the reset button once the battery (input) voltage has returned to a suitably high level.

Note that LED1 and its associated limiting resistor (R7) are connected across the relay coil, so that when the 555's output (pin 3) is low the 'OK' LED illuminates to indicate that the battery is in a healthy state, and the relay is energised. Also, D2 has been included to quelch any back-swing voltage generated as the relay coil is de-energised.

Finally, C1 and C2 have been included to help stabilise the circuit's supply rail during fluctuations in the input voltage. C1 has been selected as a large value (1000uF) so that during any *short-term* reductions in the input voltage, D1 will become reverse biased and the supply rail will be maintained from the capacitor's stored charge.

If this heavy filtering was not included, the cut-out unit would tend to disconnect the output in response to momentary line fluctuations or 'drop-outs', such as that produced when some other 12V accessory is activated. This would be a particular problem when the unit is in the manual mode, where the relay would remain de-energised until the reset button is pressed.

As it stands however, the main section of the circuit (supplied by C1) will tend to ignore the drop-out, and the 555's output (pin 3) will remain at a low level. C2, by the way, is intended to bypass any stray RF energy which may enter via the input line.

Construction

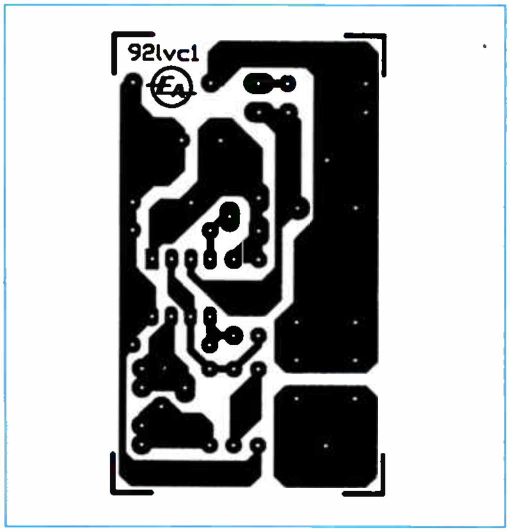
Building the low voltage cut-out unit should be quite a straightforward affair. Virtually all of the components are mounted on one small PCB measuring 62mm x 35mm, with the remaining parts fitted on the lid of the unit's case.

Begin the construction by installing all of the lower profile components into the PCB (coded 92lvc1), while paying particular attention to the orientation of any polarised parts as shown in the component overlay.

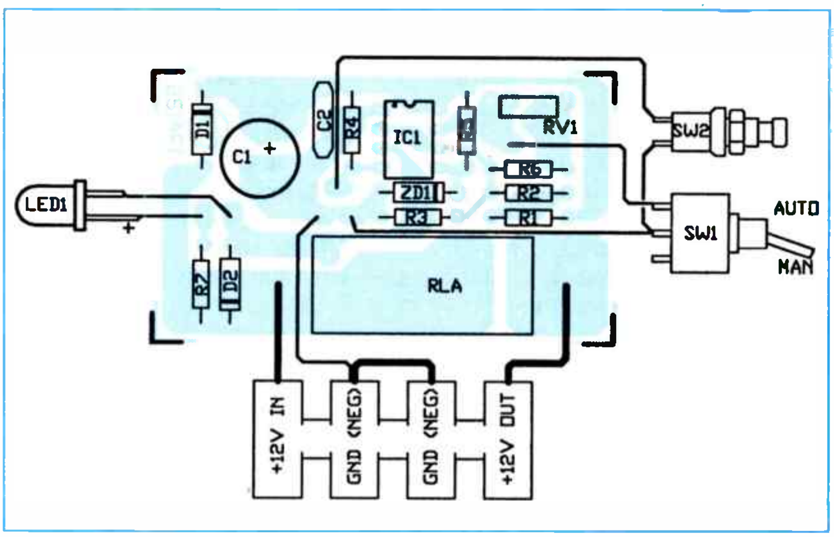
Once the relay has been fitted, add lengths of light-duty hookup wire to all of the external connection pads on the PCB, except for the +12V IN and +12V OUT points at the base of the relay. These should be formed with suitable lengths of heavy-duty hookup wire, and terminated on the copper side of the PCB.

Next, install the switches and LED (but not the terminal strip) in the case lid, and connect these components to the light-duty wires as shown in the overlay diagram. Note that a small wire link is needed between SW1 and SW2 — a component leg offcut is quite suitable for the job.

Then pass the two heavy-duty wires



A full sized copy of the PCB pattern, for those who like to make their own.



The component overlay diagram. Pay particular attention to the orientation of all polarised parts.

World Radio History

Low voltage cut-out

and the GND (NEG) wire through their matching holes in the lid, and terminate their ends in the terminal strip. The strip can now be bolted to the front panel and a short (heavy-duty) wire link added between the two GND (NEG) connections. As it happens, it's much easier to neatly pass the wires though the holes in the case lid *before* the terminal strip is bolted in place.

As you can see from the associated photographs, the PCB is designed to fit into the vertical mounting slots of a standard plastic case.

This avoids the need for messy PCB mounting hardware, allows for a much easier installation method, and makes for simple access when servicing or adjustment is needed.

Testing & installation

The easiest (and best) way to test the newly completed cut-out unit is to connect a variable power supply to the +12V IN and GND (NEG) terminals, select the automatic reset mode, and slowly increase the supply's output voltage. If you started from a low voltage, the 'OK' LED should illuminate (with a coincident 'click' from the relay) once the level has reached around 12.6V.

Then if the trimpot (RV1) is near the centre of its travel, the 'OK' LED should extinguish (with another 'click' from the relay) as the input voltage falls below about 11.5V.

Now perform the same tests with the cut-out unit in its manual mode. In this case note that once the relay has dropped out in response to a low input voltage, it can only be re-energised by pushing the reset button.

In turn, the reset switch should only have a permanent effect on the relay once the input voltage has risen *above* the lower cutout point (greater than say 11.5V). When the voltage is below this level, the relay should only hold in for as long as the reset button is pushed.

Once you are satisfied that the cut-out unit is performing correctly, it can be installed in its final location. The most convenient way to mount the device in place is to simply bolt or screw the main body of the case into position, then install the lid and attached PCB assembly into the box.

When it comes to adjusting RV1 (the lower cut-out level) however, leave the PCB in position and just move the lid far enough to one side for sufficient access to the trimpot.

As you would expect, the unit is simply wired 'in-line' with the accessory it is intended to control. If the accessory is connected with a two-core cable, this can be cut and the 'battery' side of the break wired to the cut-out unit's input connections (+12V IN and the matching GND (NEG) terminal).

Similarly the 'accessory' section of the cable is wired to the appropriate output terminals (+12V OUT and its GND (NEG) point). *Note however, that you must take particular care to maintain the correct polarity to the accessory unit, or it may be permanently damaged.*

Also check that the cut-out unit is receiving the correct voltage polarity, or its new career will be ended before it has even started!

Alternatively, the accessory could be connected via just one wire (+12V), with its return path (negative) completed through a vehicle's metal chassis for example. In this case, the single wire can pass though the cut-out unit's relay contacts via the usual '+12V IN' and '+12V OUT' terminals, and an additional wire connected between one of the GND (NEG) terminals and the vehicle's chassis.

Note that this extra wire only carries the small 'return' current for the cut-out unit, and can be formed with light-duty wire.

PARTS LIST

1 PCB 62 x 35mm, coded 92lvc1
1 Standard 12V DPDT relay, 200 ohms or greater.
1 4-way section of heavy-duty terminal block
1 Medium sized plastic case, 130 x 68 x 41mm
1 Miniature SPDT toggle switch
1 Momentary action miniature push-button switch
Light-and heavy-duty hookup wire; nuts and bolts

Semiconductors

1 555 timer IC
1 5.1V 400mW zener diode
1 5mm green LED, plus mounting hardware
2 1N4001 (or similar) power diodes

Resistors

(All 0.25W)
1 x 150k,
3 x 100k,
1 x 12k,
1 x 1.2k,
1 x 1k
1 20k vertical-mount miniature trimpot

Capacitors

1 1000uF 16V PCB-mount electrolytic
1 0.1uF metallised polyester

Adjustment & mods

While RV1 will adjust the unit's cut-out voltage over a moderate range, its actual setting will depend upon the conditions at the installation itself, and what you consider to be a sufficient charge remaining in the battery.

For example if the accessory is a refrigerator in a four-wheel-drive vehicle, it would be wise to set the trimpot for a relatively high cut-out voltage (say 11.9V), so that a reasonable battery charge remains. It seems that even a healthy battery will have trouble turning over some of the more burly 4WD motors, if its terminal voltage is much below 12V.

On the other hand, there may be a much smaller motor involved such as the auxiliary unit in a small sailing yacht, which should be considerably easier to start. In this case you should be able to set RV1 to a lower cut-out voltage, and effectively allow the accessory to run for a longer period from a given battery charge.

The cut-out unit's automatic reset voltage is fixed at around 12.6V, which should suit most situations. In practice, the battery voltage will rise to at least 13V (typically 13.8V) once the motor has been started, since the alternator will immediately begin to charge the battery at a high current. However you may wish to alter this figure if say, the battery is charged by solar cells alone.

In this situation the battery's terminal voltage is unlikely to rise above the 12.6V level — despite being in a healthy state of charge — since the solar cells can only deliver a very modest charging current. To lower the automatic reset point to say 12.2V, try changing R1 to 68k, R2 to 120k, and R6 to 82k.

Of course, there may be a situation where the cut-out unit's reset voltage needs to be *higher* than the standard setting. In this case changing just R1 to 120k brings the automatic reset point up to about 13.3V.

By the way, in both of the above cases the unit's cut-out voltage (as set by RV1) is changed by a proportional amount. For example, in the latter modification the drop-out level can be set between around 12.6 and 11.6 volts. However, if you generally need a wider range of adjustment for RV1, try increasing its value to 50k and dropping R6 to 82k or 68k.

Take some care with the adjustment though, since you could end up with a dropout voltage setting which is actually *higher* than the automatic reset voltage. ❖

World Radio History

THE SERVICEMAN

Continued from page 69

no trace of flagwaving when I had tried the set with another VCR the previous day.

It was quite obvious that the Kriesler needed a modification to its horizontal AFC circuits, at least for use with this particular VCR, and I was surprised that this had not been done earlier. All the early Krieslers that I have dealt with have needed the mod, to enable them to work with VCR's.

The modification is very simple. It consists of nothing more than using a short length of wire to join pins 3 and 8 on the horizontal module, CU451.

This changes the AFC time constant, and enables the set to operate with the less-accurate horizontal sync pulses from a video tape. It took almost no time to fit the mod then try out the combination. It worked perfectly. The picture was as steady as any I've seen, and the whole outfit could not be faulted.

When I took the set back to the customer, I explained that I had found no cause for the original problem, but only the need for the VCR mod. The original complaint would have to be listed as a complete mystery.

The customer's husband turned out to be reasonably knowledgeable on these matters and could not understand why the set suddenly needed the modification, when it had worked for years without it. He knew about these VCR mods as he had had the job done on his father's Philips K-9 some years earlier.

I returned the set to the customer and gave it a thorough test run. It was faultless. I checked a week later and it was still troublefree. So I have no idea why it put on such a performance when I first saw it.

The only possibility I can think of is that one of the plug and socket connections to the channel selector panel was loose, and that the shock of carrying it to the workshop corrected the fault.

If this was the case, then my bumping and thumping early in the exercise had re-seated the plug without my noticing it.

It's a mystery, and one that I hope is not repeated too often. One can lose one's reputation over faults that correct themselves like that!

Cheerio for now. I'll be back next month with another in the long running series that comes to you 'From The Serviceman Who Tells'! ❖

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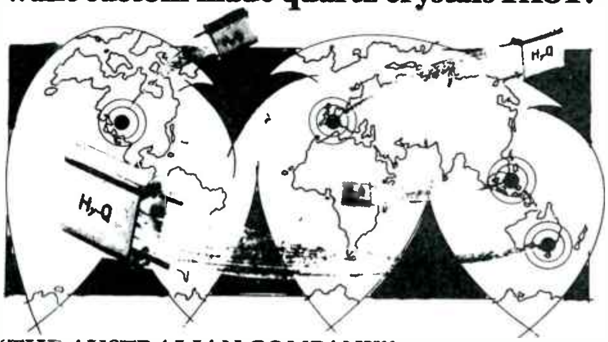

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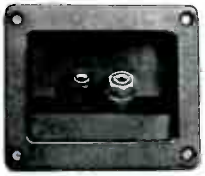

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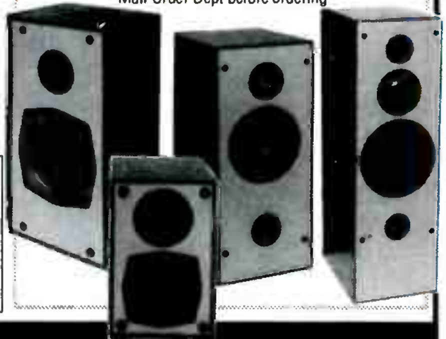

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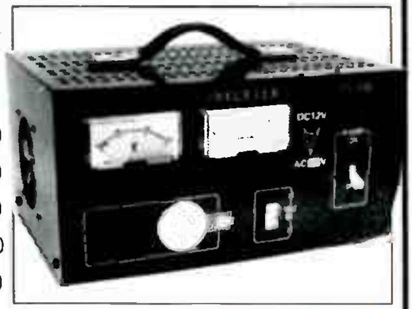

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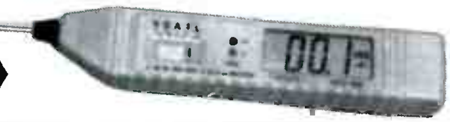

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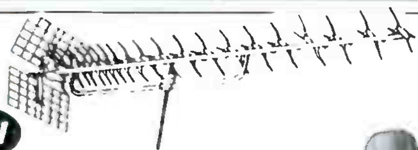

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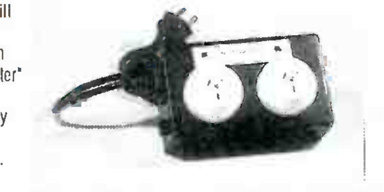
THE LATEST KITS

240V Power Relay

Ref EA Jan 1992. This simple kit will monitor the power drawn from a "master" socket and automatically switch on a slave socket.



Its very versatile because it can monitor one or several appliances plugged into the "master" and switch one or several devices plugged into the slave. An ideal use for this project would be to switch on your HiFi system. With a 4 outlet board plugged into the slave socke,t turning on your amplifier (in master) will switch on your tuner, tape deck, CD player, turntable. The Jaycar kit includes PCB, box, 240V sockets, lead and plug and all specified components.

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Ref EA January 1992

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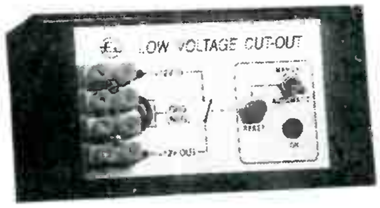

LIGHT BEAM RELAY KIT

Ref: Silicon Chip December 1991

This simple project allows you to monitor a doorway or a path using an infra red light beam. When someone walks through the beam, it triggers an alarm for a 1 second period. Kit includes PC board, case, panel and all specified parts. Plugpack and optional relay are not supplied. Plugpack Cat. MP-3006 $15.95. Cat. KC-5106

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Ref: Silicon Chip November 1991

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Ref: Silicon Chip November 1991

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Latch mode	Latches first pulse detected until manually reset	
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240V Power Relay

Here's a simple project that monitors the power drawn from a 'master' socket and automatically switches on a 'slave' socket. It is versatile, because it can monitor one or several appliances plugged into the 'master' and switch on one or several devices plugged into the 'slave'.

by PETER MURTAGH

The idea for this circuit came from a project called the 'Socket Sentinel' in the September 1991 issue of *Popular Electronics*, by John Yacono and Marc Spiwak. Their circuit used a triac as a switch which was activated by any current being drawn from a master socket. The switched-on triac then powered up two slave sockets.

At the time of seeing their circuit, we were developing a unit to automatically switch on a shared printer as soon as any of three computers was powered up.

Our original idea was to monitor the printer port strobe line voltage from each computer and, as soon as it went positive, to activate a relay to switch on the printer. But the idea of using the triac switch allows for a far simpler circuit, as well as having an added bonus that it is no longer a special purpose circuit.

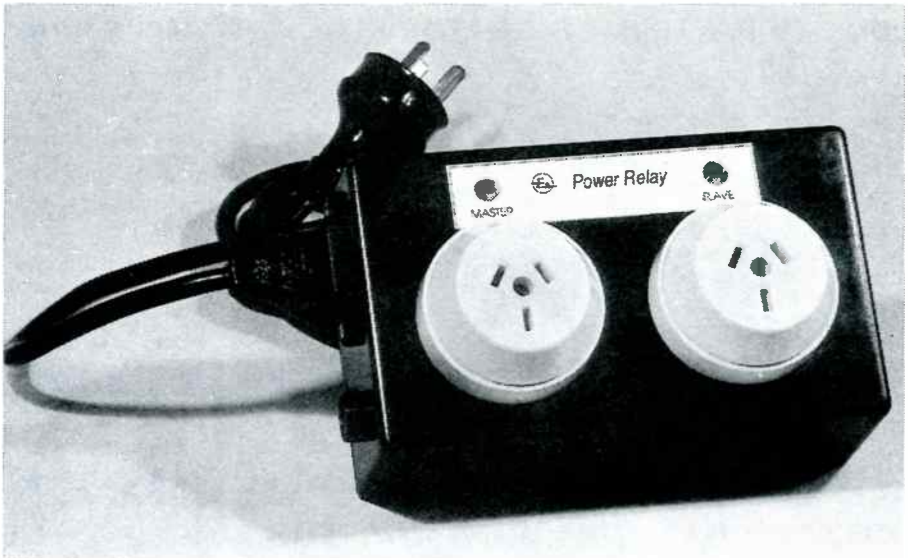
This means that it can monitor several circuits, and/or activate several, by using it with cheap and readily available multi-outlet powerboards.

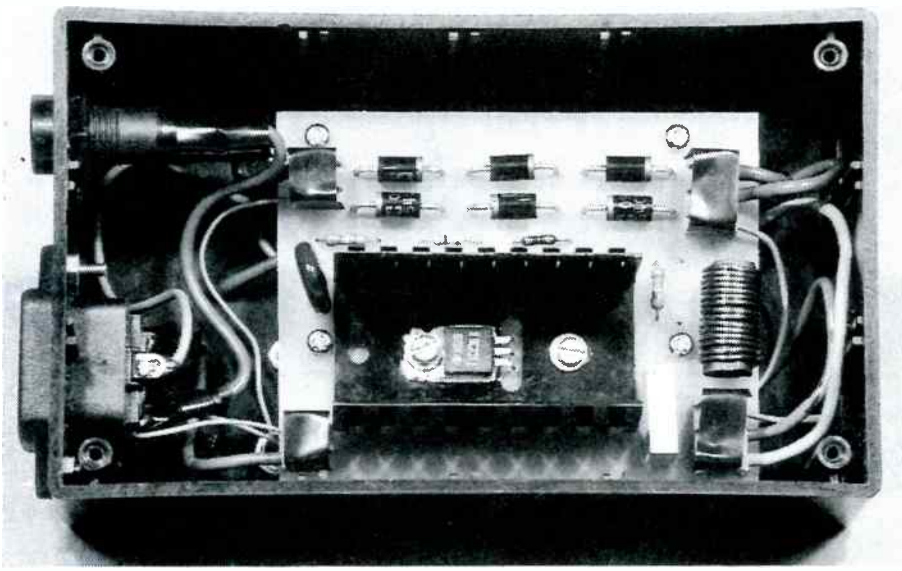
If the powerboard is plugged into the master socket, then the slave is switched on by any one of several appliances (like our printer being switched on by one of several computers).

Alternatively, with the board plugged into the slave socket, one device can switch on several (e.g., turning on your amplifier will automatically switch on the tuner, cassette and CD player).

The design can accommodate any number of inputs and outputs, but in practice the power ratings of the diodes and triac will determine that number. All the current to the master socket flows through the diodes (the limitation on the master socket), and all the current to the slave flows through the triac (the limitation on the slave).

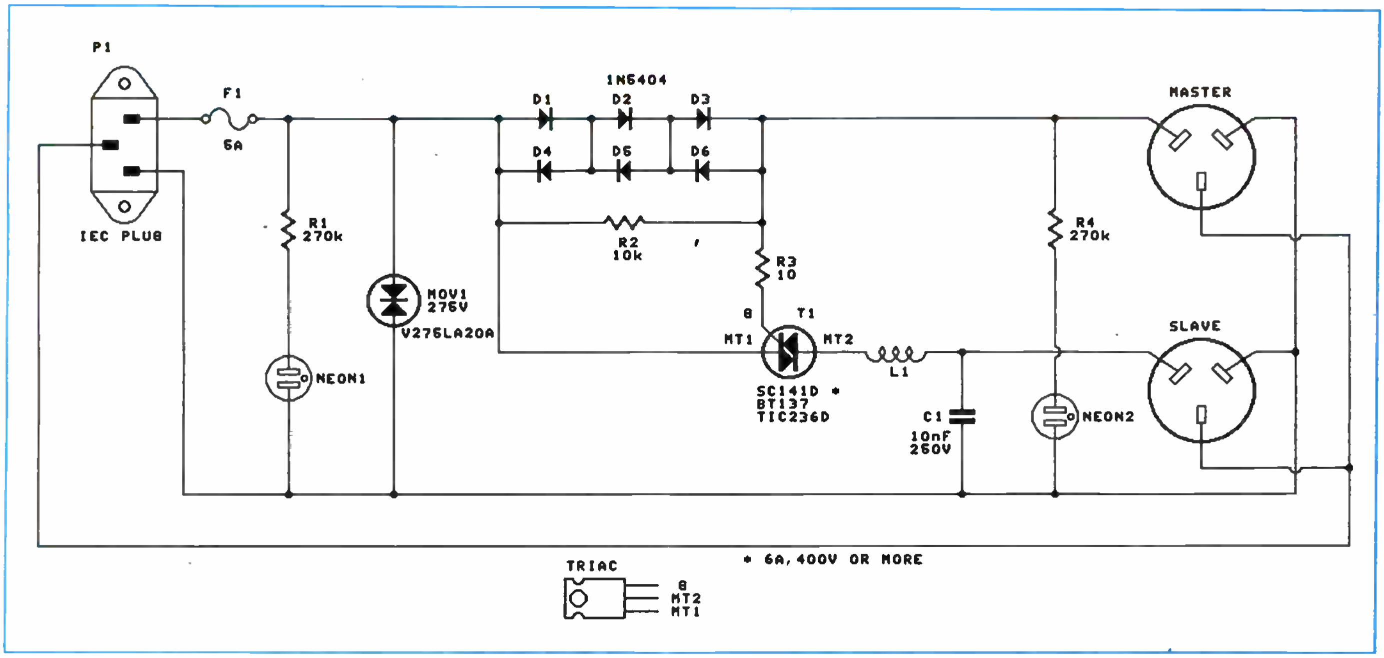
Choose the values needed for your own particular needs — our circuit uses 1N5408 diodes, rated at 3A at 1000V, and





The internal view of the jiffy box shows the layout of the components. Note the use of the chassis-mount IEC plug at the bottom left which ensures a good earth and removes the need to clamp and join the power input leads. The plug would be better positioned closer to the fuse to avoid the internal pillar.

World Radio History



The schematic diagram shows how simple the circuit is. The master current flows through the diode network, while the slave current flows through the triac. The MOV gives protection against voltage transients and spikes in the mains supply.

a TIC236N triac which can deliver 12A at 800V. The minimum rating we would recommend for the triac is 6A and 400V.

Another interesting feature of the *Popular Electronics* circuit was the use of a Metal Oxide Varistor (MOV) to protect against voltage transients and spikes.

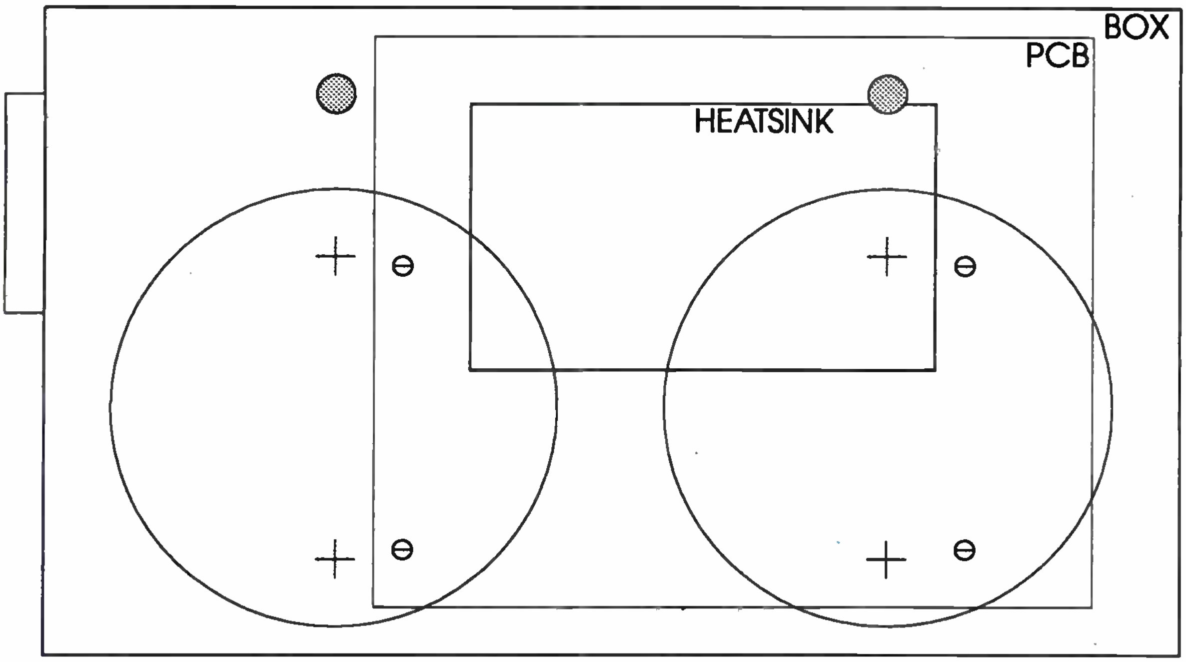
We feel that this protection is worth the few extra dollars involved, so we've added it to our circuit also.

Possible hitch

To our surprise, when we tried out the 'power relay' using two computers and a shared printer, we found that the printer stayed on, even though both computers were turned off. It turned out that our older Epson computer had three RFI filter capacitors totalling 1.5uF across the power switch on the active side. This allowed a reactive current of about 100mA to flow permanently, and this was sufficient to keep the 'power relay' turned on. So this unit, as it stands, will not work with any 'master' appliance which draws such a large reactive current.

How does it work?

Triacs have three terminals, main terminals 1 and 2 (MT1, MT2) and a gate (G).



The drilling template for the mounting holes on the front panel (actually the bottom of the jiffy box). The screws which fasten each end of the PCB mounting pillars must be outside the heatsink area, but still able to be hidden by the bases of the power sockets.

World Radio History

Power Relay

If sufficient current flows between MT1 and G, then the breakdown voltage between MT1 and MT2 is very low — i.e., the gate current makes it possible for a small voltage to turn the triac on.

To conduct AC, when MT1 is more positive than MT2, G must be more negative than MT1; when MT1 is more negative than MT2, G must be more positive.

Usually an electrical component is connected between G and MT2 to pull G's voltage away from MT1 to provide the required turn-on voltages, but our circuit achieves these voltages in a different way — by connecting a diode network between G and MT1, to sense the 'master' current.

Here's how it works. When the master socket is conducting, there is a typical voltage drop across each diode of about 0.7V. With the three diodes in series, this means that a voltage difference of about 2.1V is maintained between G and MT1; diodes D1-D3 provide the voltage during the positive halves of the AC cycle, and D4-D6 during the negative halves. The gate voltage is kept more negative or more positive than MT1 as required.

With sufficient gate current, most triacs turn on over a voltage range of about 0.7-2.0V — hence we have used three diodes in our network. So, when these diodes are conducting, most of the master current flows through them.

They also limit the voltage applied to the gate of the triac and so prevent its destruction. This voltage-limiting action means that R2 can be a low power resistor, since it only ever has a few volts across it.

But when the diodes are not conducting (-2.1 — +2.1V), this master current has to flow either through R2, or through R3 and the G-MT1 junction of the triac. Because the master load impedance is quite low, we have added R3 to limit the current flowing through the junction.

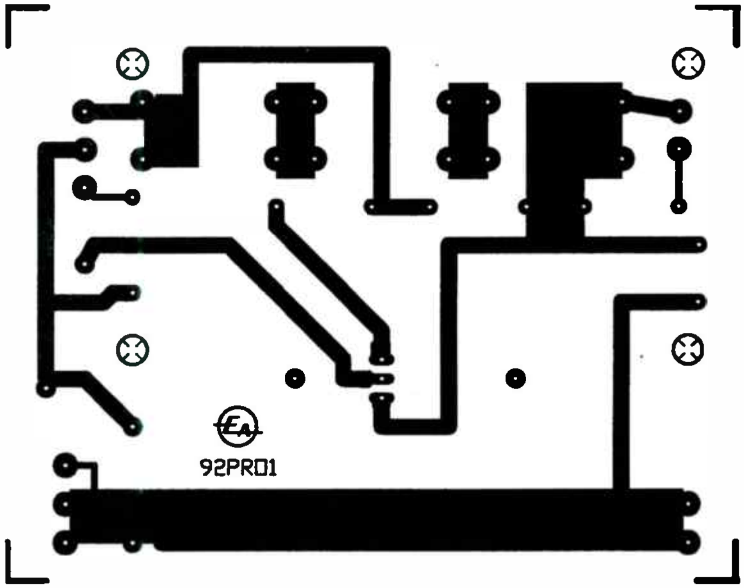
If you find that your triac seems sluggish when turning on, you might have to increase the triac's sensitivity and reduce the value of this 10 ohm resistor. In fact, the *Popular Electronics* circuit did not include R3 — G was connected directly to R2. Resistor R2 also affects the triac's sensitivity (decreasing it), because it shunts some of the gate current. It has been included to make certain that the triac, via thermal leakage current through the gate, cannot switch itself on.

As soon as the power relay unit is connected to the mains, the master bezel, neon 1, will light up — failure to light indicates a blown fuse. Then, as soon as a device connected to the master socket is switched on and draws current, the slave bezel, neon 2, will glow to indicate that the slave socket is now 'live'. The slave bezel lights up whether or not any appliance is plugged into its socket or switched on.

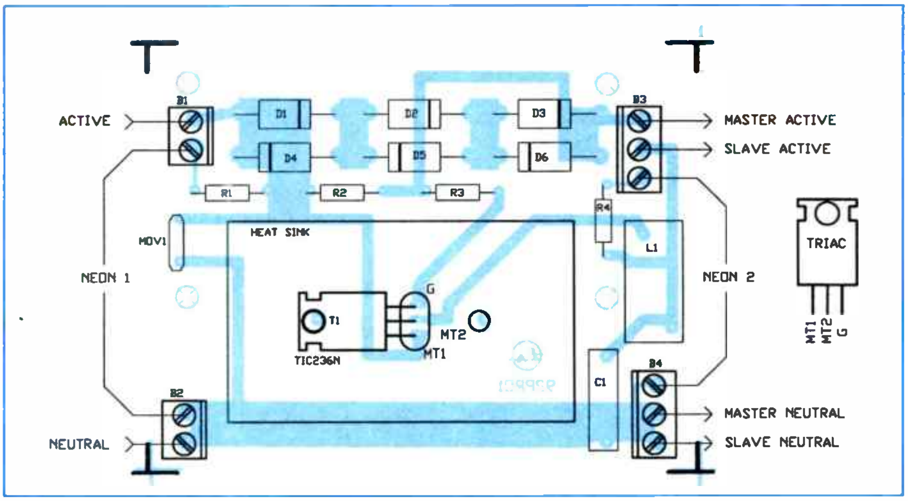
As mentioned earlier, the current rating of the diodes determines the maximum master current, and the triac rating determines the maximum slave current. Choose the size of your fuse to handle the combined currents from both sockets.

To prevent any RF interference from the triac, we have added a simple coil/capacitor filter to its output. The coil

The label for the front panel. The circles are the mounting holes for the two neon bezels.



Here's the actual size PCB pattern for those who wish to etch their own board. Note the thick tracks for the main current paths.



The component layout diagram shows how most room is taken up by the triac heat sink. The large areas of copper are meant to help dissipate any heat generated. The use of PC-mount terminal blocks makes it easy to connect the hookup wires.

World Radio History

is made from 14-1/2 turns of 1mm wire, wound onto a 23mm length of 10mm diameter aerial rod; and the 10nF capacitor is of the special '250V AC' mains rated type.

Construction

The complete 'Power Relay' circuitry is mounted on a small PCB measuring 97 x 76mm, and coded 92PR01; and this board is housed in a medium-sized jiffy box measuring 50 x 90 x 150mm, on insulated mounting pillars.

The mains input is at one end of the box via a chassis-mount IEC plug, while two standard surface-mount sockets are mounted on top for the master and slave outputs.

Start by soldering the components to the PCB, taking the usual precautions about the polarity of the diodes, etc. Note that we have used PC-mount terminal blocks to make the wiring connections much easier. The 2-terminal blocks handle the inputs, with the 3-terminal blocks for the outputs.

Next wind the coil with its 14-1/2 turns. The extra half turn means that wires at both ends are pointing down, though on opposite sides of the former. Scrape off the insulation from the ends, and solder them to the PCB. Bolt the triac to the heat sink, using silicon grease to improve heat dissipation, before soldering it to the board.

We opted to use the jiffy box upside down, with the removable lid becoming the base. Use the drilling template diagram to mark the positions for the various holes: neon bezels at the top, directly below them the holes to bolt the power sockets to the box, and to their right the holes to secure the insulated mounting pillars for the PCB.

Secure the bases of the power sockets to the box, and use them as templates to mark the holes for live, neutral and earth wires. Remove the bases and drill these holes.

Next, cut out the hole at the left hand side to take the IEC plug — but remember to position it far enough from the edge so the mounting bolt clears the internal pillar of the jiffy box. Then drill the hole for the fuse holder.

When all the holes are drilled, cut the various lengths of hookup wire. Make sure that these wires are rated for 240V and are thick enough to carry the currents required. The fuse holder will have to be attached to the box before soldering its wires, but it is probably easier to solder the wires to the IEC plug before it is attached.

Wrap insulating tape around the exposed terminals of the plug, and also cover up the exposed lugs on the fuse holder.

Fit the label to the box, then fix the neon bezels which pass through the holes on the outline. Our label was fastened to the box with double-sided tape.

Now fasten the mounting pillars to the box, checking that the bolt heads will fit inside the flanges of the power sockets. Roll the box over, keeping the IEC plug on the left; check that the mounting holes on the PCB can be lined up with the other ends of these pillars, as it is a fairly tight fit inside the box.

Once this is done, fasten the power socket bases and connect the wires to their terminals. Apart from the earth wire which loops from the IEC plug, the other wires go to the 3-terminal blocks at the right hand end. This means that the leads to the master socket have to be longer than those to the slave.

Complete the wiring by attaching the wires to the PC-terminal blocks. Make sure that the thin wires from the neon bezels go into the jaws of the terminals and so are firmly clamped. Then cover the tops of the terminals with tape so that the 'live' screws can't be touched.

Once all the wires are connected, bolt the PCB to the mounting pillars, screw on the base plate of the box, and the 'power relay' is ready for use. ❖

PARTS LIST

Resistors

All 1/4W, 5%:
- 2 270k R1, R4
- 1 10k R2
- 1 10 ohm R3

Capacitors

- 1 10nF 250V AC rated PCB-mount

Semiconductors

- 6 1N5404 3A power diodes
- 1 6A, 400V triac: SC141D, BT137, TIC236D
- 1 275V metal oxide varistor: V275LA20A

Miscellaneous

- 1 plastic jiffy box, 50x90x150mm
- 1 97x76mm PCB, coded 92PR01
- 2 surface-mount 240V power sockets
- 1 IEC chassis-mount plug
- 1 IEC mains lead
- 1 5A fuse and holder
- 2 2-hole PC-mount terminal blocks
- 2 3-hole PC-mount terminal blocks
- 4 15mm insulated spacers with screws
- 2 neon bezels
- 1 universal heat sink, 60x37x31mm
- 1 coil former: 23mm length of 10mm diameter aerial rod

520mm of 1mm diameter (B&S 18) enamelled copper wire

240V-rated hookup wire, mounting bolts, silicone grease, solder, insulating tape

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by JIM ROWE

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World Radio History

The flexible RC circuit

Describing the effects of connecting a resistor and a capacitor hardly seems enough for a whole chapter. In fact it will take two — and in this part we look at RC filters, frequency response and the decibel. In the next chapter we'll have some practical applications involving timers.

by PETER PHILLIPS

A resistor-capacitor combination is generally called an RC circuit. It's less of a mouthful! There are various ways of connecting these two components, depending on the need.

For example, an RC circuit can be part of a timing circuit; it can be used to filter out certain frequencies, or to boost others. It can change the shape of a waveform, it can even help filter out ripple on a power supply. In short, the RC circuit — simple as it may appear — has many applications in electronics.

In this chapter we look at how an RC circuit can be used as a filter for audio frequencies. This leads to the term 'frequency response'; something we've used before, but without much explanation. It also requires us to explain the decibel and how the decibel is used.

But first a bit of revision...

The capacitor

The capacitor was first described in Part 5 (May 1990), along with the term *capacitive reactance* and the fact that a capacitor blocks DC but passes AC.

You may remember that the higher the frequency and the higher the capacitance value, the less the capacitive reactance (Xc), where Xc equals 1/(6.28fC). So far we've not used this relationship, but it becomes important now.

The capacitor was more fully described in Part 6 of the series (August 1990) and the RC circuit was also introduced. The term *time constant* was explained, along with the concept of using an RC circuit as a time delay. Our main theme now is the effect of an RC circuit on AC signals, and the time constant of the circuit is again used in describing an RC filter.

The time constant of a circuit equals the product of the values of the resistor (R) and the capacitor (C). That is, time constant equals RC. By definition, a time constant is the time taken for the capacitor to charge to 63% of the applied voltage. If you're not sure about all this, perhaps a quick run through Parts 5 and 6 again might be useful.

Frequency response

The concept of *frequency* was discussed in Part 4 (April 1990), which also included a chart of the frequency spectrum.

Frequency response and *bandwidth* are terms often used in electronics, and refer to the range of frequencies over which a circuit can operate. While the main interest in this chapter is with audio frequencies, these terms also apply to radio frequencies. The main difference is that circuits associated with radio frequencies generally use an inductor and capacitor, rather than an RC circuit.

To explain the terms bandwidth and frequency response, consider an audio amplifier. Most reasonable quality amplifiers are specified as being able to amplify frequencies from 20Hz to 20kHz.

But what about a signal of 19Hz, or a signal of 21kHz? Obviously these frequencies will still be amplified — but to what extent?

The answer lies in the curve of Fig.1. This graph is a plot of output voltage versus frequency, for a typical audio amplifier. Fig.2 shows how such a plot can be derived, in which an audio signal generator is coupled to the input of the amplifier and an oscilloscope is connected to the output. By keeping the input signal at a constant level and varying the frequency, the output level can be observed on the 'scope and plotted on a graph. There are two points of interest on this graph, labelled as the *lower cutoff* frequency (fl) and the *upper cutoff* frequency (fh). These two points are the specified limits for the amplifier, and the

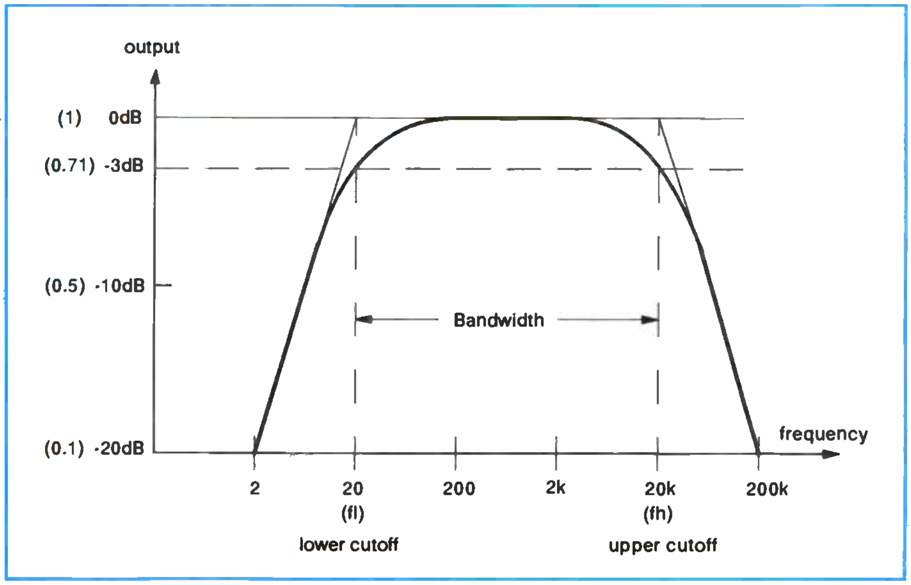

***Fig.1:** The frequency response curve of a typical audio amplifier is shown here, where the bandwidth is around 20kHz. The cutoff points occur when the output level drops to 71% of its original value.*

World Radio History

bandwidth is defined as that range of frequencies from one point to the other.

To find these points by measurement is relatively easy. By definition, the cutoff points are those points where the output of the amplifier falls to 0.71 of its normal output level. For example, if the output of the amplifier is set to 10V peak-peak at 1kHz, then the lower cutoff point (fl) is the frequency that causes the output level to drop to 7.1V as the frequency of the input signal is reduced. In Fig.1, this frequency is 20Hz.

The upper cutoff point (fh) is that point where the output again falls to 7.1V as the frequency is increased; 20kHz for Fig.1.

Before explaining the factors that determine the bandwidth of an amplifier, we need to now explain why the figure of 0.71 is chosen and also the meaning of the quantity dB.

The decibel

The decibel is a measurement that compares two levels. Although originally intended to compare levels of power, it is now also used to compare voltage levels. The 'Bel' (in commemoration of Alexander Graham Bell) is too large for most applications (like the farad) and the decibel is generally used, where 10 decibels (written as 10dB) equals one Bel.

The decibel is based on the logarithmic response of the human ear to the intensity of sound, where 1dB is a barely perceptible change in sound intensity. This is a far more useful way of defining a change, because stating that the power output has increased by so many watts is relatively meaningless unless the original power level is known. Also, the human ear can detect sound levels from around 1mW to many thousands of watts, and writing these values becomes very cumbersome.

To calculate the change in dB, the equation dB = 10log(P2/P1) is used where P1 is the reference power and P2 the power level being referred back to P1. For example, let's say an amplifier is delivering 100W of power into its speakers. If the power output is increased to 300W (say by turning up the volume control), the dB change is 10log(300/100), giving a 4.77dB increase. Thus an increase in output power becomes a positive dB value. If the power is *decreased* by three times (say from 100W to 33.3W), the dB change equals 10log(33.3/100) giving -4.77dB.

It therefore doesn't really matter which power is P1 or P2, providing you know if the change is an increase or a decrease. The dB value will always be the same, regardless of which power is on the top of the fraction. You simply assign the correct polarity, where a minus sign means a decrease and a plus sign an increase. Try it on your calculator...

The interesting value for our purposes is a 3dB change. It has been found by experiment that a 3dB change is just perceptible to the *average* human ear. Anything more is definitely audible, anything less — well, some experts may hear it, most of us won't. By rearranging the equation, we can find the change in power output that corresponds to a 3dB change. The equation becomes P2/P1 = antilog(dB/10), giving an approximate value of two. That is, if the power output level is doubled, (3dB increase) you'll just hear the difference. If it is halved, (3dB decrease) again the difference is just perceptible. Incidentally, the -3dB points on Fig.1 are often called the *half-power* points.

Because power output can be found with the equation $P = V^2/R$, if the value of R remains the same, a change in voltage can also be expressed in dBs. The equation now becomes dB = 20logV2/V1. Notice that the square-law relationship between voltage and power has been allowed for, by increasing the 10 in the equation for power to 20 in the equation for voltage.

It is now possible to find the change in voltage to give a 3dB change. For a positive increase of 3dB, the voltage will have changed by a factor of 1.41, while for a decrease of 3dB (-3dB) the factor becomes 0.71. The curve of Fig.1 shows the voltage change figures in brackets alongside the dB values.

So, putting this all altogether, the 3dB points on the graph of Fig.1 are those points where the output voltage falls to 0.71 (or 71%) of the original value, or where the power output falls by half. Because it is easier to measure voltage than power, such as with the arrangement of Fig.2, it is usual to relate dB figures to voltage rather than power when measuring frequency response.

Before we leave the subject of the decibel, we should explain how voltage gain (or loss) works when expressed as a dB value. If an amplifier has a gain of 10, this means that the ratio of V2 (output voltage) and V1 (input voltage) is 10 times. This can be expressed as a dB value, using the previous equation of 20log(V2/V1). However because V2/V1 equals the voltage gain (Av), the equation can also be written as 20logAv. For a gain of 10, the dB value becomes 20log10 giving 20dB (log of 10 = 1).

If another stage, also with a gain of 10 is connected to the first, the overall gain is 10 x 10, or 100. Converting 100 to a dB value gives 40dB. In other words, to calculate the overall gain of a number of cascaded amplifiers, simply add their individual dB figures.

The diagram of Fig.3 shows an example of how useful this can be. This diagram shows a typical installation for a TV antenna in a poor reception area. Amplifier 1 has a gain of 3dB and could be a masthead amplifier, positioned up on the antenna mast. The coaxial cable, with a loss of 9dB links the output of the masthead amplifier to a distribution amplifier (amplifier 2) which has a gain of 6dB. The tuner in the TV set is

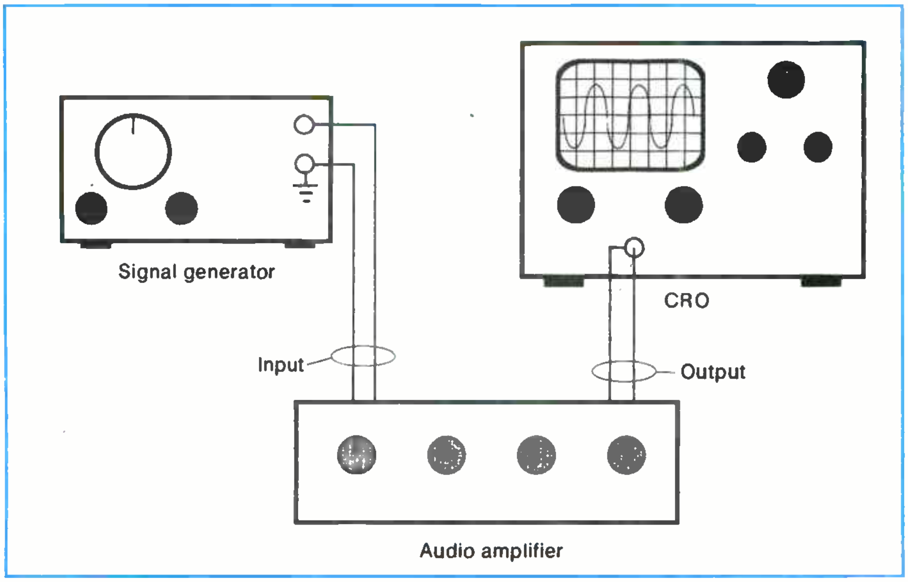

Fig.2: This setup can be used to measure the frequency response of an audio amplifier. The signal generator provides the input signal and the 'scope is used to determine the points when the output level drops to 71% of the midband value.

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amplifier 3, and has a gain of 20dB. The dB gain and loss figures are typical, in which the loss caused by the coaxial cable is compensated by amplifiers 1 and 2. The result is a system with a 20dB gain (or a voltage gain of 10). Imagine trying to work it all out using voltage gain figures!

There is a lot more we could say about the decibel, but we need to move on and show how resistors and capacitors affect the frequency response of an audio amplifier and how the RC circuit can be used as a filter.

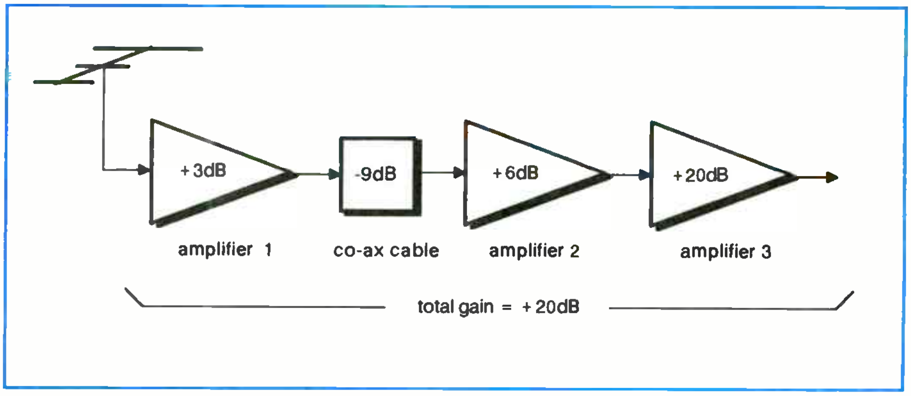

Fig.3: If the gain or loss of each section of a system is given as a dB value, the overall gain or loss can be determined by adding the dB values.

Filters

A *filter* is an electrical circuit that is designed to either pass or reject certain frequencies. There are four basic types of filters: the *low pass*, the *high pass*, the *band pass* and the *band stop*. The first two are used extensively in audio amplifier design, while the band pass and band stop are generally confined to radio frequencies.

There are two important specifications associated with filters — the cutoff frequency (or frequencies for band pass and band stop) and the sharpness of the *roll-off*. We've already described the cutoff frequency as that frequency where a -3dB drop occurs. The sharpness of the roll-off refers to the *slope* of the curve after the -3dB point has been reached and in Fig.1, the slope is -20dB per decade. A *decade* refers to a range of frequencies that extend from one value to another 10 times the first. In Fig.1, the decades are from 2 to 20, 20 to 200 and so on. Fig.4 shows a clearer example, where each decade starts at a power of 10, such as 1, 10, 100 and so on. This method of calibrating the horizontal axis of a graph allows a wide range of frequencies to be included, and most graphs will show four or five decades. There are six decades in Fig.1.

However, this system only works if the *logarithm* of the frequency is plotted. For example, the log of 3 is 0.477, so a frequency of 3Hz is located approximately halfway between 1Hz and 10Hz, rather than one third the distance. Similarly, 30Hz is located halfway between 10Hz and 100Hz.

By now you've seen that logarithms play an important part in this type of work, and most calculators can perform the conversions by simply entering the number to convert, then pressing the 'log' key. Fig.4 shows how -20dB/decade and -40dB/decade roll-off slopes look on the graph. It is also possible to achieve a slope of -60dB/decade, but this is more difficult to achieve.

Low pass filters

The circuit diagram and response curve of a simple low pass filter are shown in Fig.5. This circuit can pass frequencies from DC to its upper cutoff point (fh), and after the cutoff point, the output drops by -20dB/decade. As already described, the cutoff point is the -3dB point.

The operation of the circuit relies on the capacitive reactance of the capacitor dropping as the frequency increases. At DC (or 0Hz), the capacitive reactance of the capacitor will be virtually infinity, so the resistor is therefore the only component in the circuit affecting the output.

As the frequency increases, the capacitive reactance will decrease, and current will now flow through the capacitor, causing a voltage drop across the resistor. This effect becomes noticeable as the value of the capacitive reactance approaches the value of the resistor, and the -3dB is that point when the capacitive reactance *equals* the resistance value.

Because Xc = 1/(6.28fC) and Xc = R, it is possible to determine the value of the cutoff frequency if the values of R and C are known. Let's say R is 1k and C is 1uF. We first rearrange the equation in terms of f, which gives f = 1/(6.28RC). Substituting the values for R and C, we get f = 1/(6.28 x 1k x 1uF), which gives 159.2Hz. Thus a low pass filter with these values will pass frequencies from DC up to 159.2Hz, and thereafter the output drops by 20dB/decade. At 1.59kHz, the output will be down by 20dB, or around one-tenth the value it was before rolloff commenced.

High pass filter

The high pass filter and its response curve is shown in Fig.6. Notice how the capacitor and resistor have now changed positions, and that the output level increases to a maximum as the frequency is increased.

The operation of this circuit is similar

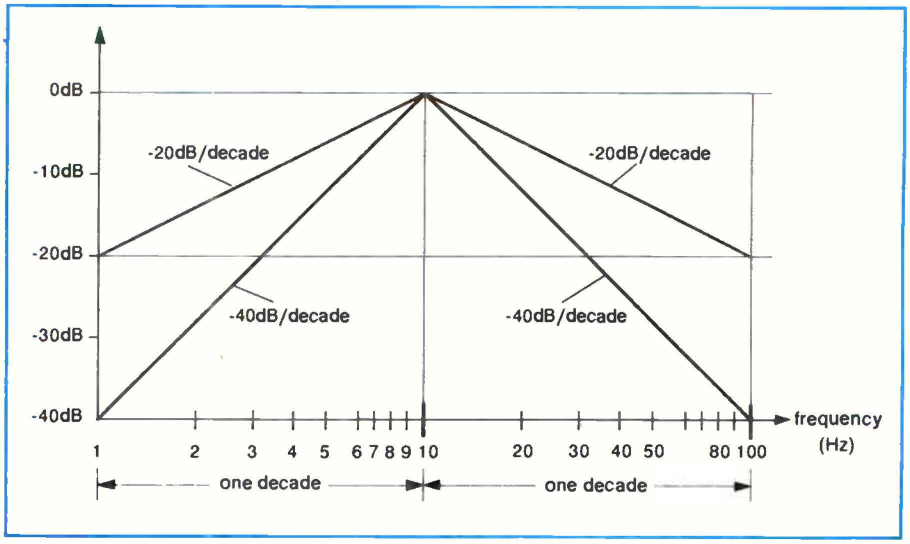

Fig.4: Most filters have a rolloff slope of either -20dB/decade or -40dB/decade. For a perfect filter, the rolloff would be a vertical line.

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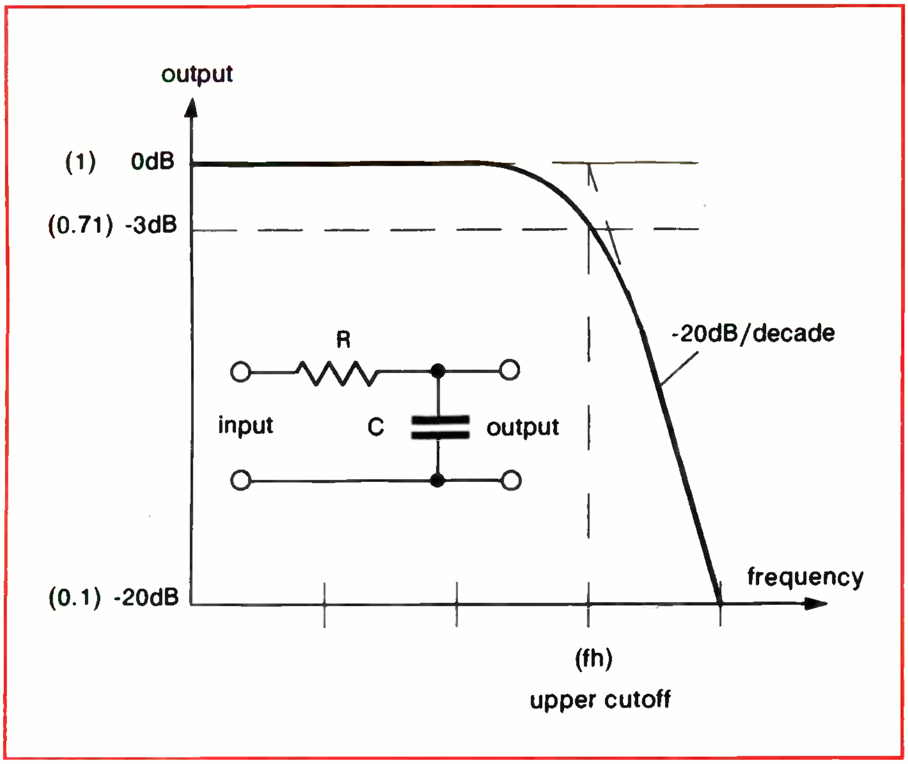

Fig.5: The low pass filter passes frequencies from DC to its upper cutoff frequency, which occurs when Xc equals R. The output then drops by -20dB/decade.

It is beyond the scope of this series to get into a full description of how to calculate the values of all the capacitors in an amplifier, but a simple example will give the idea.

If an amplifier has an input resistance of 10k, and the specifications state a lower cutoff frequency of 20Hz, then the value of the coupling capacitor can be determined. The basic equation of f = 1/(6.28RC) can be used, by rearranging it in terms of C, giving C = 1/(6.28fR). Substituting the values gives 1/(6.28 x 20Hz x 10k) which gives a value for C of around 0.8uF. The nearest preferred value is 1uF.

A low pass filter is formed whenever there is a series resistor and capacitor connected from the resistor to ground (see Fig.5). In an amplifier, there will be all sorts of stray capacitances, such as the capacitance of the shielded leads, the internal capacitance of the transistors and so on. Because the capacitance is fixed by the components themselves, the designer needs to consider the value of R, where R may be the output resistance of an amplifier stage.

About all you can do is to keep the value of R associated with stray capacitance as low as possible. This is particularly important when dealing with long lengths of shielded cable, and a buffer stage that has a low output impedance may be required to prevent the

Continued on page 119

to the low pass filter, except everything is reversed. At DC, the capacitor is an open circuit, so the output of the filter will be zero. As the frequency increases, the capacitive reactance increases, until the value of Xc equals the value of R. This point is the -3dB point, and thereafter, the capacitor can be regarded as a short circuit.

As before, the cutoff frequency can be calculated if the values for R and C are known. Again the cutoff point (fl) occurs when Xc equals R, so the equation used for the low pass filter also applies to the high pass filter. Using the values from the low pass filter, fl again equals 159.2Hz, and in this case the output for frequencies above this point is passed with virtually no loss.

The implications

While RC filters are useful in a range of applications, you can see that whenever a capacitor and resistor are combined, a filter is formed whether you want this or not. In an audio amplifier, a high pass filter is created whenever a capacitor is used to couple two stages together. As well, if a capacitor is placed across a resistor, such as in the emitter circuit of a transistor, a high pass filter is formed.

It is therefore important to use the correct values for coupling or bypass capacitors in an audio amplifier, to ensure the lower cutoff point of the amplifier is not too high. If these capacitor values are too low, the lower cutoff frequency will be high, giving a sound output that lacks bass content.

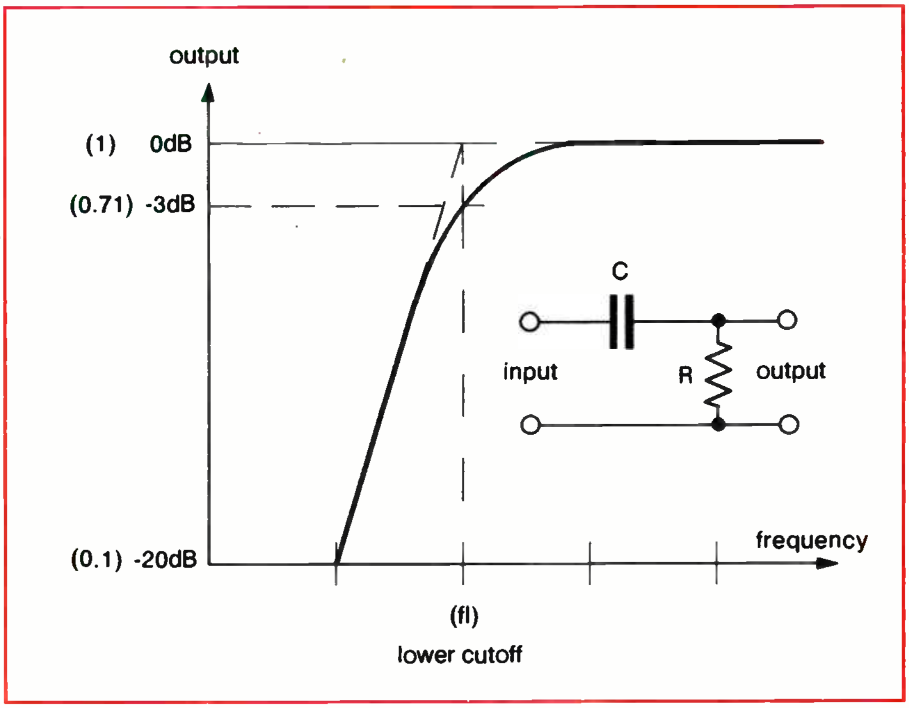

Fig.6: The high pass filter blocks DC and only passes those frequencies when Xc equals or exceeds the value of R.

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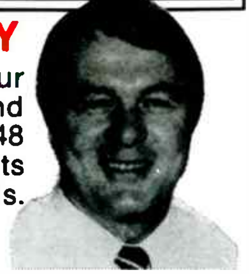

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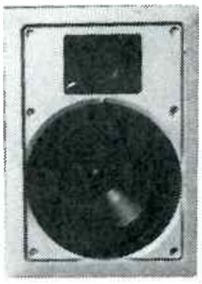

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Here's a simple project that monitors the power drawn from a 'master' socket and automatically switches on a 'slave' socket. It is versatile, because it can monitor one or several appliances plugged into the 'master' and switch on one or several devices plugged into the 'slave'. Ideal for Hi-Fi's and computers.

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NEW FOR '92

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K 5015 **$229.00**

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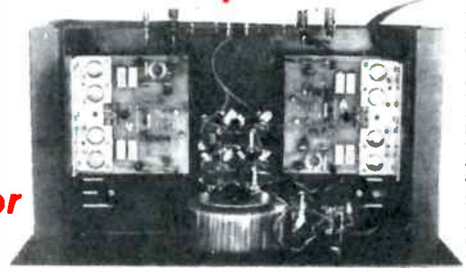
Studio 200 Series 100 Watts Per Channel Power Amplifier

K 5010 **$425.00**



The sound quality and overall specifications of this amplifier will compliment any sound system. The overall mechanical design and pre-drilled chassis means that this kit virtually falls together and should only take the average constructor about 6 hours to build. Why pay hundreds of dollars when you can build it yourself and end up with a quality professionally finished amplifier?

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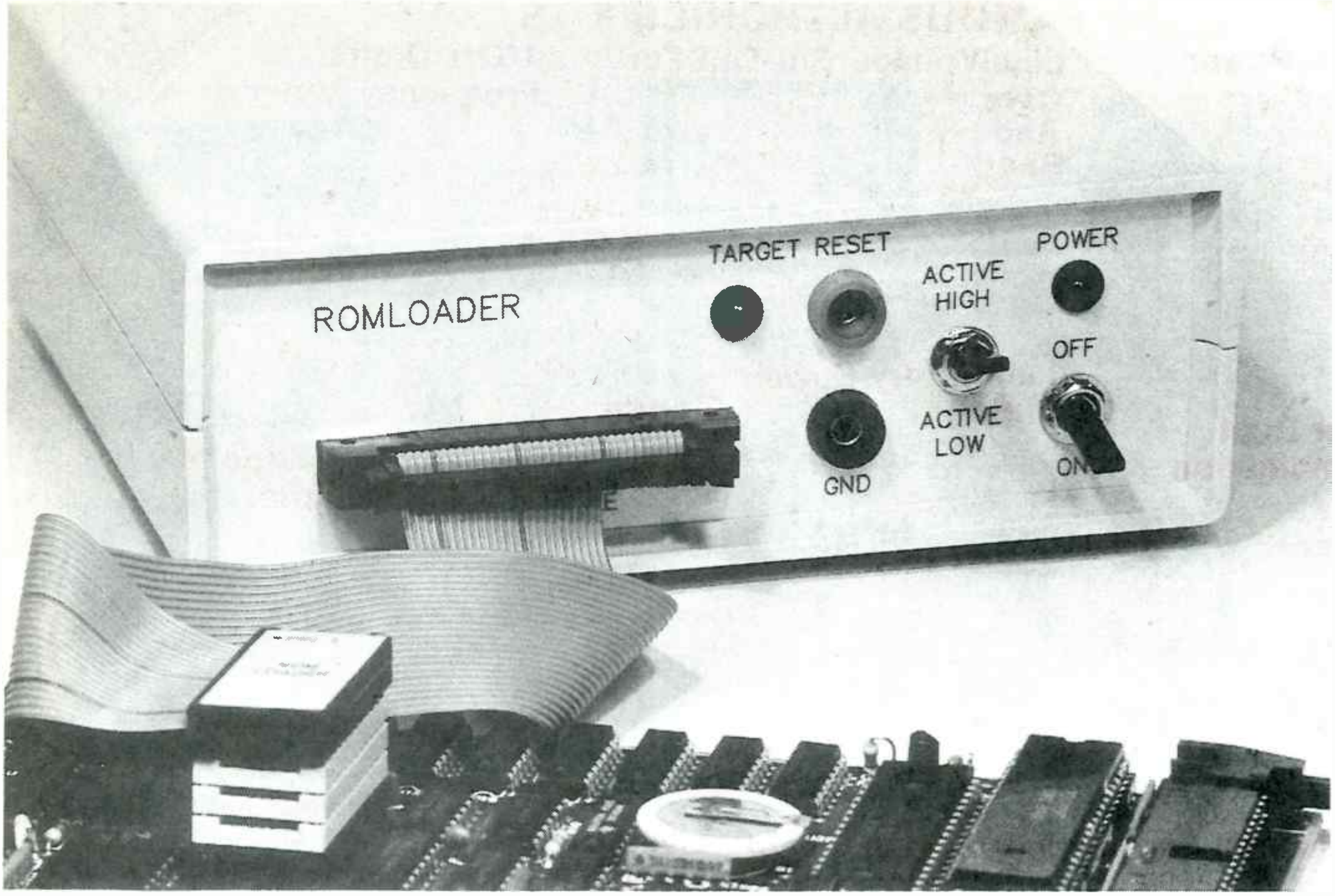

The ROMloader, an EPROM Emulator - 1

Are you sick of burning EPROMs every time you develop software for a dedicated microprocessor system? This project allows you to substitute a RAM for that EPROM and serially load data into it from your PC. Instead of taking minutes, it takes seconds!

by PETER BAXTER

Developing microprocessor-based projects can be quite challenging and rewarding, if you have the right tools. Unfortunately most of us don't, so we go through the EPROM burn cycle hundreds of times.

Not any more! No more do I assemble the software, erase an EPROM, program (burn) the EPROM, remove the old EPROM, install the new EPROM, test the software, find it doesn't work, modify the software and then go through the whole cycle again. I now use the ROMloader!

The ROMloader is essentially an EPROM emulator. But what is an emulator? To emulate is to imitate. We can't get inside computer chips to read the registers, program counters or the flags. So we need something that imitates the real thing, while allowing us to see what is happening inside. This device is called an emulator.

When developing a microprocessor-based system, a microprocessor emulator might be used. For example, let us consider a Z80 system that has a Z80 CPU and a 2716 EPROM. The Z80-CPU microprocessor chip is removed and a Z80-CPU emulator installed. The

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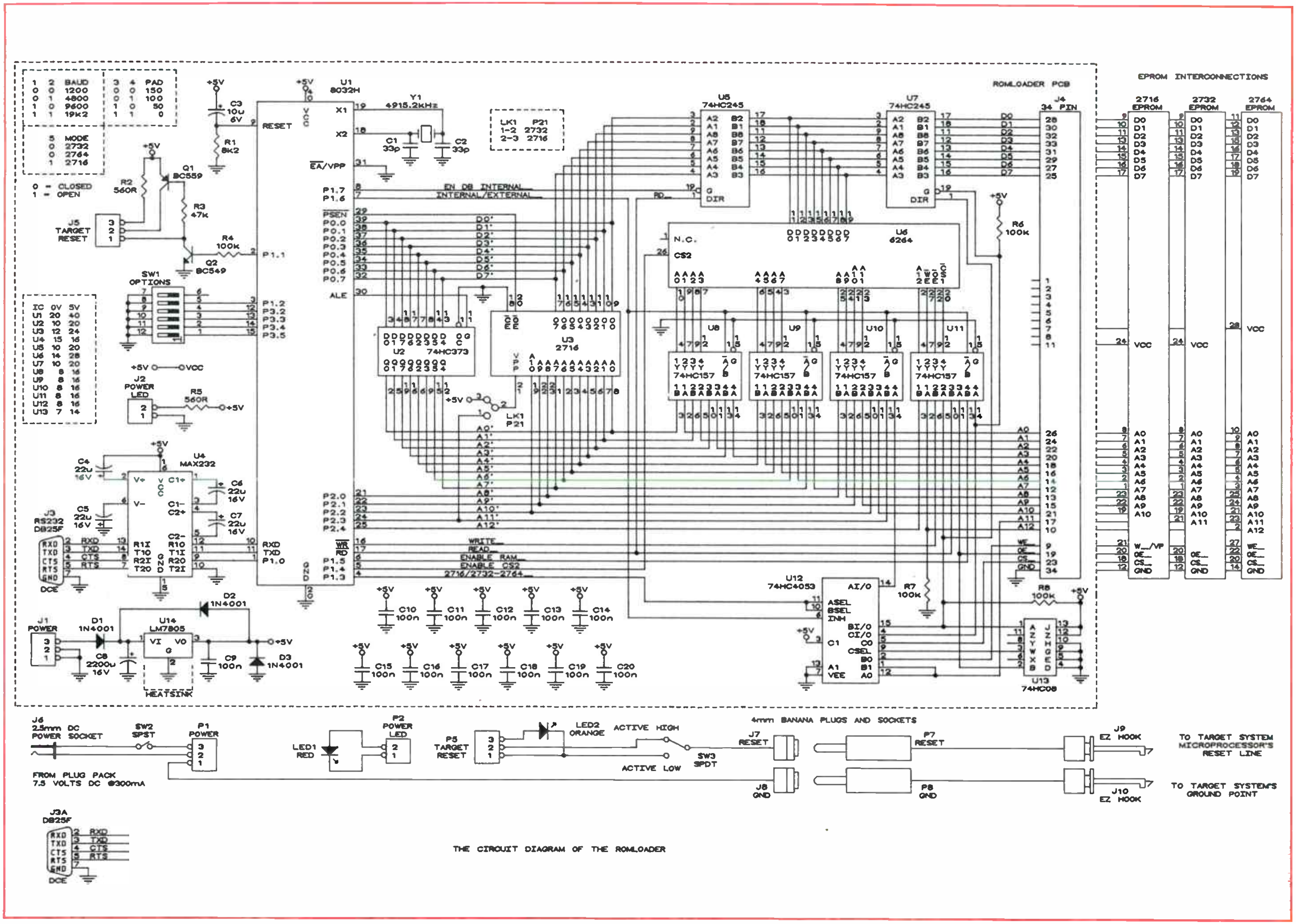

Here is the complete schematic for the ROMloader, which is itself based on an 8032 microcomputer chip (U1) running under a 'firmware' program stored in EPROM U3. Static RAM U6 is used to emulate the target system's EPROM, being connected into the target system via a cable mating with connector J4.

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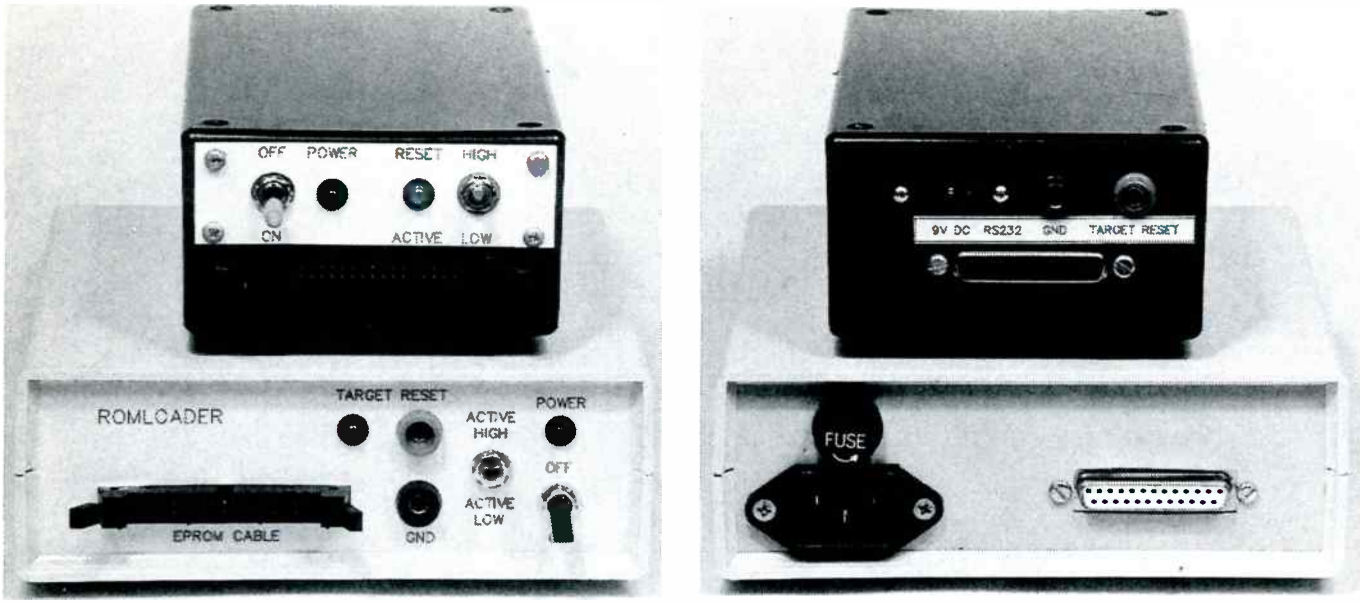
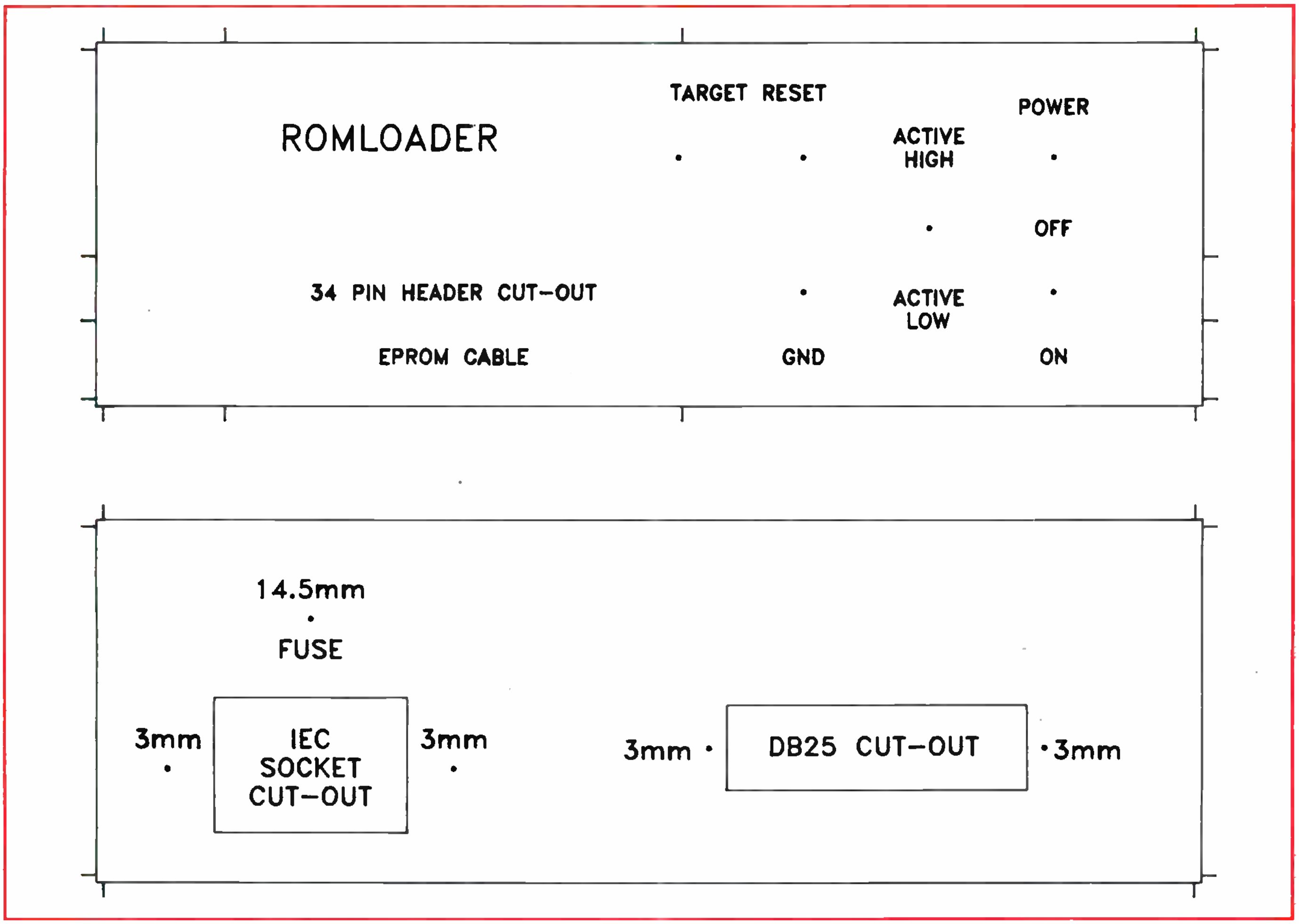


Front and rear views of both versions of the ROMloader, as built up by the author. As you can see the unit can easily be squeezed inside a standard low cost Jiffy box, although the larger case version looks rather better and allows all of the controls and test signal outlets to be mounted on the front panel.



Here is the author's artwork for the front and back panels of the larger version of his ROMloader, reproduced actual size for those who wish to make photocopies.

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2716 EPROM might also be removed and a 6116 RAM installed in its place.

The emulator may either load the freshly assembled program into the 6116 RAM or execute it directly from within its own memory. It takes over control of any CPU operations and is able to halt program execution at any point, read any of the registers, read any RAM including the 6116, read peripherals or whatever. New conditions can be set up and the program restarted from any point.

As you may appreciate, microprocessor emulators offer a good insight into what is really happening. But they are expensive, ranging from $1500 up.

An EPROM emulator is very different. It replaces the EPROM during project development. While the Z80 CPU is not replaced, the 2716 EPROM is replaced with the EPROM emulator, which electrically looks like a 2716 EPROM or a 6116 RAM.

The freshly assembled data is quickly loaded into this '2716'. The Z80 CPU is released from a reset state and program execution begins.

You can't look at registers, peripherals or restart from any point, but you can quickly reload new data and test it. You can also stop execution and then restart from the beginning. The target system's microprocessor can write into it and you can see what was written.

ROMloader is microprocessor independent, meaning that it can be used on virtually any target system. It connects to your host computer via a simple RS232 serial cable. It only has to be plugged in once. It is small, simple to use and inexpensive to build. It is a big timesaver and saves frustration with EPROMs. Once you have used it, you won't want to return to burning EPROMs!

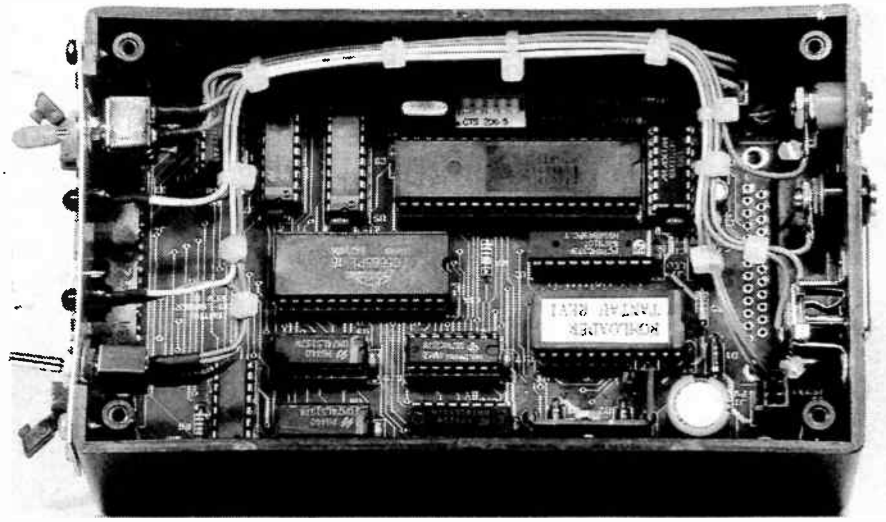
If you currently need to burn an EPROM every time you test a program modification, then this project is for you!

Features

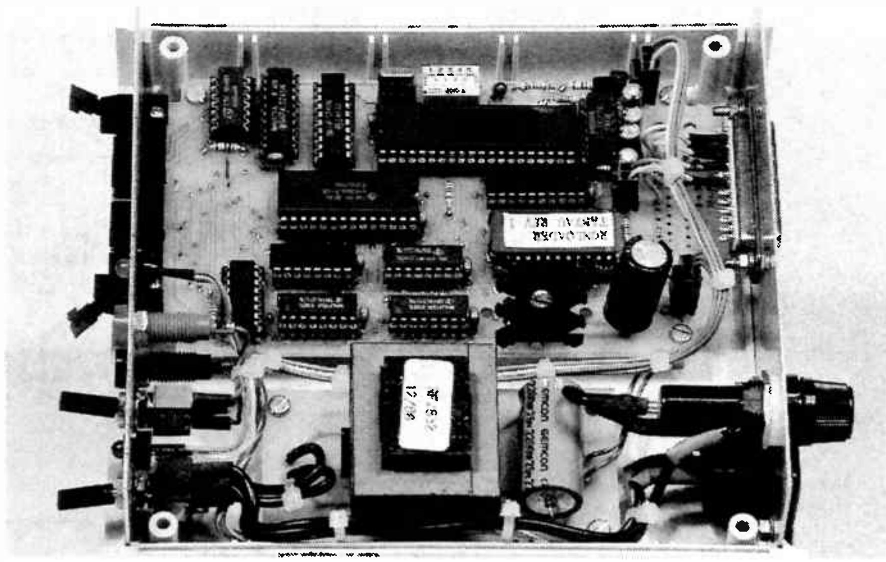
The ROMloader is designed to emulate standard Intel 2716, 2732 and 2764 EPROMs. Other non pin-compatible EPROMs can also be emulated, by simply modifying the 'EPROM' cable. It will also emulate 6116 and 6264 RAMs.

The ROMloader accepts serial data files in Intel Hex, Motorola Hex and Xmodem format through the RS232 port.

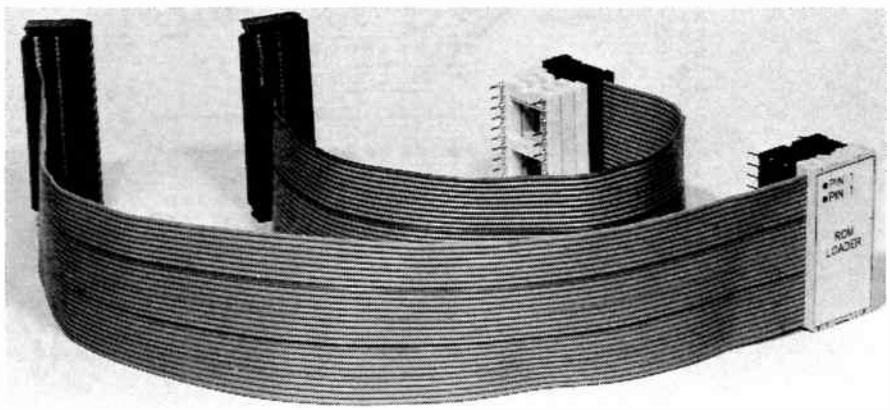
It also outputs files in Xmodem format, which can then be saved to disk. Baud rates of 19200, 9600, 4800 and 1200bps are available. Both hardware and software handshaking is available.



Inside the Jiffy box version. As you can see things are rather tight, but there's still room to fit everything in. This version operates from a plug pack supply.



And here's the inside of the larger case version, for comparison. This version has room for a small power supply module, seen here at lower centre.



This shot of two of the author's EPROM cables shows how the ribbon cables are 'bottom justified' at the J4 connector end. It also shows how machined-pin sockets are used as extenders at the EPROM plug end.

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ROMloader

With only 10 commands in total, it is simple to use.

Circuit description

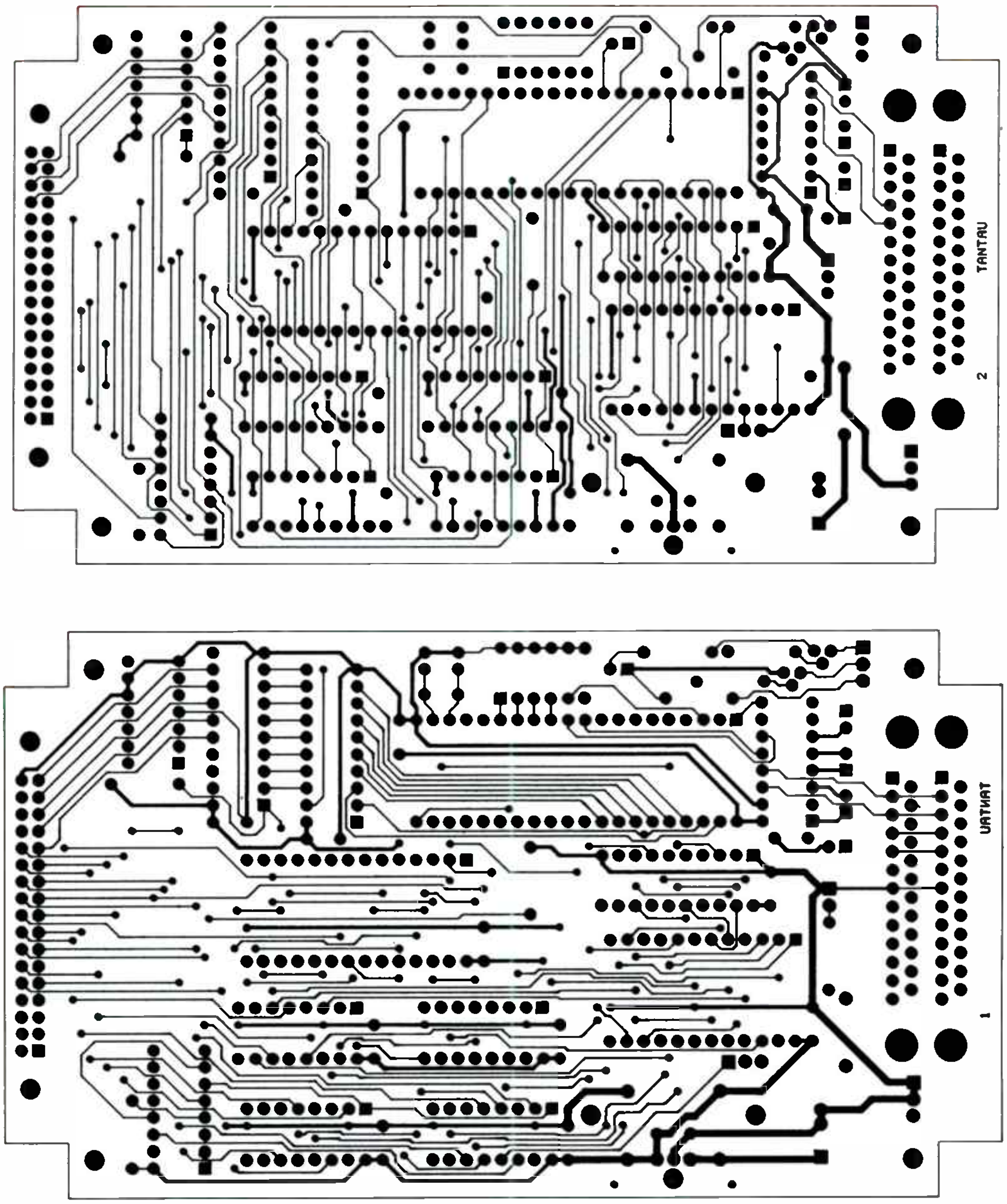
The ROMloader's function is to serially receive data from a 'host' computer, load it into a RAM and upon command, allow an external 'target' processor to access that RAM.

The circuit is itself based on the Intel 8032 microcomputer chip (from the 8051 family), for a variety of reasons. Within one 40-pin integrated circuit, there are I/O ports, timers, RAM, CPU and more importantly, a serial communications port. I would have liked to use the 8752 EPROM version, but at $80 each, they are far too expensive. The 8032, a 'ROM-less' version of the 8052, is affordable at around $8 each and spacewise, we can afford to include an address latch U2 and an EPROM U3, which contains the ROMloader's control program, on the PC board.

The 8032 was chosen over the 8031 because of the RS232 baud rates. Unfortunately, the baud rate timer within the 8031 divides the crystal by 12 before dividing down. This would have required an 11.059MHz crystal, which is virtually unobtainable for most people.

The 8052, being an enhanced version of the 8051, allows the baud rate to be generated through straight division by 2. This allows an RS232 crystal of 4915.2kHz to be used, which is fairly common.

The 8032 has internal pull-ups on all of its I/O port pins, allowing DIP switches (SW1) to be connected directly. These switches select baud rates, number of padding characters and the initial mode of operation (either 2716 or



The etching patterns for both sides of the ROMloader's PC board are shown here actual size for those who wish to etch their own boards. The component size is at top (2), with the solder side (1), below.

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PARTS LIST

PCB	Printed board, 150 x 85mm
J1,J5	3-pin connector base
J2	2-pin connector base
J3	DB25 socket, right angle PCB mount with mounting screws
J4	34-pin DIL header, right angle PCB mount with eject levers, mtg screws
LK1	3-pin Bergstrip and link
SW1	5-way DIP switch (or 6-way)
SW2	SPST miniature toggle switch
SW3	SPDT miniature toggle switch
Y1	4.9152MHz crystal

Semiconductors

D1,2,3	1N4001 diode
Q1	BC558 or similar PNP
Q2	BC548 or similar NPN
U1	8032H microcomputer
U2	74LS373 or 74HC373
U3	2716 with ROMloader firmware
U4	MAX232 or ICL232
U5,7	74LS245 or 74HC245
U6	6264 SRAM, 150ns or less
U8	74HC157
U9,10,11	74LS157 or 74HC157
U12	74HC4053 (must be fast)
U13	74LS08 or 74HC08
U14	LM340T-5.0 or LM7805
LED1	3mm LED, red
LED2	3mm LED, orange

Resistors

All 1/8W 10%:

R1	8.2k
R2,R5	560 ohms
R3	47k
R4,R6,R7,R8	100k

Capacitors

C1,2	33pF NPO ceramic (0.1")
C3	10uF 6V tantalum (0.1")
C4,5,6,7	22uF 16V electrolytic
C8	2200uF 16V RB electrolytic
C9-C20	100nF ceramic (0.2")

Miscellaneous

Jiffy box, 150 x 90 x 50mm; DIP switch settings label; 4 x 10mm tapped spacers and 8 x machine screws to suit; 2.5mm DC power chassis socket, screws to suit; 2 x 4mm panel mount banana sockets; bolts and nuts for DB25; TO220 heatsink, mounting bolt and nut, silicon grease; label for rear panel; 4 x stick-on rubber feet; 4 x No.4 x 6mm self-tapping screws; aluminium sheet 0.8mm thick x 90mm x 29mm; bezels to suit LEDs; front panel label; 2 x 3-pin crimp housings; 2-pin crimp housing; crimps to suit; hookup wire, etc.

Accessories

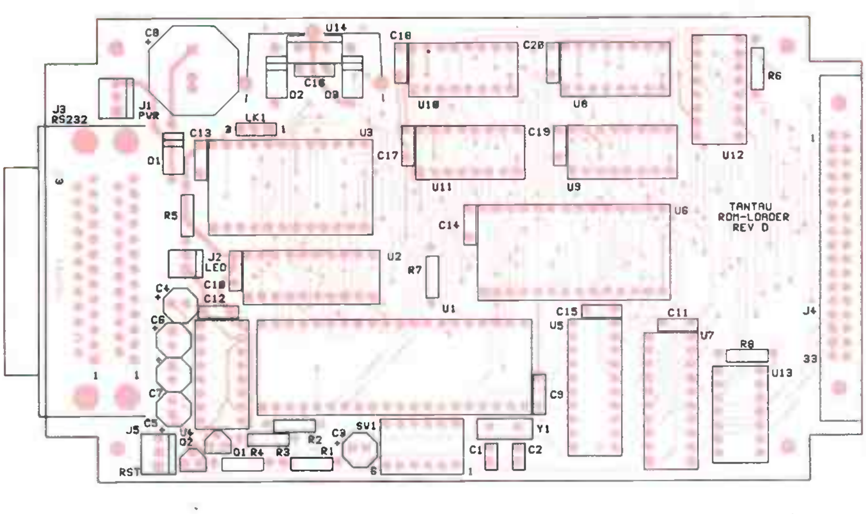
Plug pack power supply, 7.5/9V DC @ 500mA or 300mA; DB25 to DB25 cable to connect to host computer; 2 x 4mm banana plugs, one red and one black; 2 x small EZ-hooks, one red and one black; hookup wire; 26/30/34-pin IDC connector; 300mm x 34-way flat IDC type ribbon cable; 24/28-pin DIL connector plug; DIL connector label; 3 x 24/28-pin IC sockets with machined pins.

NOTE: The author can provide the following parts to constructors. Supplying a 'size 2' stamped, addressed post bag with your order will save $5, while supplying a 1.2M DOS formatted floppy disk will save a further $5 if you want the software/firmware source code.

PCB	$30
Intel P8032AH	$ 8
Program in used 2716	$15
ROMloader Source code on disk (360k)	$20
Procomm Communication package (1.2M)	$ 8
74HC4053 IC	$ 2
Label artwork negatives	$ 5
Scotchcal labels (state version)	$10
Packing and postage	$ 5

Send your requirements to:

Tantau Australia,
PO Box 206,
Gordon, NSW 2072



And here is the overlay diagram for the ROMloader, showing the location and orientation of the various components.

2732/2764 mode). The 8032 also controls the transistors used to reset the target system's microprocessor. In most situations, either of these transistors will be shorting out a capacitor in a RC network controlling the target system's microprocessor reset pin.

The MAX232/ICL232 chip U4 looks after all RS232 line driver functions.

The 6264 8K RAM was used here (U6) because it is inexpensive and readily available. This RAM must be accessed by both the 8032 and the target system. The 74LS157 data selectors U8-U11 switch the address and control lines between the 8032 and the target system. The 74LS245 bidirectional bus drivers U5/U7, with tri-state outputs, are used on the data lines. The 8032 has complete control of U5, whereas the target system has control of U7 via U12 and U13.

Whenever the 8032 is reading or writing to the RAM, U12 is disabled — preventing the target system from controlling the data bus. Once the target system is given access to the RAM, U12 and U13 decode the target system's read, write, chip select and VPP lines according to the mode of operation.

The mode of operation primarily deals with the 2716's VPP line. On the 2716 pin 21 is VPP. On the 6116, pin 21 is RD/WR-bar. On the 2732 and 2764, pin 21 is A11 and on the 6264, pin 27 is WR- bar.

Therefore, when emulating a 2716 in 2716 mode, the target system's pin 21 is connected to the RAM's pin 27 and the RAM's A11 is grounded. In 2732/2764 mode, all connections are basically the same as the RAM.

U12 needs special mention, as the chip select line toggles one of its switches very fast. A standard 4053 is too slow, so the 74HC4053 must be used. Also U11 must be a 74HC157, because of the pulldown resistor R7. Otherwise U2, U5, U7, U8, U9, U10 and U13 can all be 74LS devices.

Link 1 is available for possible future software expansion to a 2732 EPROM. For the moment it should be set up as shown for the 2716.

Construction

For this project, I have had produced a very high quality, double sided, plated-through PCB, with a solder mask and component overlay. The PCB has been designed to fit into a modified 'jiffy' box. I have also installed one of my prototype PCBs into a more attractive larger cream coloured project case, that matches most computers (see photo). This is described later.

Assembly of the PCB should be rela-

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ROMloader

tively straightforward. I suggest that you solder in the IC sockets first, install all of the ICs and then install the bypass capacitors.

This will ensure that everything fits nicely, as the bypass capacitors are a bit too close to the ICs. Also solder in the crystal before the 33pF capacitors.

The LM7805 voltage regulator must have a heatsink. The board was designed to accept the Jaycar HH-8504 TO220 heatsink, but will accept many others. Use a light smear of heatsink compound between the regulator and the heatsink, then bolt them both together firmly.

The board will accept a short or long, right angle PCB-mount DB25 female connector. To reduce the possibility of connection stresses cracking the DB25's solder joints, use bolts to secure the DB25 to both the PCB and the box wall.

Some constructors may prefer to use a panel-mount DB25, mounted to the box and connected via wires to the PCB to reduce cost. Bolts should also be used to secure the 34-pin IDC connector to the PCB. The 2- and 3-pin connectors used in this project are fairly new to most retail outlets, but Dick Smith Electronics carries them.

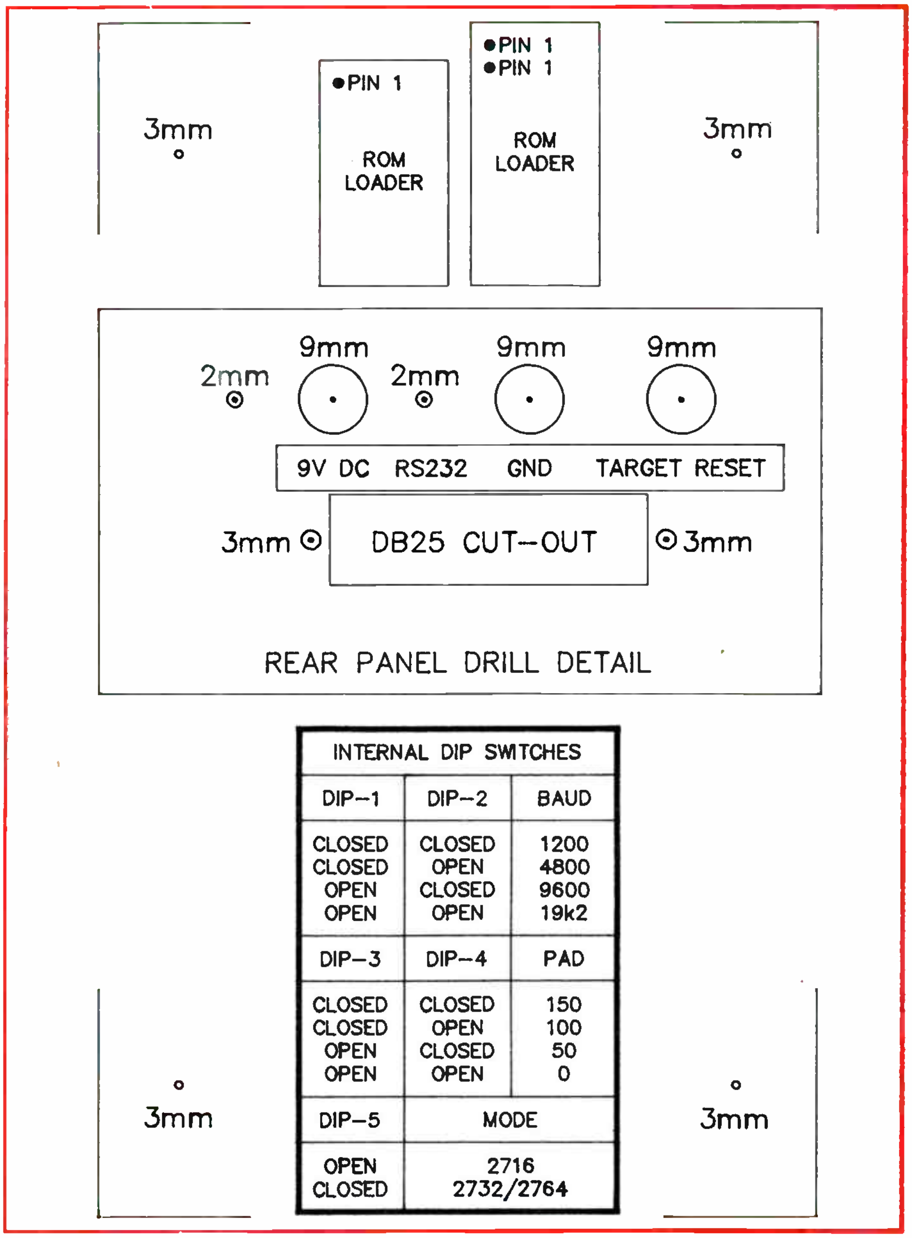
When purchasing the jiffy box, select one that has few internal slots such as the Altronics-H10101/Jaycar-HB6011 version. The Dick Smith Electronics box has far too many slots to be practical for this particular project, as these moulded PCB slots have to be chiselled out — so the fewer the better!

The 'slot removal' can be done quickly by using the inside corner of some brickwork or stairs to hold the box, while you bash away on the chisel. Wrap newspaper around the box to prevent damage to its surface. Firm yet careful chiselling will have the job done within five minutes, for the recommended box.

I had some boxes in which the sticky tape holding the lid on had left glue residue on the box. From experience, don't use freon to clean it off — this will damage the box's finish. Use ethanol or methylated spirit.

The box will now need to be cut and drilled. To save you having to measure up the box, photocopy the mechanical drawings, cut them out with a knife and sticky tape them accurately over the appropriate box panel.

Centre punch the holes and any slot corner points. Remove the paper and scribe the slot shapes. Now drill and file out the box. I found the easiest way to work on these boxes is to secure the box to a table with a G-clamp.



INTERNAL DIP SWITCHES		
DIP-1	DIP-2	BAUD
CLOSED	CLOSED	1200
CLOSED	OPEN	4800
OPEN	CLOSED	9600
OPEN	OPEN	19k2
DIP-3	DIP-4	PAD
CLOSED	CLOSED	150
CLOSED	OPEN	100
OPEN	CLOSED	50
OPEN	OPEN	0
DIP-5	MODE	
OPEN	2716	
CLOSED	2732/2764	

There are a number of drawings superimposed here: a drilling guide for the PCB mounting holes, artwork for the Jiffy Box version front panel, the DIP switch setting table and labels for the EPROM plugs and internal EPROM.

The front control panel plate needs to be marked and drilled too. Once done, the label can be affixed to the panel. To give the label a clean edge, put the label side of the panel face down on some newspaper and run a knife along the panel edge.

Use a small sharp knife with a fresh blade. Cut out the switch and LED holes. Finally, using a black texta pen, black out the aluminium edge so as to make the aluminium invisible. Mount the switches and LEDs.

When the box is ready, mount the PCB inside and bolt the DB25 connector to the box's rear panel. This will reduce stress on the PCB during connection and disconnection. At this point, do all of the interwiring — keeping it tidy and away from the heatsink. Next mount the front panel using self-tapping (PK) screws.

Towards the end of project development, I realised the ROMloader could be installed in many different types of boxes. The cream coloured box is an Arista UB-16, obtained from Geoff Wood Electronics. Its extra space inside allows for a transformer to be mounted.

I used a surplus low profile PCB mount transformer, with a rectifier and capacitor on a simple PCB. There are so many options available here that I must leave it up to individual constructors to use their own resources.

The PCB is a few millimetres too short to fit into this box perfectly, so I

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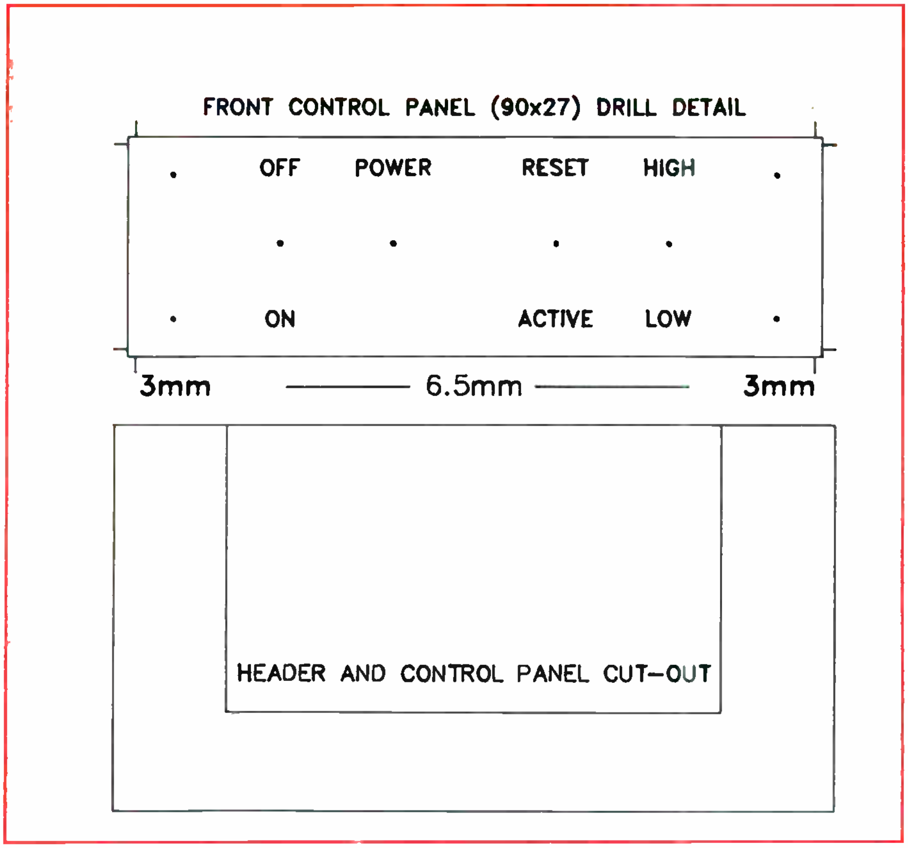

Finally, here are drawings (again actual size) to guide you in drilling the holes for the Jiffy Box version's front panel, and cutting out its rear panel.

pushed the board up against the front panel and used a panel-mount DB25 with interconnection wires. Again, use the mechanical drawings to mark the panels.

Finally, we come to the DIP switch. The switch label can be affixed to the bottom of the box, where it is out of sight until you need to refer to it. It could also be stuck inside the box. Some constructors might also like to mount the DIP switches under the PCB, so they are accessible through a hole cut in the bottom of the box. A few constructors may be able to make their own labels from scratch. Unfortunately, photocopying the magazine's labels doesn't give quality results. I will be able to supply 1:1 negatives of the artwork for those who want them. I can also supply complete 'Scotchcal' labels too. Just state whether you are building a 'jiffy box' version or an 'Arista box' version. If you take care in constructing the ROMloader, you will have a development tool that will last you for many years.

The second of these articles will cover making the interconnecting cables, hooking the ROMloader up to your host computer and target system, setting up the hardware and software, and how the ROMloader is used. ■

Electronics Australia's latest publication:

PC-BASED

CIRCUIT SIMULATORS

AN INTRODUCTION

by JIM ROWE

Computer programs capable of simulating the performance of complex analog circuits can now be run on many personal computers, heralding a new era in the design of electronic equipment. In the future, much of the tedious design hack-work will be performed on a PC, providing faster and more accurate results than bench testing.
Find out more about this rapidly growing technology, with our new publication *PC-Based Circuit Simulators*. Based on a popular series of articles run recently in the magazine, it provides an easy to read introduction to circuit simulators, plus an unbiased evaluation of the main simulation packages currently available.

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READER INFO NO. 16

Software Review:

PROGRAM TEACHES THE BASICS OF 'C'

Still finding it difficult to get a good grasp on programming in C, from conventional textbooks? Don't despair, because the Waite Group has developed a new low-cost software package called *Master C*, which turns your PC into a teaching system for this popular language.

by JIM ROWE

When a sample copy of the Waite Group's *Master C* arrived at our office with a parcel of other technical books for review, we thought at first that it too was another conventional textbook on C programming.

We noticed that it included some floppy disks in a pouch inside the back cover, but then quite a few modern books come with a disk or two — usually containing source listings of sample programs discussed in the text, to save you having to key them in, before compiling and trying them out.

It was only when we actually came to review *Master C* that we made the first discovery: it isn't so much a book with a couple of support disks, but a teaching program on disks — with a support and reference manual.

In fact most of the 'book' part of the package is a detailed reference manual to generic ANSI, with a small section at the front forming a user manual for the

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Master C program itself. Then when we loaded it into one of the office PC's and fired it up, we made the second discovery: it's a good deal more than just an 'electronic book', with friendly computer-aided learning (CAL) features that almost reach the level of a dedicated human teacher. In short, it's a most interesting and impressive package.

But I'm jumping the gun a little. First a few facts and figures about the *Master C* package itself.

System requirements

Master C comes on four 360K diskettes, along with the 232-page User/Reference Manual. It's designed to run on virtually any PC/XT/AT compatible, as long as it has 384K or more of system memory, DOS 3.0 or later, at least one floppy disk drive as well as a hard disk, and either a monochrome or colour video adaptor (although things will be a lot easier to follow in colour).

You do need to have a reasonable amount of free space on your hard disk, though, because when fully installed *Master C* takes up about 2.2 megabytes. (In case you're wondering, the manual explains that it is stored on the four 360K distribution floppies in compressed form.) Installation is done automatically, by an installer/expander supplied on the first floppy.

The authors

The people behind *Master C* are Mitchell Waite, founder and president of the Waite Group, and well-known author of many computing books; Dr Stephen Prata, Professor of Physics and Astronomy at the College of Marin, in Kentfield, California and also a prolific author on computer programming; and Rex Woollard, an expert on computer-aided learning who teaches at Sir Sanford Fleming College in Peterborough, Ontario in Canada.

From the comments made in Mr Waite's preface, it appears that *Master C* is a development from the very successful Waite Group textbook *C Primer Plus*, with Rex Woollard having played a major role in turning that book's material into a PC-based CAL course. The project apparently took over two years.

What it does

Master C is a complete CAL course on all of the essentials of ANSI standard C. It can be used in conventional 'linear' fashion, taking you through a sequence of 15 lessons or 'chapters' which begin with basic programming concepts and take you right through to file I/O, storage classes, structures, the C preprocessor and the standard C function library. When used in this way, it's estimated to require a total of between 31 and 40 hours to work your way through the material.

Needless to say, you don't have to work through the course in one marathon sitting! The package lets you break off at any time, with your current position and learning status to date both saved to disk. Then when you fire up *Master C* again for your next session, it begins automatically where you left off.

For those like me with limited time to squeeze in learning sessions, the package can even advise you in advance how long a selected lesson is likely to take, along with its particular learning objective...

Although this kind of use is probably most appropriate for the newcomer to C, it isn't the only way that *Master C* can be used. For example there's nothing to stop you jumping ahead to a particular chapter, if you wish, to learn a topic of particular interest ahead of the others.

Another feature of the package is an on-line C glossary, which can be used at any time to look up information on a particular C word — and if you wish, receive a short 'refresher lesson' on its correct usage.

People who are already familiar with C, but a little 'rusty', can also use *Master C* to review the course quickly, and only receive lessons on those aspects of the language where they're weak. This can be done by jumping straight to the 'Review' sections at the end of each main chapter; then if you can't answer the quiz questions, the package will give you the option of jumping back for refresher lessons...

In short, then, *Master C* is quite flexible and can be used in a number of different ways. But that's not all; it also offers a number of noteworthy features in terms of aids to learning, and user friendliness.

Present at the bottom of the screen, most of the time, is an 'option bar' menu listing your currently available options. Much of the time, when *Master C* is being used in linear fashion, you generally choose either 'Forward' to pass to the next stage, or 'Back' to check a previous one. But often one or both of two other options will be flashing to attract your attention: 'Note' and/or 'Example'. If you press the appropriate key, these result in the display of additional screen windows with helpful further information or program examples. You return to the main lesson screen by pressing 'Refresh'...

Needless to say, the package checks your comprehension of the material regularly by means of quiz questions — a good feature, because it forces you to pay attention. Most often the quiz questions call for you to type in a 'true' or 'false' answer, or the name of a function, or perhaps a complete C statement — although at times you're asked to work your way through a complete small program, with your accumulated statements building up in one screen window on the right, while you're being prompted to supply each new step on the left.

A claimed feature of *Master C* is its 'sophisticated answer judging', whereby it has the ability to judge if your answer to a quiz question is correct, even if it is not expressed in one particular way. According to the manual it can accept wrongly spelt words, poor grammar, abbreviations, 'rough approximations' and a variety of alternative answers.

The package is also designed to be able to analyse incomplete and incorrect answers, and give you helpful advice or hints. For an incomplete answer this might be along the lines "You are correct so far; please continue:". On the other hand if your answer is wrong and it can analyse where the error lies, you may get a response like "No. Remember that... Try again:"

More about these features shortly.

Other features of *Master C* include an online 9-digit scientific calculator, and an on-line 'Tutor' for the package itself (for those unfamiliar with using this kind of CAL program). A tutorial about the tutor!

Incidentally you can get a printout at any time of program fragments, notes or examples that are on the screen, simply by hitting the 'Print Screen' key. Assuming you have a printer, of course...

So it's evident that a lot of planning and effort has gone into making *Master C* a friendly and easy to use learning package. But what's it like in practice?

How we found it

On the whole, we found it lived up to its promise surprisingly well. The course material it provides on C is generally well organised and presented, and after working through it the reader/student should have a sound basic knowledge of the language.

The 'sophisticated answer judging' and overall CAL methodology is also very impressive in most places, giving the package quite a good pseudo-human 'persona'. In fact at times you tend to forget that you're only interacting with a program. The authors are to be congratulated for this achievement, which un-

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doubtedly makes *Master C* very suitable for use by individuals for private study.

All the same, though, it does still have a few shortcomings, some of which can be quite irritating. There are a significant number of spelling mistakes and typo's, for example, and even a few grammatical errors. Somehow these seem particularly incongruous in a program which a good deal of the time has the persona of a somewhat pedantic teacher...

Although in most places the program's flexibility in judging your quiz answers is very good, there are occasions where it seems very rigid and inflexible. For example in chapter six, it asks a question about the function of *indentation* in C programs. It wouldn't accept the answer 'visual clarity only', and eventually revealed that the 'correct' answer is 'It aids the human reader in understanding program structure'.

Earlier in chapter five it wouldn't accept the answers 'unary minus' or 'unary minus sign', and insisted that 'unary - sign' was the only correct answer to its question about the 'second' use of the '-' operator.

Similarly back in chapter three it asks you to list the three members of the floating-point data type variable family, in order starting at the smallest. It wouldn't accept 'float, double, long double', but stated that the correct answer was 'float double long double' — exactly the same apart from the commas, which if anything are desirable as delimiters!

There are a few other cases where the quiz questions are either vague or slightly confusing, or where it's not clear exactly what kind of answer is required. There are also a few cases where the 'full' or 'correct' answer, given in response to your answer, is either not really the answer called for by the question, or strictly incorrect.

For example in chapter six a question about *do while* loops calls for a 'true or false' answer, yet the supposed 'full answer' given is 'A *do while* loop is always executed at least once'. Similarly in chapter seven a question asks what value a particular integer variable should have in order for a logic relational test to give a 'true' answer. The correct answer '9' is accepted, but the supposed full answer is wrongly given as 'nine'.

For an Australian reader/student *Master C* also comes over in places as rather precious and/or patronising, with its responses when your quiz answers are judged correct: "Good work, Jim!", "Super!", "Perfect!" and so on.

One can't criticise this in terms of positive-reinforcement learning psychology, yet at times it does seem a bit gushy and overdone by Australian standards.

But these criticisms are perhaps a bit carping in themselves. Considered overall, *Master C* really is a well planned and easy to use learning package, and a very good example of what can be achieved with CAL in the PC environment. If the Waite Group people can fix those remaining little spelling and grammatical errors, and make it just a bit more friendly and/or flexible in places, it will be really superb.

In the meantime and minor shortcomings aside, it already provides an excellent way to learn basic C language programming, in a relatively fast and efficient manner. And it represents good value for money, at the quoted Australian RRP of $80.

Copies are available from most larger bookstores. The review copy came from the Waite Group's Australian distributor Woodslane, of Unit 8, 101 Darley Street, Mona Vale 2103. ❖

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REVIEWS

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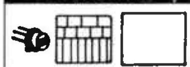

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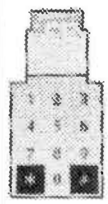

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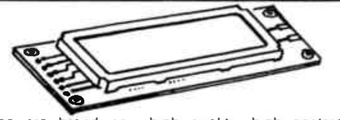

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SHORTWAVE LISTENING

by Arthur Cushen, MBE

70 years of radio broadcasting

Within the next few months, many of the pioneer radio stations of Australia and New Zealand will be celebrating 70 years as commercial broadcasters, and reflecting on their long history of community service.

The first radio broadcasting to be established on a regular basis was by the Otago Radio Association. Following a public meeting in Dunedin, its broadcasts commenced on 4th October, 1922. The station was a volunteer non-commercial broadcaster, and still continues today, using the slogan 'Dunedin 4XD'. However, since deregulation in New Zealand, it is now a commercial station. Its broadcasts are on air 24 hours a day on 1305kHz with 2.5kW.

In Australia the Government gave approval in 1923 for the establishment of four stations — two in Sydney, one in Melbourne and one in Perth.

The first station to commence transmission was 2SB (later 2BL) in Sydney, which started officially at 8.00pm on 23rd November, 1923. The next station on air was 2FC Sydney on 5th December, 1923, followed by 3AR Melbourne on 26th January, 1924, and 6WF Perth on 4th June, 1924.

The oldest station in Australasia is operated by the Otago Radio Association, Dunedin, New Zealand and commenced broadcasting in October 1922. This vertification was issued using one of the earlier calls, 4ZD.

Radio pioneer

As indicated from the above brief resume of early radio stations in Australia and New Zealand, the Otago Radio Association Dunedin was operating 13 months before the first Australian commercial broadcaster.

Radio in New Zealand made history on November 17th 1921, when Professor Robert Jack of the Otago University broadcaster the first known radio message and music in New Zealand.

His work at the University of Otago resulted in the eventual establishment of private non-commercial radio stations in New Zealand. These flourished for many years. In 1937, the Labour Government bought out all these stations except two, and formed what is now Radio New Zealand Ltd.

On November 17th, 1921, when Dr Jack transmitted the first radio programme, it was heard at Shag Point near Dunedin. The information that this signal was being received was conveyed back to him by telephone. The call-sign 'DN' was allocated to Dr Jack for his experimental broadcasting at Otago University. His transmission was also the first regular broadcast of music and speech in the Southern Hemisphere.

Dr Jack had visited England in the late months of 1920 and brought back the equipment which gave the station its first transmitter. In February 1922, when broadcasting music from the University Students Ball, the transmission was picked up in mid-Tasman by the vessel 'Melbourne'. This reception made history, for the distance the signal had travelled from a transmitter whose output was estimated to be only two watts.

Later Dr Jack, after concluding his experimental radio station, helped establish the Otago Radio Association, as an amateur club with hobby broadcasts on Tuesday and Thursday evenings.

The success of the Otago Radio Association was followed up by many small private stations throughout New Zealand, which also helped to pioneer radio in this country. By 1921, some 28 stations were operating and these continued until the State purchased them in 1936. Two stations, 2ZM Gisborne and 4ZB Dunedin were allowed to continue, since they were of an experimental nature.

The death of the late Percy Stevens

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.

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resulted in the Government purchasing 2ZM, but the Otago Radio Association, now with the call 4XD, still continues to operate today.

Another gospel broadcaster

There is an increasing number of gospel broadcasters in the US. One of the latest has been announced by George Jacobs, who is a consultant to the private radio stations in North America. According to a recent Media Network programme, the broadcasts will originate from Alabama — which is the key station for this cable network. It was expected that construction would begin early in the new year, and be complete in two years.

The complex will consist of four 500kW transmitters, and a large number of curtain antennas, to cover North and South America, Europe and Africa. The funds are being provided by the Catholic Church which operates the largest cable network in the US.

The idea now is to bring this programme to the world on shortwave, with many programmes being simulcast and covering at least 12 languages. The power of the transmitters can be reduced to 250kW for certain areas close to the United States.

The new station is not affiliated with Vatican Radio. It is run by an organisation set up by a monastery called 'Our Lady of the Angelus'. While affiliated with the Catholic Church, it is not a relay of Vatican Radio.

Plan for Radio Scandinavia

A proposed 'super-station' to cover the Nordic countries is under discussion, as already Radio Norway is carrying programmes for Radio Denmark on its transmitters. The Danish transmitting site outside Copenhagen requires considerable capital expenditure, and it was found to be cheaper to hire transmitter time from Radio Norway.

The proposal for Radio Scandinavia comes from the Nordic Council, which is a common government body for all the Nordic countries including Iceland, the Faroes, as well as Sweden, Denmark, Norway and Finland. The main moves to form this new super broadcasting group have come from Radio Sweden and Radio Denmark.

Radio Norway has had an excellent response from its English speaking listeners since it increased its English programmes from one to two days a week. Radio Norway had its beginnings in 1939, but following German occupation, its broadcasts were made from the United States. The transmissions came back to Norway for the winter Olympics in Oslo in 1952; and with the winter Olympics again in Norway in 1994, further expansion of programming is expected.

Radio Norway would like to broadcast daily in English, and add other languages to their schedule, but funds are the problem. The English broadcasts are funded from the Foreign Ministry, while the licence fees paid by Norwegian listeners go to fund the internal service to a population of four and a half million.

There are many thousands of Norwegians overseas, particularly in shipping, and a recent survey showed that the broadcasts in Norwegian were very popular with those living abroad.

AROUND THE WORLD

The move back to Standard Time in the Northerm Hemisphere has resulted in some transmission changes.

GERMANY: Broadcasts from Cologne to the Pacific in English are now carried on some additional frequencies: the broadcast at 0900-0950 is now on 6160, 11915, 17780, 17820, 21465, 21650 and 21680kHz. The second transmission at 2100-2150 is on 6185, 9670, 9765, 11785 and 15350kHz.

HUNGARY: Radio Budapest's English service is now carried at 0200-0300 on 6110, 9835 and 19910kHz to North America, while broadcasts to Europe and the Middle East are at 2100-2200 on 6110, 9835 and 11910kHz.

NORWAY: Radio Norway Oslo has English transmissions on Saturday and Sunday only, and its schedule for reception in Australia indicates a transmission at 1200 on 21695 and 25730kHz, and at 1900 on 15220 and 17730kHz. There are daily broadcasts in Norweigan at 0700 on 9590, 11735, and 17765kHz; 0800 on 17740, and 25730kHz and at 0900 on 2735 and 25730kHz.

UNITED KINGDOM: BBC World Service has replaced 11750 with 11955kHz for the period 1800-2300. Another transmitter on 17830kHz has been extended and now operates at 0600-1030. London also broadcasts at 0600 on 7150, 9640 and 11955kHz and at 0900, 11955 and 15070kHz are alternative frequencies.

USA: The Voice of America in its transmission to the South Pacific in English has dropped 9760 and 15155kHz for the period 1100-1200; frequencies still in use are 5985, 6110, 11720 and 15425kHz. ❖

Basic Electronics

Continued from page 99

high frequencies from being reduced because of stray capacitance.

RC filters

But RC filters are also very useful, particularly in tone control circuits or applications where the frequency response of a system needs to be tailored. A graphic equaliser generally contains numerous RC filters, where the values of the resistors are made variable, usually with front panel potentiometers.

The simplest tone control circuit is the low pass filter of Fig.5. This circuit is commonly called a 'treble cut' control, in which varying R changes the cutoff frequency. If R is increased in value, the cutoff frequency will be reduced, giving the effect of a treble cut (or bass boost).

Taking this further, a high pass filter (Fig.6) can be used as a treble boost circuit, whereby the low frequencies are attenuated as R is varied. By combining a low pass and a high pass filter, a tone control circuit with two controls can be obtained, in which both the treble and the bass frequencies can be changed.

There are numerous kinds of tone control circuit, usually defined as either *passive* or *active*. In a passive circuit, the RC networks are connected somewhere in the signal path, thus directly modifying the actual signal. The active type uses RC filters in the feedback path of an amplifier stage, and this type of circuit is relatively common as it has less loss. The shape of the response of a filter can be changed by adding another stage. In the circuits of Figs.5 and 6, a single RC network is used. These circuits are referred to as *single pole* circuits, and have one time constant. A characteristic of a single pole filter is that the rolloff slope is -20dB/decade. If another single pole filter is added, the rolloff can be increased to -40dB/decade. A two pole filter therefore has two time constants, and for best rolloff, the time constants should be the same.

The topic of filters is almost never ending, and there are countless designs ranging from the so called 'Butterworth' filter, through the 'Chebyshev' configuration to active filters. Most texts on electronics describe these types of filters; indeed whole books have been written about filters. We cannot go into all the circuits, but at least you should now have an idea of what a filter is and the meaning of the various terms associated with filters and frequency response. ❖

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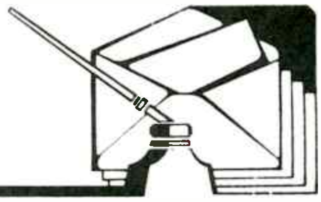
Information centre

Conducted by Peter Phillips



'What' kind of meanie am I??

There's quite a bit of discussion about my What?? questions this month. I think you'll enjoy what our readers have to say, even if the topic is rather esoteric. On more practical matters, there's also discussion on devices for switching regulators, 240V inverters and their suitability to drive different kinds of equipment, and even a practical tip on etching PC boards.

The What?? questions I present in this column each month often lead to letters protesting the answer, protesting the question, or offering alternative solutions. Some writers offer questions for me to use (for which I'm most grateful), while others even hope for my disposal by diabolical means (in jest, I trust?). Sometimes with good reason, perhaps, when my figures are juxtaposed — as apparently happened in the solution printed in October '91 concerning the RMS value of a DC and a superimposed AC.

Our first letter will show you what I mean...

What indeed?

Peter Phillips' circuit quizzes are good exercises, but his September What?? solution needs help. Integration of the voltage expression (etc) yields 20.5 as the mean square, which agrees with his value. Although he verified this answer by two other means, the square root of 20.5 (the RMS value) is still NOT the 4.25 he stated. It's about 4.53. Since he expressed his solution to a precision of the nearest 1/100th, it is badly in error.

As to his diabolical October quiz, it shouldn't be called 'What??' but 'What in Hell??'. By differential equations, the instantaneous current is determined by the initial current (I) and a power of e (2.271828).

However, to assess either I or the power of e, one must divide non-zero numbers by the circuit resistance (R), which he set at zero. Hence the problem isn't simply indeterminate, it's impossible, given that division by zero is not allowed.

I understand that even when superconduction is achieved the current doesn't reach infinity, but can we mortals yet calculate its limit?, I have never heard of any physicist defining losses under such cooling, let alone formulating them.

P.P. has earned a new rope and a fine hanging for being mean to us. Doesn't he like us anymore? (May he bet heavily on Drool, the Wonder Camel, in this year's Melbourne Cup!) (G.L., Redfern NSW).

Thanks a lot, G.L. Still, you're right about the incorrect answer to the September What??. In checking back, it seems I typed the answer with the 2 and the 5 reversed, and it should have read 4.52, not the 4.25 I gave. My humble apologies.

But before I visit the TAB, or buy some rope, read on. According to the following letters, the answer to the October question is simple — assume there is resistance! Hmm...

Capacitor 'classic'

Quite a few letters have arrived about the classic question posed in October '91 — the one about connecting two capacitors in parallel after initially charging one of them. Assuming no losses, the question is where does the energy go, as the combined energy stored is now less than the original energy in the initially charged capacitor.

But it seems not everyone agrees with the answer printed in November:

Disregarding the liquid helium business, assuming the capacitors are ideal and that the connection of the two capacitors has zero loss, the key to the problem lies in the fact that the voltage across a pure capacitance can't change instantly. At the instant the capacitors are connected together, dv = 100V and C = 2F. The current will be infinite, decreasing incrementally with time until both capacitors are equally charged having reached a steady state voltage of 50V.

However, let's consider the practicality of an infinite current at the instant the two capacitors are connected. This, of course, cannot be allowed to occur, and we MUST accept that there is some resistance present, regardless of the operating temperature. This value could be very small, but nonetheless finite; so we can get around the problem of an infinite current.

Accepting some resistance, at the instant the capacitors are connected all of the voltage will appear across it. As time passes the voltage and the current will decrease exponentially until both settle close to zero.

The total power lost is given by the integral P = integral between the limits of infinity and zero of I^2Rdt. The current I is the instantaneous current and equals $V/Re^{-t/RC}$. Substituting this in the integral, simplifying and differentiating it can be shown that $P = 1/2CV^2$.

Notice that R has disappeared and that the expression looks rather familiar. Considering that energy J is simply power per unit time, (1 joule = 1 watt/second) we can write $J = 1/2CV^2$. Substituting the values given in the question, the lost energy in the resistor is 2500J.

There you have it Peter, 2500J lost regardless of the magnitude of R, providing it remains finite. Hope this helps you and is of interest to your readers. (D.C., Gladesville NSW).

Thanks D.C., for your solution to this question. The answer given in November '91 initially assumes that resistance is present, but goes one step further and poses the conundrum of an infinite cur-

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rent for zero time, referred to as a Dirac function by the correspondent who supplied this answer. Although I don't know what a Dirac function is, apparently it solves the problem for this impossible condition. Or does it?

Here's another contribution:

Having heard of the 'missing energy in a capacitor' problem at university, I was surprised at your courage in printing your answer on page 110 of the November issue of EA. It is precisely this occasional error that makes your magazine so fascinating.

The simple solution is not found with zero resistance, infinite current, zero time, Dirac functions or Fourier transforms.

The energy (E) stored in the charged capacitor is equal to the work (W) done to put the charge there in the first place. This can be shown to be $E = W = Q^2/2C$. When the two capacitors are connected together, the total charge is still Q, but the capacitance is now 2C. The energy stored in the capacitance drops to $Q^2/4C$ and the mind bending exercise is 'where did half the energy go?'.

The simple answer is: the same way it got there. It takes energy to move an electric charge, which was $Q^2/2C$ to put the charge onto the first capacitor. It now takes $Q^2/4C$ amount of energy to move the charge Q to spread out over the new capacitance of 2C.

I mean, if the charges were men, you would have to feed them to give them energy to walk the distance. (L.S., Salisbury Qld).

I'm not sure if you're complimenting me or not, L.S. In any case, as I see it, the answer given to the problem is not in error, and it therefore took no courage to publish it.

The thing that keeps bothering me about this problem is the question of zero resistance. Given this (admittedly) impossible situation, it should take zero energy to move the charges (electrons). Given that, the question still remains: where did the energy go, if none was required to move the charges. According to the answer supplied by the original correspondent who posed the question, a Dirac function solves the problem, and the energy is dissipated as white noise. In a resistance, however small, the energy is dissipated as heat which makes the problem very easy.

But thanks L.S. for your letter, which is supported by the next correspondent. I've shortened the following letter by removing some rather hard to reproduce mathematics, but the sentiments are (I hope) left intact:

Fancy raising the old C1 + C2 furfee?!! It's all a question of work: like shovelling sand. Makes you sweat.

The 'missing' 2500J is stored work that has been done in the transfer of charge, which becomes heat energy. If you keep repeating the experiment something gets hot, but since time is not a factor, a connection via a lamp will make this evident. Incidentally, even a 10M ohm resistor will make no difference to the final result. (D.L., Tumblong NSW).

My comments on the previous letter still apply to your letter D.L., (for which I thank you): what about zero resistance? No ohms = no heat!

And finally, it seems I've posed this problem before, albeit differently as the next letter points out:

May I be so bold as to suggest that your memory must have slipped, when you penned your introductory remarks about the October '91 What?? — in that the January '91 What?? used a slightly more complex version of the same problem. (Of course the numerical values are different, but this does not affect the principles involved).

The January question was not aimed at the question of energy redistribution, but surely you had your 'definitive answer' in my letter which you had the grace to publish in April '91? (G.W., Florey ACT).

Looking back to April (on page 110), it seems your answer G.W., agrees with that given by the first correspondent. Fair enough, as zero resistance is a practical impossibility anyway and it doesn't affect the end result, as everyone has pointed out.

But if anyone can elucidate on the Dirac function (without too much maths please — it's very difficult to typeset!), I'd be pleased to know.

And now back to the real world, with real components that do get hot...

Why not a 2N3055?

Over the years a small number of transistors have become firmly ensconced as 'popular'. The BC548 and BC558 for small signal stuff, the BD139 and its complement the BD140 for medium power and, of course — the ever popular 2N3055. Add a few more, such as the BF115 for higher frequencies and some of the recent equivalents to those already mentioned, and nearly every task required of a transistor can be accommodated.

The operative word of course is *nearly*, perhaps explaining the myriad of transistor types available. Still, it's tempting sometimes to wonder if one of the popular types can be substituted for that hard-to-get transistor that may be specified. The next letter asks just this question:

I would like to ask your design team a technical question relating to the design philosophy involved in the Switch-mode Power Supply presented in May and June 1983.

I would like to know the reasons for using a PNP output transistor, type MJ15004. The ratings of this device seem to be far in excess of that required for the application.

What were the reasons for not designing the control circuit to drive an NPN transistor such as the cheaper 2N3055? This transistor seems to have ample ratings for the job. (C.B., Renmark SA).

A good question C.B., as the nominal specifications of the power supply (50V, 5A) are certainly within the 60V, 15A ratings of a 2N3055. However, while this would apply to a linear regulator, the power supply in question uses a switching regulator. The complete cir-

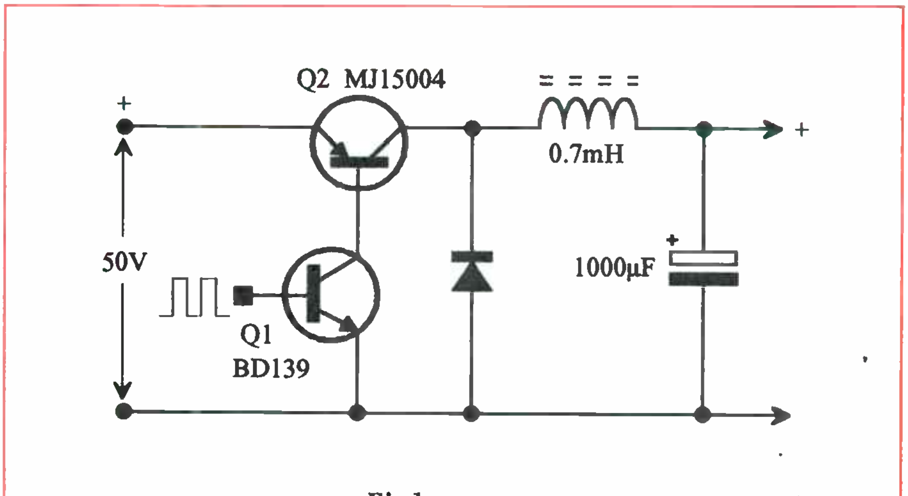

Fig.1

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cuit contains quite a few components, but the regulator section can be boiled down to that shown in Fig.1.

This circuit is often referred to as a step-down or 'buck' regulator, as the output voltage is usually less than the input voltage. The transistor is used to switch the input DC, and the on-off ratio of the waveform driving the transistor controls the output voltage. The control circuit samples the output voltage, compares it to a reference and varies the on-off ratio of the switching signal accordingly.

When the transistor is turned on, the full DC input is applied to the coil and current flows through the transistor and coil, charging the capacitor. When the transistor is switched off, the magnetic field around the inductor collapses and, by Lenz's law, current is maintained, this time flowing via the diode. The overall effect is a sawtooth waveform for the current, which has a peak value well in excess of the DC current that will flow in the load.

There are several considerations for the transistor that make the ubiquitous 2N3055 unsuitable. In the first case, the switching circuit will cause voltage transients which will effectively add to the 50V input, as far as the transistor is concerned. The MJ15004 has a V_{CE} rating of 140V, giving a much better safety margin compared to the 60V rating of the 2N3055. As well, the peak current rating of 20A for the MJ15004 is some 33% higher than the 15A capability of the 2N3055, an important consideration as already described.

The switching characteristics of the transistor are also important and include specifications such as the current gain, saturation voltage and switching speed. The 2N3055 has a current gain of 20 (at 4A), a crossover frequency (f_T) of 0.8MHz and a saturation voltage of 1.1V at 4A. For the MJ15004, these values are 25 (at 5A), 2MHz and 1V at 5A.

While the differences may be relatively small, they are significant in this application.

The question of using a PNP transistor is another important design consideration. This arrangement allows the base current to flow from the DC input voltage (at the emitter) to ground, via the driver transistor. An NPN configuration has the disadvantage that the emitter voltage is no longer constant, as it depends on the output voltage. At higher output voltages, the base current would fall, giving a higher saturation voltage across the transistor.

So all in all, the ever popular 2N3055 (or even its PNP counterpart the '2955) is not the best choice in this circuit. An interesting question, and one I hope I've answered for you C.B. Incidentally, the prototype is still in our laboratory and despite its ratings, we have had the output transistor fail on two occasions. Admittedly we were asking the supply to extend itself, but imagine the problems if a lesser device were used.

Staying with switching type power supplies (well — sort of), the next letter asks about 12V to 240V inverters.

Electronics Australia's latest publication:

PC-BASED CIRCUIT SIMULATORS AN INTRODUCTION

by JIM ROWE

Computer programs capable of simulating the performance of complex analog circuits can now be run on many personal computers, heralding a new era in the design of electronic equipment. In the future, much of the tedious design hack-work will be performed on a PC, providing faster and more accurate results than bench testing.

Find out more about this rapidly growing technology, with our new publication *PC-Based Circuit Simulators*. Based on a popular series of articles run recently in the magazine, it provides an easy to read introduction to circuit simulators, plus an unbiased evaluation of the main simulation packages currently available.

Now available for only $2.95 from your local newsagent — or by mail from Electronics Australia Reader Services, PO Box 199, Alexandria 2015.

Non-sinusoidal inverters

I am after some information about the suitability of using a non-sinusoidal inverter for powering items such as a computer, a hifi and so on. If you read the advertisements, the only thing to use is a sinewave inverter. Having purchased such an inverter from a Melbourne manufacturer, and finding it rather unreliable (and only repairable in Melbourne), I have decided to cut my losses and buy something else.

I am interested in the 300W Autostart Inverter published in April 1988, providing it can handle the 15m cable connecting the inverter to the load (XT type computer or hifi). Previously, this cable used to trigger the autostart, or at least keep the inverter running even when the load was disconnected. Perhaps this is due to the capacitance of the lead.

I realise that a square wave supply will cause minor problems, as power transformers are not designed to operate with a square wave. Also, the electrical noise generated by the inverter is likely to cause problems. The previous unit used to kill an AM radio up to 150m away! (D.H., Beechwood NSW).

This is a rather tricky question to answer. In the first place, the output waveform of the April '88 inverter is not constant, and varies according to the load. This also affects the RMS value, although the average value of the waveform is essentially constant.

I can see no problems using such an inverter with a computer itself, as the power supply generally has the rectifier section connected directly to the 240V mains. In fact, a square wave input may even suit it, as the peak voltage value will be less than for a sine wave, giving reduced stress on the filter capacitors. As well, most computer power supplies can operate over a wide range of input voltages.

However the computer's monitor will probably have a linear power supply (although not always) and problems may occur as a result. Driving a transformer with a low frequency square wave will possibly cause heating of the windings and a 'spiky' output at the secondary. This could cause interference to the display and even a loss of vertical synchronisation.

However, the output waveform of the April '88 inverter is not a conventional square wave, and can even approach a sinusoidal shape with some loads.

My gut feeling is that it *will* drive a computer monitor, but I stress that I have never tried it, and it will depend on the type of power supply in the monitor anyway.

I have definite reservations about using it with a hifi set, although you just never know. You don't give the details, but I'm assuming your hifi has the usual amplifier, turntable, CD player, cassette deck and so on.

The possible effects are again overheating of mains transformers and noise on the DC supply. As well, the output voltage of the transformers may be higher than normal, due to overshoot at the secondary. Unless the supply is regulated (as it generally is in a computer monitor), it's possible that damage to the equipment could occur.

And just how a turntable motor (or any induction motor that relies on the frequency being constant) will perform

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with a square wave is difficult to predict. Again all may be well, depending on your equipment.

If it was me, I'd probably build the inverter as it should at least be OK to use with the computer. Just keep a check on the computer monitor. Then you could at least try the hifi, again keeping a close lookout. I would also measure a few voltages, just to make sure.

If the 240V lead is causing problems with the auto-start function, perhaps you could try running two separate leads, one for the active and the other for the neutral. This will reduce the lead capacitance and possibly solve the problem.

If any readers can give me further information I'll include it in future editions, as this is a question quite a few people may be interested in. Thanks D.H. for an interesting question, and I'd like to know what you end up doing.

Mains DC

I've received several letters commenting on the drill speed control system described in October. In this system, a diode is connected in series with the drill motor when slow speed is selected. While simple and apparently effective, adding such a diode has a few problems — as our correspondents point out.

The 'half wave/half power' switch has been around ever since the invention of the diode. It was a standard way in the '40s (or '50s) to keep soldering irons on standby via a hookswitch.

However, the whole business brought the house down in the '50s when imported TVs with half wave power supplies were introduced as — horror! — it introduced DC in the mains. This problem also reappeared with colour TV and bought with it an increasing awareness of harm that could arise to the electricity distribution system and other installations. Several thousand hours of research was subsequently carried out by various authorities, under the auspices of Standards Australia.

In summary, the DC generated in the active/neutral mains returns via parallel paths (neutral and earth) to the substation. The division is roughly 10% via earth, including water, gas and some metal telecommunications cable sheaths. This will cause (as per Mr Faraday) corrosion of earth electrodes, either at the consumer's premises or at the substation, depending on the polarity. Water pipes will particularly suffer.

Although the statistical polarity current summation might seem to be zero, the local current paths do their damage before combining. The DC maximum current to earth, per consumers residence, was established at 0.4mA continuous for reasonable survival of underground metal plant.

All mains operating appliances are now rated accordingly in AS 3100 and its associated test specifications, on the basis that different appliances have different duty cycles. Appliances outside the limit cannot legally be connected to the supply mains.

One wonders how the repaired drill in the October article would rate! (B.B., Indooroopilly Qld).

I have to admit to forgetting this most important aspect of diode control. The topic of DC on the mains has featured before in *EA*, and is one that supply authorities will usually get quite bothered about. For good reason, as the next letter states...

I am surprised that your remarks about the drill speed change electronics did not mention the antagonistic attitude adopted by local supply authorities to appliances (like this) which return DC through the mains.

Perhaps they don't use the multiple earth neutral (MEN) system in France (where the switch was manufactured), but here, DC in the mains can result in electrolytic corrosion of the customer's earth connection. Ineffective earths could render life rather more hazardous for appliance users (G.W., Florey ACT).

My thanks to the writers for this reminder. Makes you wonder if drills with the 'electronic' switch are even legal.

PCB etching

I like to publish useful ideas, and while simple, the idea contained in the next letter is well worth presenting:

I'm not sure if this idea is a new one, but it should be of interest to those hobbyists who make their own PCBs. Over the years I've tried all kinds of methods to speed up the etching process, including bubbles, sloshers and so on. The trick that I've now found does away with all these methods and more than halves the etching time.

All that's required is to put the printed circuit board in the etchant with the track side facing down. As the board begins to etch, the residue will fall to the bottom of the tank, with good old gravity doing all the work.

The only extra preparation that's needed is to put some wire standoffs on each corner of the board, to keep it off the bottom of the tank. Bits of insulated telephone wire work fine, but any suitable method will do.

This method reduces erasure of the resist, which is important for boards with fine line work. It also reduces accidental spillage, and you seem to get a much sharper edge to the tracks.

Hope this idea is useful and thanks for a fine magazine. (T.N., Hastings Vic).

Thanks T.N., both for your letter and kind comments. A simple idea, and one that invites the comment 'Why didn't *I* think of that?'

What??

I can't resist it! Here's another question about capacitors, this time from Wen Liang Soong who has been a great supplier of questions over the years. He asks:

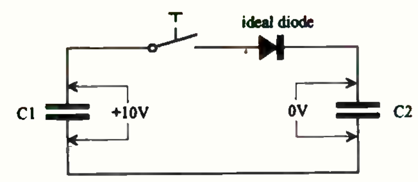

Fig.2

In the circuit of Fig.2, C1 and C2 are capacitors with equal values. C1 has an initial charge of +10V and C2 is initially discharged. You can ignore losses in the diode. What are the final voltages on C1 and C2 after the switch is closed?

Answer to December What??

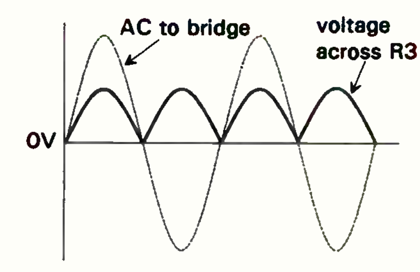

Fig.3

The waveform is shown in Fig.3, which is identical to the unsmoothed output of a full wave rectifier. To prove it, assume the diodes are switches and using Ohm's law for both conduction cycles you should see that the output is always positive — but reduced by potential divider action. ❖

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Vintage Radio

by PETER LANKSHEAR

Rejuvenating valves

A major advantage of semiconductors is that normally they don't wear out. Valves, of course, slowly lose their cathode emission to the point where they are eventually unservicable. Of interest to the vintage radio enthusiast was the Serviceman's column in the July 1991 edition of *EA*, which included a story about reviving a tired old 6V6G valve by a method sometimes used to extend the life of black and white TV picture tubes.

Now that manufacture of valves has virtually ceased, any method of extending their life is clearly worth investigation. Accordingly I carried out some experiments with a selection of valves to see how effective the 'picture tube' method was. More about my results shortly; first some background.

The conventional oxide-coated cathode was patented by Arthur Wehnalt in 1904, but exactly how it operates is imperfectly understood and manufacturing processes have not been widely published. I did however, find a description in *Fundamentals of Radio-valve Technique*, published by Philips in 1949.

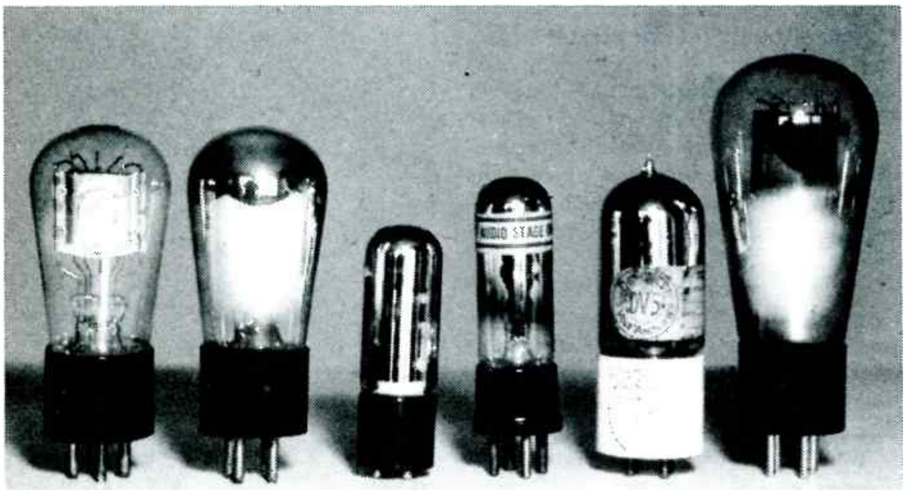
During manufacture, the emitting surface of a cathode is coated with a mixture of 'rare earth' carbonates — primarily barium but including others like strontium and calcium — which, during evacuation of the valve are decomposed to oxides. At completion of evacuation, the valve is not 'activated' but must be 'burned out' or 'seasoned'. This involves operating the filament at up to double its normal voltage, and connecting the grids and anodes to a positive voltage supply.

The electron flow from the cathode steadily increases during this process, and after a while, the control grid voltage is reduced, reducing the electron flow. The filament voltage is then further increased for a period, until the valve is fully activated. Very important is the presence in the oxide coating of small amounts of metallic barium and strontium, which contribute significantly to the emitting properties of the cathode.

Why do valves wear out?

There appear to be two reasons for the eventual loss of cathode emission. Most commonly, there seems to be a gradual 'wearing out' of the cathode coating, at a rate related to the anode voltage and current. Despite the importance of this phenomenon, I have not been able to find an explanation of exactly what happens to the coating; but valves operating well within their limits can generally be expected to provide the longest service.

Whereas the fine filaments in battery valves had a life expectancy of about 1000 hours, at the other end of the scale, special quality industrial types made under rigid conditions were guaranteed for 10,000 hours. A special run by Western Electric of their 175HQ valves for a submarine telephone cable gave an actual continuous service life of 22 years, or 190,000 hours. When expense was no object, very long lives could be achieved.



Some common valves with thoriated tungsten filaments. From left to right are the 200A, 201A, UV199, 120, DV5 and 210. Note the absence of reflective 'gettering' in the unique gas-filled 200A.

Cathode poisoning

The second reason for loss of emission seems to be better understood. Valves operating at zero or very low anode currents can suffer from premature failure, from what is known as 'cathode poisoning'. This condition results from the absorption of minute traces of water vapour and oxygen left behind in the evacuation process, and it is likely that the metallic components in the cathode coating are oxidised. Some industrial valves likely to be operated for long periods at zero anode current were given special degassing, to minimise the risk of cathode poisoning.

A valve which no longer has sufficient emission is usually discarded, but the cathode-ray tubes used in 'black and white' TV receivers, with essentially the same cathodes as valves, were expensive and various ways to extend their lives have been explored.

One common means of getting more 'mileage' was to increase the heater voltage by about 25%, but another method

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called *rejuvenation* was also widely used. In its crudest form this consisted of progressively applying up to about 50% excess filament voltage and applying mains voltage via a low wattage lamp, between the cathode and the other electrodes connected in parallel. As the lamp started to glow, the filament voltage was backed off and the process repeated until the lamp would still glow at the rated filament voltage. At this stage, cathode emission was often found to have been significantly improved.

Trying it out

This somewhat brutal treatment is fundamentally the same as the burning-in during in manufacturing, and to test its effectiveness with ordinary valves, a test rig was assembled.

First a row of various valve sockets was mounted on a baseboard, and wired so that all grid and anode pins were paralleled and connected through a low wattage 230-volt lamp to a 250V transformer winding. A 5-watt lamp was used with low current valves, and a 15-watt lamp for output valves. The other side of the winding was connected to the cathode pins.

Although a tapped winding could have been used for the filament supply, a 'Variac' variable transformer was available to control the primary of a transformer with 6.3 volt and 5.0 volt windings connected in series.

Although I normally throw out low-emission valves, I found sufficient representatives of various types to experiment with. Filament voltage was slowly advanced until the lamp glowed, often accompanied by spluttering and flashing from the cathode. The filament voltage was immediately reduced until the lamp was extinguished, and then was again advanced until the lamp again glowed — and so on, until there was no change in the filament voltage at which the glow commenced.

The results

The results are listed in Table 1. The first three valves were directly heated type 45 output triodes. Number 1 remained practically unchanged, number 2 was degraded and number 3 was improved slightly, but still nowhere near new performance.

Three very early indirectly heated valves, type 27 general purpose triodes, were next. The results here were more encouraging, with significant improvements, although full performance was not achieved.

Results with three 2A5/6F6G output pentodes were poor, with one expiring completely! Unlike the 6V6 involved in the July article, mine, number 10, did not respond. Neither did number 11, a standard 6D6 RF pentode.

Finally, numbers 12 to 16, the group of five double-diode high-mu triodes were much more successful, with three regaining full performance.

MEASUREMENTS WITH AVO MARK IV VALVE CHARACTERISTICS METER

SAMPLE NO.	VALVE TYPE	RATED		VALVE CHARACTERISTICS INITIAL		AFTER TREATMENT	
		Gm Ma/V	PLATE Ma	Gm Ma/V	PLATE Ma	Gm Ma/V	PLATE Ma
1	45	2.10	34.00	0.68	10.00	0.68	11.00
2	45	2.10	34.00	1.20	13.00	0.80	11.00
3	45	2.10	34.00	0.90	9.50	1.10	12.00
4	27	0.90	5.20	0.35	2.00	0.40	3.50
5	27	0.90	5.20	0.20	1.60	0.50	2.10
6	27	0.90	5.20	0.10	0.95	0.60	2.80
7	2A5	2.50	34.00	1.00	10.00	**	**
8	6F6G	2.50	34.00	*	0.25	*	1.75
9	6F6G	2.50	34.00	0.85	8.50	0.85	10.00
10	6V6GT	4.10	45.00	0.60	7.00	0.20	7.00
11	6D6	1.50	8.00	0.70	5.20	0.70	5.20
12	DH63	1.20	1.10	0.10	0.50	1.10	1.10
13	75	1.10	0.90	0.50	0.60	1.00	1.00
14	2A6	1.10	0.90	0.75	0.55	0.75	0.55
15	2A6	1.10	0.90	0.15	0.50	1.10	1.00
16	2A6	1.10	0.90	0.45	0.35	0.85	0.50

* TOO LOW TO MEASURE
** VALVE DID NOT SURVIVE

Table 1: The results achieved by the author with his experiments to investigate rejuvenation of oxide-coated cathodes. Really successful results were obtained with the valves listed as number 12, 13, 15 and 16.

Conclusions

Although results with the high current output valves were disappointing, the lower current triodes recovered to a degree. But the recovery of some of the high-mu triodes was excellent, and similar to the results that can be achieved with TV picture tubes.

There is a possible explanation for the different results. Whereas the output valves were 'worn out', I suspect that the original loss of emission of the high-mu triodes and picture tubes was not due to wearing out of the oxide coating, but cathode poisoning. These tubes operated at low anode currents, in the case of the triodes only a few hundred microamperes, over a long period and this was possibly insufficient to keep the metallic barium from oxidising. In this situation the rejuvenation technique is successful, as it is similar to the seasoning process when the barium layer is formed during original manufacture.

Valves with thoriated tungsten filaments

There is obviously a challenge for further research into rejuvenating high anode current valves with oxide coated cathodes. But the good news is that the revival of thoriated tungsten filaments is an old established practice, and is remarkably successful. The process is quite different from that just described, however.

During the early and mid-1920's, valves with thoriated tungsten filaments dominated American radios — the best known example being the 201A. They were very popular in Australasia and to a certain extent in Europe.

Thoriated tungsten filaments are quite unlike the familiar oxide coated type. They operate at the high temperature of 1800 - 1900K or bright yellow, and good emission depends on the presence of a molecularly thin layer of thorium on the surface of the tungsten. This thorium layer is relatively fragile and disappears during normal use or the application of excessive voltage. Fortunately, restoration of full performance is quite easy.

Alert vintage radio enthusiasts can today benefit from this characteristic. Collections of early equipment often contain low emission thoriated tungsten filament valves, which were put to one side by owners who did not realise that they could be rejuvenated.

Never discard this type of valve without first trying restoration! From my own experience, provided that there are no shorted or loose elements, and that the filament and vacuum are intact, restoration techniques to be described have at least a 90% success rate — frequently restoring the valve to full performance. They can also be applied several times.

Two approaches

The first method, described on the information sheet supplied with RCA valves, is to disconnect all plate supplies and operate the filament at full voltage

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for 20 minutes or so. Often this will be sufficient restoration.

In many cases however, a stronger method is needed. First the filament is 'flashed', or heated to a much higher temperature than normal to bring thorium to the surface. Then the filament temperature is reduced somewhat and 'seasoned' for half an hour or so. During restoration it is most important that no plate supplies are connected.

Guide table

Figures for valves most likely to be encountered are given in Table 2. At first sight, flashing the filament at more than double normal voltage must appear to be guarantee for a burnout, but the positive temperature coefficient of tungsten acts to limit current. In reality the temperature during flashing is no greater than that of a tungsten filament lamp, and the risk of a burnout is slight.

Provided that there is accurate metering, either AC or DC filament voltage is suitable. A comprehensive valve tester is ideal, but a tapped transformer or variable bench supply is fine.

Identifying candidates

It is most important to note that only thoriated tungsten filaments can be rejuvenated by 'flashing'. Any other type of filament will be destroyed. As well as the valves listed in Table II, some English and European valves made during the early 1920's also had thoriated tungsten filaments, but detailed information is hard to find. BE WARNED!

Replacements for thoriated tungsten types made during the 1930's often had oxide-coated filaments and of course, these cannot be flashed. Obviously, careful identification is essential.

There are two clues. As thoriated tungsten filaments are very sensitive to gas, a considerable amount of 'gettering' was always used. Consequently, with the exception of the 200A gas-filled detector, it is difficult to see much of the interiors of these valves as most of the internal surface of the glass has a heavy mirror coating. However, a large area of gettering alone is not a guarantee of a thoriated tungsten filament.

An important confirmation is the colour of the light from the filament. At the correct voltage, oxide filaments glow a dull red or orange, whereas the light from thoriated tungsten filaments is a *bright yellow* and illuminates much of the interior of the bulb.

For valves not listed, filaments should be flashed for 30 seconds at 250% of normal voltage and then aged at 125% for about 30 minutes.

Some very early valves had pure tungsten filaments, and like oxide-coated types, these will be destroyed by flashing. Such valves can be recognised by the *absence* of gettering, and the filament operating at full lamp brilliance.

So there it is. Both oxide-coated cathodes that have operated at low currents and thoriated tungsten filaments respond to rejuvenation. Results with other types are not so consistent. Clearly there is plenty of opportunity for further investigation into this increasingly important aspect of vintage radio.

I'd be happy to hear from anyone able to provide further information. ❖

THORIATED TUNGSTEN FILAMENT REJUVENATION

VALVE TYPE	FILAMENT VOLTS	FILAMENT AMPS	FLASHING VOLTS	FLASHING SECONDS	AGEING VOLTS	AGEING MINUTES
UV199, UX199	3.3	0.06	12.0	10 TO 20	4.0	15 TO 60
C299, CX299	3.3	0.06	12.0	10 TO 20	4.0	15 TO 60
AWA33, AWA99, 99X	3.3	0.06	12.0	10 TO 20	4.0	15 TO 60
DV-1, DV-3, DV-3A	3.3	0.06	12.0	10 TO 20	4.0	15 TO 60
UX120, CX320	3.3	0.125	12.0	10 TO 20	4.0	15 TO 60
UV'01A, UX'01A	5.0	0.25	16.0	20 TO 30	7.0	10 TO 60
AWA101A, AWA101X	5.0	0.25	16.0	20 TO 30	7.0	10 TO 60
PHILIPS C509	5.0	0.25	16.0	20 TO 30	7.0	10 TO 60
DL-2, DV-2, DV-5	5.0	0.25	16.0	20 TO 30	7.0	10 TO 60
UV'00A, UX'00A	5.0	0.25	16.0	10 TO 20	7.0	10 TO 60
UX240, CX340	5.0	0.25	16.0	10 TO 20	7.0	10 TO 60
171,371 (NOT 71A)	5.0	0.5	16.0	10 TO 20	7.0	10 TO 60
210, 310	7.5	1.25	NO	FLASHING	10.0	2 TO 15
213,313 RECTIFIER	5.0	2.0	NO	FLASHING	7.0	10 TO 60
216B,316B " "	7.5	1.25	NO	FLASHING	10.0	10 TO 60

Table 2: The recommended rejuvenation conditions for the more common valve types which have a thoriated tungsten filament. Note that the 'flashing' technique can only be used with this type of valve. Other types of filament will be destroyed.

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READER INFO NO. 19

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World Radio History

EA with ETI marketplace

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WANTED: any old microphones made before 1960: for collector in Perth. John (09) 279 1234. 85 Parker St Bassendean 6054 WA

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Wireless at Sea

Continued from page 41

course, they would find the offending apparatus 'quite interesting' in an historical sense, but would certainly be entitled to put a firm stop to the offending activities.

Notwithstanding such gloomy considerations, there is no doubt that the station, as completed, is a very attractive assembly of components and in visual terms alone represents all that was good about Victorian and early Edwardian engineering.

Clearly, as the illustrations indicate, no modern radio amateur or shortwave listener should be without one!

So, in conclusion, and in the immortal words of the Comedy Company's Con the fruiterer, "Good on yer, Genlemens" and the best of luck in your efforts.

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The author also gratefully acknowledges the assistance of the Marconi Company at Chelmsford, England who gave access to archival records and apparatus and also supplied photographs. ❖

FORUM

(Continued from page 65)

inefficient — remember how hot those old rectifier valves used to get?

I hate to think how much additional energy would be wasted nowadays, if all of our TV sets, VCR's, personal computers and other gear had gone back to valve power supplies...

No, surely the answer is to find ways of removing, or at least reducing that waveform distortion, without wrecking the relatively high efficiency of modern power supplies. And judging from the brief details so far released, it sounds like Melbourne electronics engineer and occasional *EA* contributor David Whitby may have found a way of doing just that (see our news story on page 116 of the November issue).

I don't know about you, but I'm looking forward to learning exactly how David has solved this problem. Hopefully when he's received patent protection, he'll be able to tell us.

Not always cheaper!

Finally, I think we just have room for one more brief letter, before we end up this month. It turns out that I was wrong in writing that compact fluorescents are indeed significantly cheaper to run than conventional incandescents. There is in fact *one* area in Australia where at least a 9W model works out to be more expensive, as Mr Ron Coleman of Rivett in the ACT points out:

In reference to your 'Forum' of September 1991, the cost comparison between incandescent and compact fluoro's takes on a different light in the ACT, where the domestic energy rate is 7.32 cents per kWh — significantly less than for Sydney.

In particular, the 9 watt compact fluoro costs more to operate than its stated equivalent, the 40 watt incandescent. Note that in the ACT, incandescent lamps are available for 67 cents, but the best consistent price I can find for compact fluoro's is $28.00.

Fair enough, Mr Rivett — I stand corrected. I won't even try to make any cracks about people in the ACT being able to save on heating bills, because of all the hot air in the vicinity!

Seriously, though, I imagine that there are possibly other areas where the actual money saved with the 9W compact fluoro evaporates, due to either a significantly lower electricity tariff, or a higher local cost for compact fluoro's, or both. As I noted in the September column, the 9W compact fluoro does tend to provide the least saving, because of the way all models are sold for the same price.

Still, even if you're not saving much money — isn't it nice to think of all that energy you're saving, and hopefully a similar reduction in pollution?

I hope you'll all join me here again, next month. ❖

World Radio History

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.

January 1942

The Klystron: The klystron represents a most important development in the generation of ultra-short waves in that portion of the spectrum that lies above the microwaves. First produced only 24 months ago, the klystron is a modern miracle of science.

This revolutionary little ultra-high frequency resonator throws an astonishing beam that bids fair to answer the prayers of communications engineers.

Telephone engineers believe that they can transmit 600,000 telephone conversations simultaneously through a 6" pipe line and unscramble the talk at the other end; television engineers can supplant the co-axial cable as a carrying agent making long-distance television cheap and simple.

Half Way Round The World: What is almost certainly the most distant short wave station from Australia has recently been logged in Sydney.

This newcomer is 'Emissora Nacional', located in Ponta Delgada, Azores, and operates on 7305kc, 41.07m. Considering the distance from this country, it comes in at surprisingly good strength.

January 1967

Tiny Magnetic Cores: Scientists at IBM have shrunk the size of computer memory cores — tiny doughnuts of magnetic material — to an almost invisible size by using the ancient art of the candlemaker.

Reducing the size of the memory cores permits increasing the capacity of the computer memory.

Over the years the size of the units have shrunk to where today millions can be assembled in a single computer. Instead of being formed in a pressing operation, a long filament of nylon — the 'wick' — is passed through a bath of varnish and magnetic powder.

After drying, the cycle is repeated until the desired thickness is built up: the overall diameters of the cores and hole are 7.5 and 4.5 thousandths of an inch.

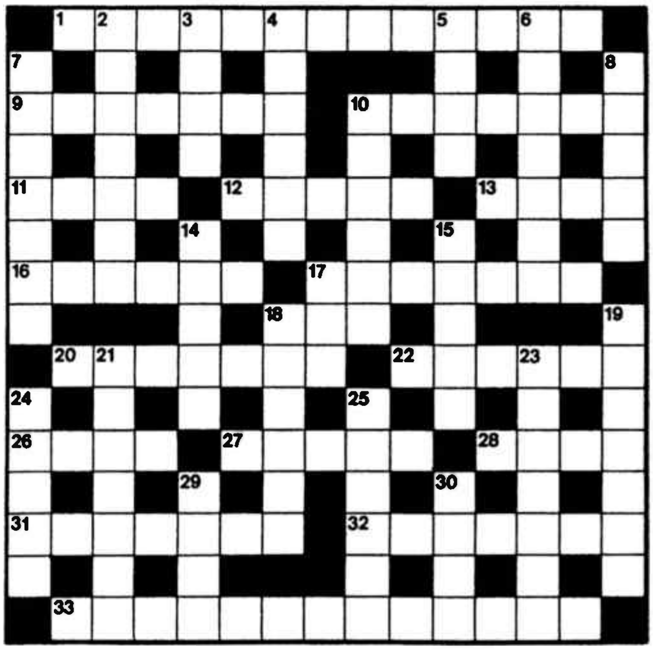
This very small ratio of the ring of magnetic material to hole diameter means that the cores can be switched with very little power.

400 Picosecond Circuit: A monolithic circuit with basic propagation delays of less than 400 picoseconds is believed to be the smallest and faster silicon mono-lithic circuit so far developed.

It contains five transistors and three diffused resistors, and occupies an area less than one 10-thousandth of a square inch.

The speed is a function of both its reduced size and its current switch logic. In this form of logic, one of a pair of transistors is always fully on, while the other is slightly on, rather than off — this reduces the turn-on time substantially. ❖

EA CROSSWORD



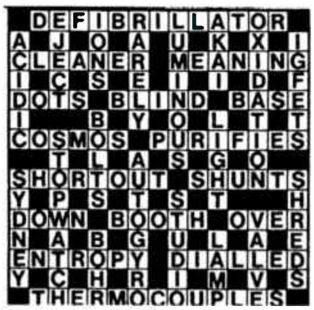
ACROSS

1. Subscriber-based video entertainment. (3,10)
9. Neutron-absorbing metal. (7)
10. Watch for checking purposes. (7)
11. Applications. (4)
12. Positive pole. (5)
13. Search through available data. (4)
16. These can be associated with I^2R. (6)
17. How sounds are perceived. (7)
18. Major computer brand. (1,1,1)
20. Generators. (7)
22. Detection dev ice. (6)
26. Quieten. (4)
27. Indicators of field, —— of force. (5)
28. Developer of space rocketry. (1,1,1,1)
31. Quartz is silicon ——. (7)
32. What is transverse, progressive, wet and salty? (7)
33. Making events recur together. (13)

DOWN

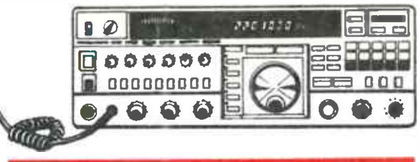
2. That which specifies a location in a computer. (7)
3. Doubled, or —— cone speaker. (4)
4. Light units. (6)
5. Absorber of heat. (4)
6. Such is a method of bar-code reading. (7)
7. Having eight elements. (7)
8. Long-distance telephone call. (5)
10. Frequency of an MF wave. (6)
14. For hands-free operation, the —— switch. (5)
15. Composer of Carmen. (5)
17. Durable plastic. (1,1,1)
18. Isotopically useful element number 53. (6)
19. The communication business? (7)
21. Such are the spectral D lines. (7)
23. Prolong a note. (7)
24. ILS helps pilots in the —— path. (5)
25. The 'father' of optics (6)
29. Substance used in common dry cell. (4)
30. Unwanted sounds in hi-fi circuits. (4)

SOLUTION FOR DECEMBER



World Radio History

Amateur Radio News



1992 Call Book

The WIA has published its *1992 Australian Radio Amateur Call Book*, which is now available from Divisional bookshops. As usual it contains information on all Australian callsigns, plus reference material such as band plans, repeater and beacon details, a DXCC list and current records.

The price for WIA members is the same as last year's Call Book — a very reasonable $10.00, plus postage and packing if required.

1992 Gosford Field Day

The Central Coast Amateur Radio Club's annual Gosford Field Day has been a feature of Australian amateur radio for many years, and this year's event looks like being no exception. It's planned for Sunday February 23, and as in previous years will be held at the Gosford Showground.

All displays are under cover, and the event will take place regardless of the weather. The gates will open at 8am, with registration costing $6.00 for adults and $3.00 for pensioners. Children under 12 will be admitted free.

Attractions of the field day include seminars and technical lectures; trade displays and sales; display stands by ALARA, the WIA Historian and WICEN; demonstrations of amateur TV and packet radio; a QSL bureau; a 'flea market' and auctions of disposals equipment. For family members not interested in amateur radio there will also be bus tours to the nearby Reptile Park. A courtesy bus will run between Gosford railway station and the Showground between 8.00am and 10.30am, meeting trains from both Sydney and Newcastle. Return transport may be arranged at the information booth at the Showground.

Plenty of off-street parking is available at the Showground itself. Tea, coffee and biscuits will be available in the Dining Room from 8am to 3pm, at no charge. Takeaway food can also be purchased within the Showground. An information service will be provided on the Gosford 2m repeater (146.725MHz) during both the Saturady afternoon prior to the day, and the morning of the field day itself. The callsign is VK2AFY/P. Further information is available from the Field Day Committee, Central Coast Amateur Radio Club Inc., PO Box 252, Gosford 2250.

Amateur station atop Sydney Tower

For the recent Jamboree on the Air, Bankstown Amateur Radio Club set up a temporary station on the Observation Deck of Sydney's highest building: the Sydney Centrepoint Tower. This was the first time that a station had been set up on the tower, and was due to co-operation between BARC, Kenwood Australia and Sydney Tower Management.

The station operated on the 2m, 70cm and 23cm bands, and operation included FM phone, packet data, amateur TV and satellite communications via Aussat transponders. DoTC allowed the use of special callsign VK2BP for the event; this is the main callsign of the NSW Scouting Association, with the initials 'BP' standing for Lord Baden Powell, the founder of the Scouting movement.

The 1991 JOTA was the 34th annual staging of this world-wide event, which began in 1958. ❖

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- Free entry tickets to Australian Reptile Park.
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- Bring your picnic lunch or buy hot and cold food and drink from the stalls in the showground

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FIRST CONTROLLED FUSION REACTION ACHIEVED BY UK SCIENTISTS

TOSHIBA DEVELOPS A4-SIZED INMARSAT-C TERMINAL FOR PC'S

REVIEW OF HEWLETT-PACKARD'S NEW 34401A 'AFFORDABLE' 6.5-DIGIT BENCHTOP DMM WITH IEEE-488.2, RS-232C PORTS

World Radio History

NEWS HIGHLIGHTS

RAMTRON, AWA & INTAQ FORM US JOINT VENTURE

Australian-financed semiconductor maker Ramtron International has formed a joint venture with AWA Limited and Australian hi-tech marketing firm Intaq International, to develop and market automated RF electronic identification (A/ID) systems using Ramtron's non-volatile FRAM semiconductor technology.

The joint venture is known as Racom Systems Inc, in which the three parent firms have equal shareholdings; it is based in Boulder, Colorado. According to Dataquest, the A/ID market worldwide is currently estimated to be in excess of US$4 billion per year, with the RF-based segment worth around US$260 million.

Applications for RF/ID tags include animal ID, inventory tracking, electronic ticketing and baggage ID, electronic article surveillance, factory automation, non-contact smart cards and security access control.

Ramtron's FRAM technology is well suited for RF/ID applications because it combines nonvolatility with fast read/write cycles and extremely low power operation.

Racom Systems has already made a multi-million-dollar payment to Ramtron for a worldwide licence to the FRAM technology.

SUCCESS FOR CSIRO'S AIRBORNE CO_2 LASER

Back in the July 1988 issue, we reported that the CSIRO Division of Exploration Science in Sydney had developed the world's first 'active' airborne remote mineral sensing system, based on infrared scanning with a rapidly tuned and pulsed CO_2 laser.

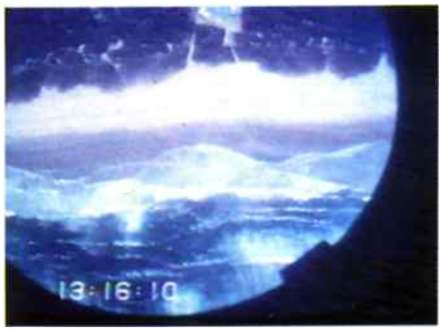
Since then the system has undergone continual refinement, and has recently been successfully trialled in a series of airborne tests over Southern NSW.

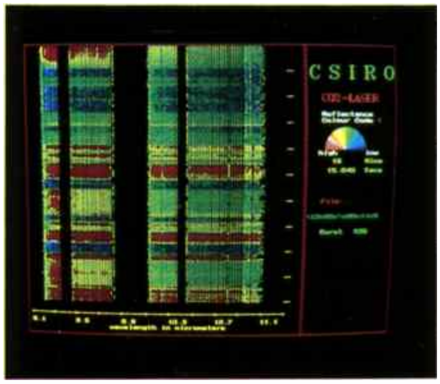
In addition to refinement of the system hardware, considerable progress has also been made in software to process the huge volume of data collected by the system, and present it in a form that is readily interpreted and used.

The latest software processes the data to produce pseudo images, which display ground reflectance coded in colours, with the image's horizontal lines each representing a scan of IR wavelengths, and the vertical axis representing laser/aircraft position along the traversed path.

This allows a much easier interpretation of the data, compared with previous methods.

Shown in the pictures is an aerial photo taken during a scan of a beach, with the corresponding pseudo-image of the laser scan data for the same path.





Red areas show high reflectance at the wavelengths concerned, while blue areas show low reflectance. Each kind of mineral tends to exhibit a characteristic pattern of reflectance at different wavelengths.

FIRST CONTROLLED FUSION REACTION

After many years of intense research and experimentation, scientists in the UK have finally succeeded in achieving a substantial amount of energy from a controlled nuclear fusion reaction — ahead of their rivals in both the USA and Japan.

The reaction took place at the Joint European Torus (JET) experimental fusion reactor, at Oxfordshire in Southern England.

Although it only lasted for 'a couple of minutes', it apparently produced over one megawatt of energy. The energy came from fusion of deuterium atoms, with a small amount of added tritium (both deuterium and tritium are isotopes of hydrogen).

Temperatures reached in the JET fusion reactor were 300 million degrees Celsius, 20 times hotter than the centre of the Sun. The fusion plasma is contained by very intense magnetic fields, to prevent the very high temperatures from melting the reactor walls.

Although the success represents an important milestone in the development of fusion reactors for production of energy, the scientists warned that there is still a long way to go.

It is regarded as unlikely that an operational fusion reactor will be in use before about 2040.

NASA CONTRACTS TO FIX HUBBLE TELESCOPE

NASA's Goddard Space Flight Centre in Greenbelt Maryland, has awarded a contract to the Ball Corp of Boulder, Colorado to complete construction of the Corrective Optics Space Telescope Axial Replacement (COSTAR) for the Hubble Space Telescope (HST).

COSTAR was recommended by the HST Strategy Panel members from more than 50 options. The first opportunity to install the COSTAR is during a servicing mission currently planned in early 1994.

This contract award is part of a definition and development process, the results of which will be confirmed early next year.

Using a set of 10 small mirrors and mechanisms to position and support the mirrors, COSTAR is designed to correct the Hubble Space Telescope's spherical aberration.

The correction is intended to restore significantly the scientific potential of three major instruments on board the observatory — the Goddard High Resolution Spectrograph, the Faint Object Spectrograph and the Faint Object Camera.

World Radio History

REMOTE METER READING INTERFACE

Siemens has launched its 'CAMRI' computer-assisted meter reading interface, developed and manufactured in Australia to allow automatic remote reading of electricity, gas and water meters for both domestic and industrial installations.

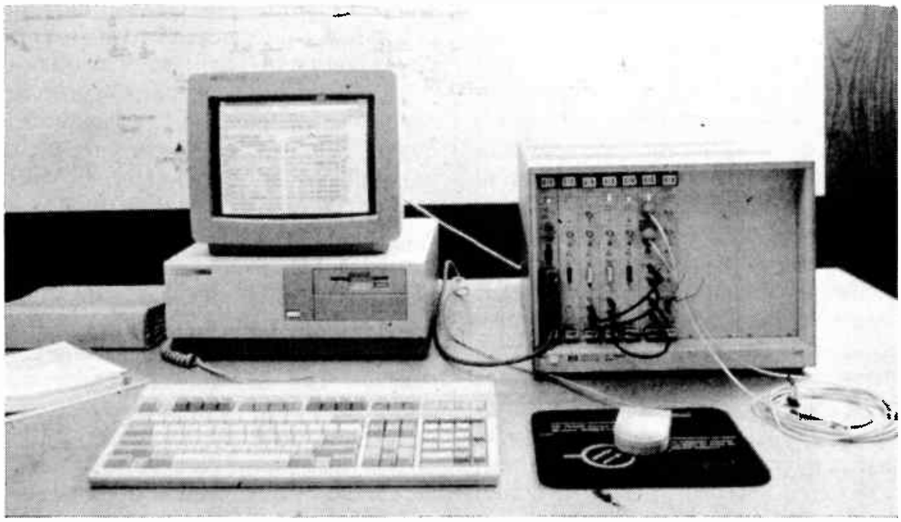
The CAMRI system uses the paging network for outgoing commands to the remote units at customer premises, so that either individual or 'broadcast' commands can be sent. The remotes then use existing telephone lines to send the metering data back to the Host Control Centre, based at each utility. There is no disturbance to existing telephone equipment, and no additional exchange equipment is required.

Features of the system include load management, billing management and security detection for both tampering and loss of supply.

It also has the ability to be fitted with a convenient 'consumption meter' display, allowing consumers to manage better their consumption of resources.

A Siemens spokesman said that Melbourne provided an ideal environment in which to develop this kind of system, because of the unusual degree of co-operation between both the supply authorities and the telecommunications carrier.

The Company believes that the CAMRI system has great potential for mass application, both within Australia and overseas.



HIGH END OPTICAL NET TESTER FROM H-P

Hewlett-Packard Australia has developed an advanced high-end optical communications network testing system, the HP 75000 Series 90 Modular SONET/SDH Analyser, which appears to have stolen a march on competing products from Japan, the USA and Europe.

The new Analyser is able to generate, receive and analyse optical network data at rates of up to 622Mbps. Although estimates of the hardware development time alone for the instrument were 30 man-years, the complete project was achieved in less than 12 months by a team of 22 technicians and engineers at H-P's wholly owned subsidiary the Australian Telecommunications Operation (ATO), based in Melbourne. A feature of the HP 75000 is its use of 'soft technology', where high speed FPLA (field-programmable logic array) chips are configured by downloading micro-instructions from a floppy disk.

This allows updating at any time, as system standards and requirements change — an important consideration in optical communications, where global standards are still in a state of flux.

In the first 10 weeks since it was launched, the Analyser gained world-wide orders of over $6 million from major telecomms organisations in Japan, Europe and North America. The potential global market is estimated to be around US$100 million per year, by 1995 — when countries like the USA are expected to have converted approximately 50% of their networks to optical fibre.

WINNERS OF OUR OBIAT SCOPEMETERS

During the months of May-August 1991, *Electronics Australia* subscribers had the opportunity to win one of three exciting new Philips-Fluke handheld ScopeMeters, provided by local distributor Obiat Pty Ltd. The ScopeMeters combine a dual-channel 50MHz digital sampling scope with a 3000-count digital multimeter, all in a compact handheld package.

Lucky winner of the top-of-the-range model PM97 ScopeMeter, worth $2796 including tax, was:

Mr T. Lester, of Picnic Point in NSW.

Winners of the two PM95 ScopeMeters, each worth $2274, were:

Mr G. Cutting, of Chelsea in Vic;

Mr F.B. Crosby, of Norandu in WA.

Our congratulations to these lucky subscribers for their success in the competition. We hope to review one of the ScopeMeters soon in the magazine itself — when Philips-Fluke can spare one. We hear they're proving an extremely fast-moving line, with orders well in advance of stocks.

AUSTRALIAN BALLASTS FOR TAIWAN

Sydney manufacturer Vossloh-Schwabe is successfully exporting its fluorescent lighting ballasts, made with Australian BHP steel, to South East Asian markets including Singapore and Taiwan. A wide range of Vossloh-Schwabe ballasts is manufactured at Castle Hill, including a very successful low loss ballast which offers substantial energy cost savings for operators of large buildings.

The low loss ballast uses 1.5 watt loss grade steel, which allows a ballast unit to lose just six watts of energy during operation, compared to 10 watts for the more commonly used 3.5 watt loss grade steel.

This provides substantial savings in electricity usage for a major building, both directly by reducing lighting electricity requirements, and indirectly by producing less heat so the building needs less electricity for air conditioning.

AWAM CHIPS TO SILICON VALLEY

In a 'coals to Newcastle' operation, AWA MicroElectronics in Sydney is supplying chips to Silicon Valley in the United States. The firm delivered five million high performance graphics clock generator chips last year to Chrontel Inc, an electronics company based in California.

The chips were to be used in over 25% of the Super-VGA cards sold on the US

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market. Chrontel's chip design synthesises 32 programmable frequencies on-chip, thus eliminating multiple external clocks and saving on board space.

According to the president of Chrontel, David Soo, AWA was originally chosen as a second source to a large Japanese semiconductor company. However, AWA consistently produced product in much less time than other suppliers while at the same time costing less, he said.

AWA Microelectronics recently commenced a second shift at its modern semiconductor plant in Homebush in Sydney to cope with the overseas orders it is winning.

BIG INVESTMENT IN LCD'S BY PHILIPS

Philips is to make major investments in the setting up of a large scale production facility for flat panel displays, in Eindhoven. Philips plans to invest more than 200 million Dutch Guilders in the first phase of the project.

The new facility — producing flat panel displays based on Active Matrix LCD technology — will start commercial deliveries in the course of the first half of 1993. At full capacity about 450 people will be employed in manufacturing and development. The unit will serve both as an inhouse supplier to several divisions of Philips Electronics, as well as to electronic equipment manufacturers outside Philips.

Discussions are taking place with various companies interested in a possible participation in a joint venture, for which the factory in Eindhoven would be the mass production centre.

$15M SATELLITE NETWORK FOR PAPUA NEW GUINEA

The Papua New Guinea Post and Telecommunications Corporation has signed a A$15 million contract with Scientific-Atlanta for a new domestic satellite communications system which will provide state-of-the-art telecommunications throughout the country.

When the system is completed in late 1992, all residents of Papua New Guinea will have greater access to reliable telephone, telex, data and television services.

The new network will provide all-digital telecommunications capability for transmitting voice and data information as well as transport services for conventional analog FM television. The satellite system is a restoration vehicle for the current terrestrial microwave system which has had reliability problems caused by a variety of factors, including vandalism and natural disasters.

The new system consists of one 11 metre master digital earth station, 13 seven metre remote digital earth stations and four 2.4 metre transportable earth stations. The transportables are designed to be airlifted by helicopter and relocated to rural areas on an as needed basis. The earth stations will communicate via Paiapa — an Indonesian satellite.

TRIALS USE ISDN FOR OB LINKS

Savings of up to 70% in transmission costs and substantial increases in signal quality have been achieved in ISDN link trials recently completed by Telecom Australia and Radio 2WS.

According to Fred Tuckwell, Principal Consultant/Corporate Customer Division, Telecom Australia, ISDN offers broadcasters a number of benefits which have significant impact on both the cost and quality of broadcasting.

"2WS engineers are impressed with the lack of noise and distortion, the consistent quality of the signal and savings derived from the switchability of the link," said Mr Tuckwell.

Designed to replace dedicated 10kHz bandwidth analog lines linking OB venues to the studio, ISDN Microlink connections can be made on demand with guaranteed high quality transmission.

"A conventional OB requires a broadcast quality link, one way, from venue to station, a broadcast quality line, one way, from station to venue, a normal (two way) line for off air voice communication, and often a low speed data link for information and/or remote control," explained Mr Tuckwell, who has pioneered this ISDN application.

"The recent trials have established the effectiveness of incorporating all of these functions in a standard Microlink line comprising two 64-bit/s information carrying 'B' channels and one 16 kbit/s signalling 'D' channel."

PORTABLE INMARSAT-C TERMINAL FOR PC'S

Toshiba Corporation has developed a portable satellite earth station terminal for wireless data communications between personal computers via Inmarsat-C. The new terminal makes it possible for a user in a remote location to communicate with other computers directly via satellite, as well as over public telephone and telex lines. Cost of the terminal is US$17,000.

With its light weight (4.0kg) and a compact size (about that of an A4 sheet), the new terminal is intended for businessmen, journalists, world travellers and the staff of international organisations who require timely transfer of data to and from offices.

It will be particularly effective in regions where the poor availability or quality of telephone services makes it impossible to communicate via modems. Combined with a notebook computer, the complete system can be carried in a brief case.

The new TM1700A hardware comprises a four-element flat type satellite communication antenna for sending and receiving data, and its related transmitter and receiver circuits. Dedicated PC communication software allows operation on IBM compatible computers that connect to the terminal with an optional RS-232C cable.

NEWS BRIEFS

- Australian PC enhancement-board builder ***Hypertec*** has promoted Adrienne Lambert to the post of National Dealer Manager, and Andrew Mote as Dealer Manager to assist Ms Lambert.
- The ***Public Broadcasting Association of Australia*** has announced the appointment of Dr. Jeff Langdon as National Co-ordinator of Public Television, to cater for the growing number of public television groups.
- ***BASF Australia***, a subsidiary of the giant German chemical, plastics and magnetic media group, is moving to a new $40 million head office and distribution centre in Noble Park in Melbourne. The new address is 500 Princes Highway, Noble Park 3174; phone (03) 212 1500.
- Hathaway Systems Corporation of Denver USA now has a controlling interest in CSD of the UK, which is now known as Hathaway-CSD Systems. ***Macey's Electrical***, which has represented CSD for many years, has been appointed the sole Australasian representative for both companies.
- ***Composite Electronic Components*** is a new distributor for the extensive array of Siemens Semiconductor devices, from ISDN to signal diodes. CEC's address is 53 Talavera Road, North Ryde 2113; phone (02) 878 5099.

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The terminal is easily set up by switching on the equipment and aligning the antenna with an Inmarsat satellite. Positioning is confirmed by a LED level meter, while all the directions necessary for control and operation are displayed on the connected computer.

Features that contribute to ease-of-use include automatic dialling up of up to eight addresses that can be stored in the unit, and an error check function which ensures error-free transmission.

A rechargeable NiCad battery allows users in the field to transmit for 30 minutes or to receive for 60 minutes, sufficient for most data communications.

The batteries can be recharged from a car battery, and a display meter on the terminal indicates remaining power and when recharging is necessary.

Mains power operation is also possible with an AC adaptor (available for 100 and 240V) that is included as a standard accessory.

JINDALEE ANTENNA CONTRACT SIGNED

Telecom Australia and Melbourne-based company Radio Frequency Systems (RFS) have signed a $27.5million contract for the design, manufacture and installation of the antennas required for the Jindalee Over-the-Horizon-Radar project.

RFS already has substantial experience in supplying sophisticated communications equipment to both Telecom and the Defence Department.

Telecom's Jindalee Project Office chose RFS on the basis of its track record, the fact that it is based in Australia, and its considerable previous experience with antennas at the existing Jindalee facility at Alice Springs.

CYBEC BREAKS INTO UK ANTI-VIRAL MARKET

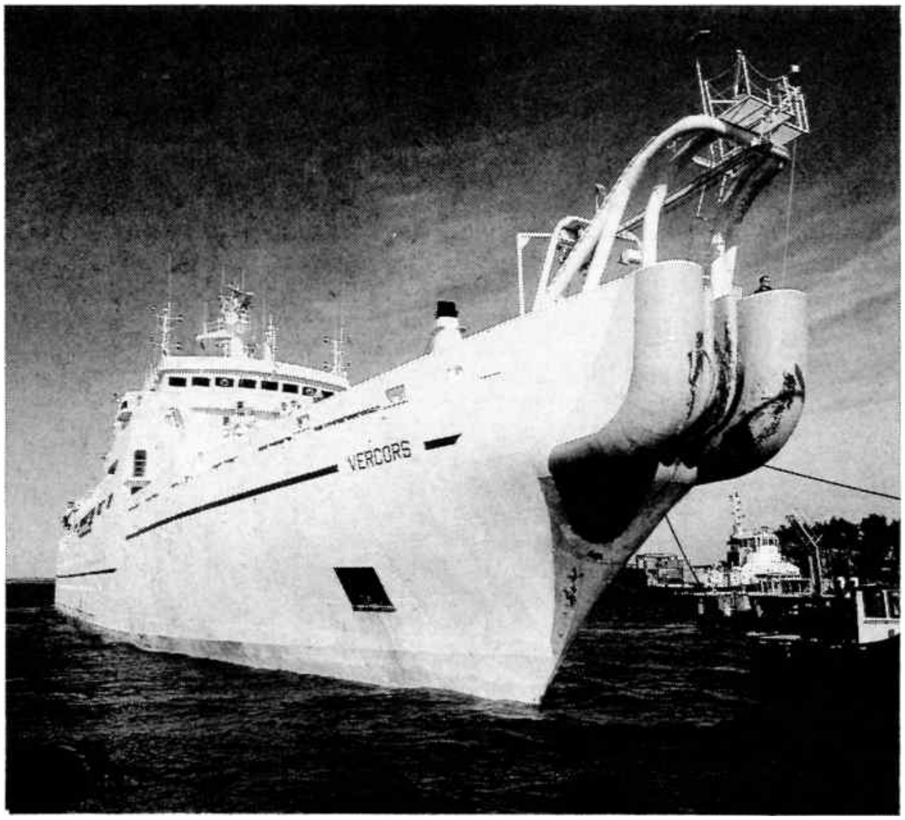
Melbourne based computer security firm CYBEC has recently made a major advance in its bid to enter the export market, with the signing of a site licence to cover all 3500 PCs at Manchester University with with the firm's VET Anti-Viral package.

CYBEC is a wholly Australian owned company founded by electronics expert Roger Riordan, well-known in the electronics industry for his development of the first high performance gyrator using op-amps.

Mr Riordan has been working against computer viruses since 1989. He was a lecturer at Chisholm Institute of Technology when the Marijuana virus paralysed thePC labels there.

None of the available software seemed to be able to bring the outbreak under control, so Mr Riordan set about writing one of his own which he called VET.

CYBEC is also rapidly increasing its market share back home in Australia. Both Sydney University and the Victorian University of Technology have also taken out licences.



A recent visitor to Sydney's Port Botany was the French cable ship 'Vercors', whose visit was for laying the Tasman 2 optical fibre cable between Australia and New Zealand. To ensure accurate laying and recovery of marine cables, the vessel is fitted with full GPS navigation systems. It also carries its own jointing room, with X-ray facilities for testing the completed joints. Under normal weather conditions she is capable of laying up to 120 nautical miles of cable per day.

ADELAIDE TO HOST HOME ENTERTAINMENT EXPO

Some of the world's latest electronic gadgetry and sound and audio visual equipment will go on show in Adelaide next July, when it hosts The News Home Entertainment Expo.

The event, the biggest of its kind ever staged in the state, will be held at the Adelaide Hilton from 24th to 26th July, 1992 and will feature home theatre and television, hifi, photographic and video equipment, musical instruments, personal computers, electronic games, CD's, records and cassettes, and communication systems.

US CONTRACT FOR AWA TRAFFIC LIGHTS

The first high-tech traffic control system of its type ever installed in the United States to control road traffic and combat congestion is being provided by AWA Limited.

The signing of a A$2.7m contract for the system management and provision of the traffic equipment to Oakland County in Michigan is described by AWA's chairman and chief executive Mr John Iliffe as a market breakthrough of major significance.

"Australia has established a lead in its development of road traffic management systems and leads the world in this area of technology," he said.

"The system will be installed under this new contract in the city of Troy, Oakland County and is based on the SCATS Adaptive Traffic Control System developed by the Roads and Traffic Authority of NSW. It is now used in Sydney and most other Australian and New Zealand capitals." ❖

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Silicon Valley NEWSLETTER

Apple-Sony alliance possible

The ink on the Apple-IBM alliance documents had hardly dried before the Cupertino personal computer maker said it is negotiating for a second major alliance, with Japan's Sony. The goal of this deal would be to merge Sony's consumer electronics hardware and manufacturing technologies with Apple's superior software and systems design skills.

"I can't talk about this, other than to say that I am talking to Ohga," said Apple chief John Sculley — referring to Sony president Norio Ohga, who also engineered the take-over of Columbia Pictures and CBS Records.

An alliance between Apple and Sony would not be surprising, and far less unlikely than the teaming up with IBM. Sony has been a steady supplier to Apple of leading edge components, including the active-matrix flat panel displays Apple used in its original Macintosh laptop.

During the past year Apple and Sony have cooperated closely on a series of projects, and reportedly one of the three laptop and notebook computers Apple introduced at Comdex is manufactured for Apple by Sony.

The new talks apparently are aimed at giving the two companies a better shot at the future market for advanced consumer electronics products. More and more computer and consumer electronics technologies are overlapping or joining, such as in multimedia computing, CD-ROM and DAT.

Combining Sony's ideas for next generation consumer electronics with Apple's easy to use computer technology could generate a whole new class of products that consumers may be able to snap up by the millions.

Intel Corporation's president and CEO Andy Grove, shown here in relaxed mood. However like most other companies in Silicon Valley, Intel has had to keep a tight rein on expenditure, and Grove has been particularly vigilant in this regard — as shown by the story opposite.

Chip speeds up laser printers

Destiny Technology, a Milpitas-based chip startup, launched its first product with the promise of becoming a big name in the market for laser printers.

The chip, a 'Raster Image Device Accelerator' (RIDA) allows laser printers to print any kind of typographic typeface with the same ease, and precisely copy complex graphics images as seen on a computer display.

The chip, also known as a WYSIWYG (What-You-See-Is-What-You-Get) device, will potentially allow even low cost laser printers to increase their processing speed by a factor of 20 to 50.

According to Destiny its US$35 RIDA chip will enable laser printers to print out up to three pages of text per second — that is if the printer is able to keep up with the chip's dazzling speed.

By comparison, most of today's laser printers produce 4-to-8 pages per minute, but only under ideal circumstances. In many applications, only 1/2 to 2 pages per minute are produced.

"Technologically this chip is important," commented market researcher Angele Boyd at International Data. She explained the chip will enable many low end laser printer makers to compete head on with the market leaders such as Apple and Hewlett Packard.

Already Destiny claims to have signed supply contracts with nine of the 11 largest laser printer makers in the world.

The company which was formed by a group of Tainwanese chip engineers, expects sales of the chip to reach US$20 million in its first year.

Chip will cut teleconferencing costs

Today's full-motion teleconferencing systems cost US$20,000 or more. But thanks to a hot new chip produced by Silicon Valley startup Integrated

Continued on page 138

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SIEMENS

Performance you can take with you: PCM 30 analyzer K 4304

Soon you will never want to be without the K4304 again. Partly because you can always take it with you wherever you go to make bit error measurements in 2-Mbit/s systems. But especially because the K4304, despite its small size, has a performance equal to that of large units. It is transmitter and receiver in one. It diagnoses during operation — as an in-service monitor for 2-Mbit/s transmission routes and their 64-kbit/s channels. And it can operate out of service as a bit and code error tester.

Its individual features:

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Siemens test equipment for reliable communications

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Continued from page 136

Information Technology (IIT), that price tag may soon come down to less than US$3000. IIT has launched its first product, a US$150 data compression circuit that leapfrogs the competition, including such moguls as Intel, C-Cube and LSI Logic. With the device, teleconferencing can be brought down to the PC level, according to IIT vice president Paul Chu.

Mr Chu said the company's chip incorporates all of the data compression formulas currently under consideration for use as an industry standard. Processing full-motion video takes as much as 24 megabytes of data per second. With compression technologies, ICs can vastly reduce the amount of data that needs to be sent.

Compression Lab, a pioneer in data compression based teleconferencing, announced it is already using the IIT chip in a new product to be launched in the near future.

Monterey hopes for 'Silicon Bay'

First there was Silicon Valley. Its success spun off other concentrated high-tech industrial areas, such as Silicon Mountain, Silicon Desert, Silicon Glen, Silicon Island — and even Silicon Swamp, as LSI Logic chief Wilf Corrigan usually refers to the Milpitas location of his company. Now, there may soon be a Silicon Bay as well.

Early last year President Bush and the US Congress agreed to the closure of more than 30 US military bases, including the huge Ford Ord facility in Monterey Bay.

The closure is expected to put a huge dent in the local Monterey economy. But local authorities are seriously considering converting the 28,000 acre base into a high-tech manufacturing centre, where companies from nearby Silicon Valley can quickly expand production.

The move makes a lot of sense. Labour rates in the Monterey area are less than half of those in the Valley. And the close proximity to headquarter facilities in Silicon Valley would provide high-tech firms with several logistical and economic advantages over locating facilities in other parts of the US or overseas.

The Ford Ord base is scheduled to close some time between now and 1997. If the government accepts proposals for converting the base into a manufacturing business park, it could speed up the closure procedures.

For one, the government would stand to reap in a handsome profit from the sale or lease of the base, which is situated on some of the most desired ocean front property in the world.

Setting a good example

Intel and its chief Andy Grove have fostered a solid reputation for leaving little room for lavishness and waste in the way Intel operates. Apparently, Grove lives quite strictly by the rules he imposes on his staff.

Grove was spotted recently by a Silicon Valley reporter at a Palo Alto gas station, using a pay telephone. Less than 10 feet away was Grove's Saab 900 convertible equipped with the latest in cellular telephone technology. After Grove ended the 20 minute call, the reporter approached Grove and asked why he was using the pay phone when he has a cellular system in his car.

"Why do you think? Because it is cheaper. That's right!" responded Grove, before driving off to work.

Intel to double speed of 486 chips

Intel is apparently planning to make selected high-end processors available, produced with an advanced technology that effectively doubles the speed of the chips.

Intel will offer the so-called 'clock doubling technology' as a premium option on 486 and 586 processors. The technology was recently used to double the speed of Intel's i860 RISC processor. Key features of the new technology is that chips made with the technique can simply be plugged into the socket of a standard 486 processor and vastly boost the system's overall performance. Even current 486 PC owners will be able to upgrade their systems with the advanced chip.

Until now, systems houses had to redesign their entire product if they wanted to incorporate a higher clock speed processor.

Apple signs new deal with Adobe

Adobe Systems of Mountain View has announced the end of a challenge to its dominance in computer typeface software, saying Apple Computer will again use Adobe technology.

The announcement came almost two years after Apple and Microsoft, the leading personal computer software maker, announced plans to jointly create an alternative to Adobe's so-called 'Type-1' software that controls the way computer display typefaces appear on the screen. Apple and Microsoft also were to create an alternative to Adobe's PostScript software, which controls the output of laser printers.

Microsoft abandoned the development in June. Apple, earlier this year, launched TrueType along with its new System-7 operating system. But Apple customers have demanded that the company continues to support Adobe's Type-1. Apple said it will now ship laser printers and other products with both Type-1 and TrueType, following the new agreement.

Analysts said the agreement with Apple signifies a complete victory for Adobe which has survived the potentially devastating onslaught by the Apple-Microsoft effort. Now, the company will be virtually assured market dominance in the laser printer typefont business for years to come.

IBM is firmly committed to the Adobe standard, and may have leaned on Apple to stay with the industry standard in order to enhance the marketing success of future systems that will result from their joint effort.

HAL gets US$40M from Fujitsu

Japanese giant Fujitsu is investing US$40 million in Silicon Valley startup firm HAL Computer Systems.

The money will be used to complete development of a new high performance mainframe computer, which will use SPARC RISC processors and the Unix operating system to compete with IBM, Amdahl and others serving the vast corporate large-scale data processing market.

HAL is based in Campbell and was founded in May 1990 by a group of veteran computer executives and engineers, to challenge the mainframe market leaders with a new breed of high performance, yet inexpensive computers. The company is headed by Andrew Heller, former general manager of IBM's workstation division.

Heller said that while HAL has relied on several US venture capital firms in the first round of financing, the money needed to complete the project is "beyond the scope of the US capital community."

HAL currently employs some 150 people. To date, the company has refused to discuss any details of their computer, expect in the vaguest of terms. ❖

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Subharmonics:	-25dBc (>500MHz), None (<500MHz)
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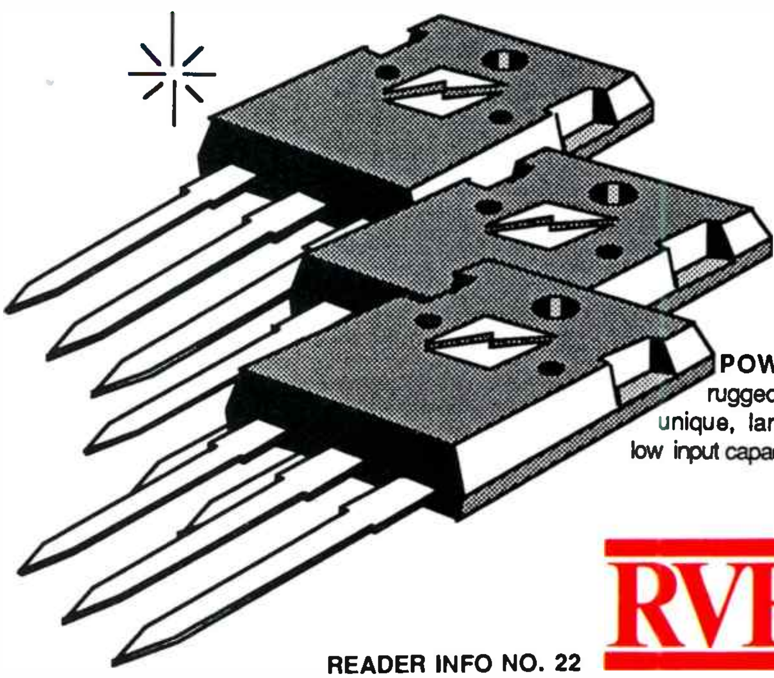

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Test Instrument Review:

H-P'S NEW 34401A 6-1/2 DIGIT BENCH DMM

The latest addition to Hewlett-Packard's growing range of 'affordable' mid-range test instruments is a new 6-1/2 digit bench-type digital multimeter with system capabilities. Like the new 54600 series of DSO's released early last year and the E3610/11 power supplies which followed a few months later, it offers many impressive features — for a surprisingly competitive price.

by JIM ROWE

When the 54600 series of digital sampling scopes was launched in Australia last year, H-P spokesmen warned that these were merely the start of a complete new range of instruments which would extend the company's traditional high performance and reliability down into the more competitive mid-priced market area. H-P had decided to exploit some of the innovative technology developed for both the design and manufacture of its high-end products, we were told, and would be using this to re-establish itself in cost-sensitive areas such as production testing and field servicing. (See our review in the May 1991 issue).

It was indeed only a couple of months before we saw the new E3610/11 compact benchtop power supplies, as we reported in our November issue. And now a further instrument has been

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released, shortly before the end of the year: the new 34401A bench DMM. As with the earlier instruments, the 34401A is the end product of quite a lot of market research.

H-P was apparently well aware that the market for traditional benchtop DMM's is shrinking — squeezed from below by the handheld models (many of which now offer much the same performance, at a significantly lower price), and from above by the 'system' models with their higher performance and ability to be interfaced with a computer for automated testing.

In developing the 34401A, the goal was therefore to produce an instrument with as many of the features of a 'system' model as possible, but at a price which would be comparable with traditional benchtop models. And judging from the basic specs of the new instrument, that goal certainly seems to have been achieved.

For a start, the 34401A offers 6-1/2 digit resolution — at least one full digit more than others in the same price range. It also boasts such features as a basic 24-hour DC accuracy of 0.0015%; both HPIB/IEEE-488.2 and RS-232C interfaces inbuilt as standard; the ability to make up to 1000 readings, and as many as 50 range/function changes per second; 'maths' functions such as null or zero compensation/relative reading, direct dB/dBm readings, minimum/maximum and limit testing, and DC ratio measurements; a choice of either two-wire or four-wire resistance measurements; a memory capable of storing up to 512 readings; two alternative sets of test jacks (front and rear), selected by a pushbutton; and the ability to make true-RMS ACV, dB, dBm and frequency/period measurements up to 300kHz.

In terms of performance, then, the 34401A offers most of the features found on high-level 'system' instruments. Thanks to H-P's extensive use of surface-mount technology it also offers a level of ruggedness and reliability so high that the calculated MTBF (mean time between failures) is greater than 100,000 hours — corresponding to a working life of around 50 years, if used for 40 hours a week! In fact H-P is so confident of the reliability that it's offering the instrument with a three-year warranty.

The 34401A also meets industry standard tests for environmental tolerance, such as MIL-T-28800E (Type III, Class 5) and MIL-461C. And the price for all of this? In Australia it will be selling for a list price of only **$1300** — a figure that will, I suspect, give H-P's competitors a great deal of heartburn.

As you can see the rear end of the 34401A is quite crowded. Visible at the left are the alternative set of input jacks, along with their protective fuse. At upper right is the mains input and voltage selector, with the HP-IB and RS-232C interface connectors below them. The two BNC sockets in the centre are for external triggering and a logic output signifying the end of each measurement.

A closer look

The basic 34401A is by no means tiny; it measures 88.5 x 213 x 349mm (H x W x D), and weighs 3.6kg. There's an adjustable tilting bail/carrying handle built into the case, and it also comes with a set of protective rubber 'buffers' — which can be removed (along with the handle) if you wish to mount the instrument in a rack. An optional strap-on accessory pouch houses the test leads, accessories, user manual and power cord for transport.

The display is of the vacuum fluorescent type, with bright green characters. The main characters are 10mm high and highly readable, with a total of 12 positions used for polarity sign, reading digits, multiplier, unit and measurement mode indication respectively. Below these main characters are a set of 12 smaller annunciators, used to display secondary functions.

The main section of the display actually has full alphanumeric capabilities, and is used in this way during selection of the 34401A's many operational modes and functions — which is done via a series of menues.

Under the display are 15 pushbuttons, with the power switch at far left and the remaining 14 in two rows forming the main control keypad. Most of these keys have dual functions, with a blue 'shift' key at lower right used to select the second function as desired.

The five keys at upper left are used for measurement function selection, giving a total of 10 basic modes: DC volts or current, AC volts or current, 2-wire or 4-wire resistance measurement, frequency or period, and continuity or diode test. The other two keys at upper right are used for selection of 'maths' options for measurement display processing: dB or dBm, reference reading null, or Min/Max storage.

Three keys at the centre of the lower row are used for measurement range and resolution selection. Like all modern DMMs the 34401A has autoranging, but here it also allows you to disable this and select the desired range manually when doing so is more appropriate or convenient.

It can also operate in a choice of three different resolution modes: either 4-1/2, 5-1/2 or 6-1/2 digits. Why? Well, measurements to full 6-1/2 digit resolution inevitably take longer than for lower resolution, so H-P has thoughtfully made provision for 'dropping back a digit or two', where measurement speed may be more important than resolution. The default when the instrument powers-up is the 'compromise' 5-1/2 digit setting, but this is easily changed up or down as desired — and separately for each kind of measurement.

The same three lower centre keys are also used in conjunction with the pair at lower left, for negotiating the 34401A's secondary-function menu system. The menues have a top-down 'tree' structure, with six main menues — each of which

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has a number of command selection options, with the lowest level allowing selection of parameter settings. To move around the menu levels you effectively have four cursor keys (up, down, left and right), and an 'enter' key to terminate a selection.

The six main menues are labelled MEASurement, MATH, TRIGger, SYStem, Input/Output and CALibrate. The first of these is used to select such secondary functions as AC filter time constant, continuity beeper threshold, input resistance for the three lowest DC volts ranges (10MΩ or 10GΩ), enabling of the DCV/DCV ratio function and resolution programming (in greater detail than with the dedicated keys).

The MATH menu allows selection of the various options for processing the 34401A's readings: Min/Max, Null value, dB relative, dBm reference impedance level, limit test, and setting of high and low limit levels.

The TRIGger menu similarly allows selection from a number of options, when it comes to triggering each measurement. In default mode, the 34401A takes measurements like most DMM's on a continuous basis, with automatic self-triggering.

However if desired it can provide a number of other options: single shot via a front-panel key or external trigger signal, or programmed software triggering via the HPIB or RS-232C interfaces.

In the latter mode the 34401A can make from 1 to 50,000 measurements per trigger command, and can also be programmed to insert a delay of from 0 to 3600 seconds between each trigger command and the actual measurement(s). It's very flexible.

The SYStem menu allows you to set up some eight different aspects of instrument operation. These include enabling/disabling the reading memory function, activating memory recall, retrieving error messages, performing a complete self-test, enabling/disabling the display or 'beeper', or enabling/disabling a 'comma' digit separator in the display, as used in many European countries.

As you'd expect, the Input/Output menu is used to set up various aspects of the 34401A's communications interfaces. Here you can select either the HPIB or RS-232C interface to be active; set the instrument's HPIB address (0-31); set the RS-232C baud rate and parity mode; and finally program the 34401A to communicate in either SCPI (Standard Commands for Programmable Instrumentation) language, HP 3478A language or Fluke 8840A/8842A language. Only SCPI language is available for RS-232C communication — but as you can see, the instrument is again very flexible.

Finally, there's the CALibration menu. This provides various options to allow securing of the 34401A's calibration, 'unsecuring' for calibration, and the actual calibration process itself — which can be automated.

Incidentally, virtually all of the 34401A's operation and functions can be controlled remotely via the HPIB or RS-232C interfaces. This includes control of all secondary functions via the menu system.

At the right-hand end of the front panel are the input jacks, which are of the fully shrouded and recessed type. And as noted previously there's a complete second set of jacks at the rear of the instrument, for use in rack installations. The final pushbutton on the front panel is used to select between the two sets.

Two of the input jacks are the usual 'Lo' and 'Hi', used for all voltage measurements, 2-wire resistance and also diode testing and continuity. A third jack is used as an alternative 'Hi' input for current measurements, while the two remaining jacks are used for the 'sense' inputs for 4-wire resistance measurements.

Incidentally the 34401A actually provides two different ways to measure lower resistances accurately. You can either use the 'Kelvin' 4-wire method, with separate pairs of wires for supplying the test current and sensing the voltage drop, or use the simpler 2-wire method and rely on the instrument's reference nulling facility to cancel out the resistance of its test leads.

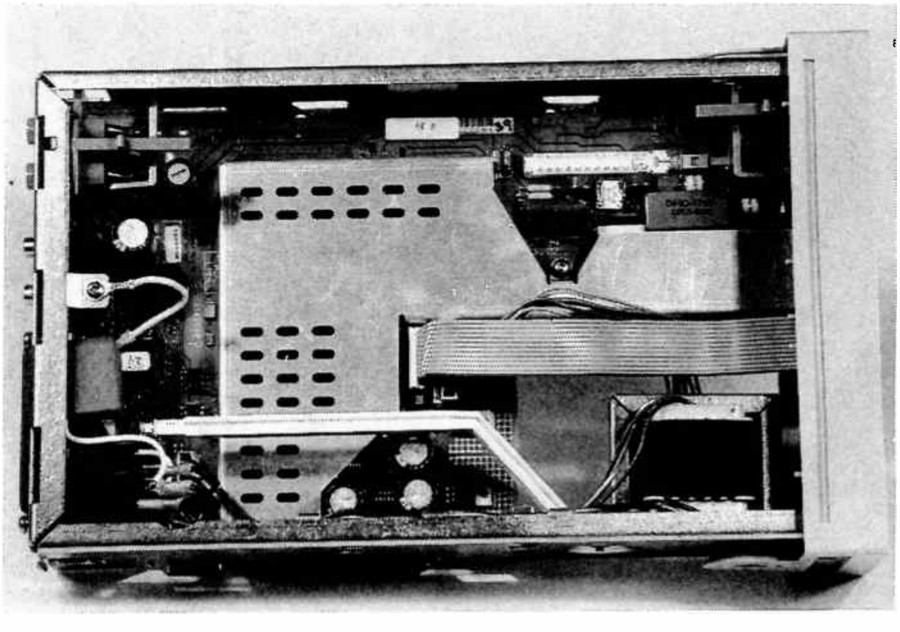
The 4-wire method is of course that favoured by metrology labs, and tends to be more accurate. But the 2-wire method is somewhat faster and less fiddly, and can often give sufficient accuracy. In any case the 34401A gives you the choice, so it's up to you!

As you might expect, the rear panel of the 34401A is fairly busy. Along with the duplicate set of input jacks there's a fuse for the current inputs (both front and rear), the mains input socket and voltage selector/power fuse, the HP-IB/IEEE-488 and RS-232C (DB9S) connectors, a chassis ground terminal and a pair of BNC connectors — one for external trigger input, and the other providing a 'measurement complete' signal for possible triggering of other test equipment.

The instrument can be set up to operate from any of four AC mains voltages: 100V, 120V, 220V or 240V, with a tolerance of ±10% on each. It can also cope with any mains frequency between 45-66Hz, and in addition between 360-440Hz for use on aircraft and ships. Power consumption is a modest 10W, with peaks of 25VA.

As you can see, then, the 34401A not only provides a wide range of measuring facilities, but is also very flexible. You won't be surprised to learn that in order to achieve all this it incorporates not one,

Continued on page 144



A general view inside the case of the meter, showing its construction. There's a second vertical PCB, mounted just behind the front panel. Virtually all of the meter's circuitry uses surface mount technology.

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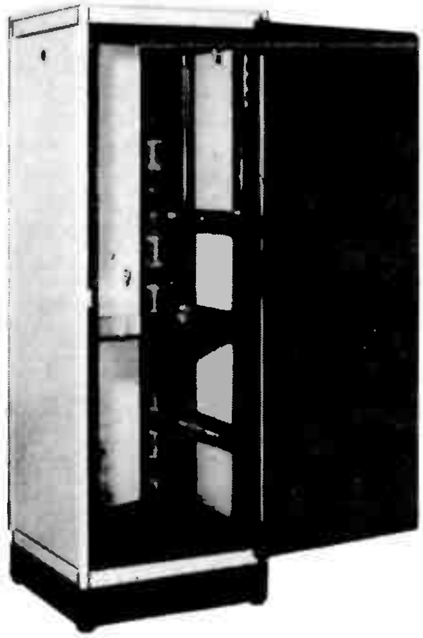

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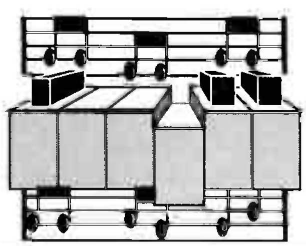

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HP's 34401A DMM

Continued from page 142

but THREE different microprocessors, along with a proprietary H-P analog switch chip and resistive divider network, and a number of ASIC devices. It also uses a special continuously integrating 'Multi-slope III' A-D converter, with a basic linearity of (0.0002% of reading + 0.0001% of range).

By the way the 34401A comes complete with a test lead kit, power cable, calibration test report, a comprehensive user manual and even a servicing manual.

Rated performance

So much for the 34401A's facilities, though; now let's look at its rated performance. This too is pretty impressive, for an instrument in this price range.

There are five DC voltage ranges, with nominal full-range readings of 100mV, 1V, 10V, 100V and 1000V. But except for the 1000V range, these ranges actually extend to 120% of the nominal figure — i.e., 120mV, 1.2V, 12V and 120V. This is a very handy feature, and also applies to most of the 34401A's other measurement functions; the only other exception is the top AC volts range. Rated basic 24-hour DC voltage accuracy at 10V is (0.0015% of reading + 0.0004% of range), extending to (0.0035% + 0.0005%) for one year from calibration. The corresponding figures for the 100mV range are (0.0030% + 0.0030%) and (0.0050% + 0.0035%), with the other ranges in between these limits.

For AC voltage measurement there are also five ranges, but here the top range extends only to 750V. All measurements are in true RMS, with AC coupling capable of rejecting up to 400V DC on all ranges. Useful AC measurements can be made from 3Hz to 300kHz, with the accuracy between 10Hz and 20kHz on most ranges being (0.04% of reading + 0.02% of range) for the 24-hour rating, and (0.06% + 0.03%) over one year.

Needless to say the accuracy is not as good as this at either end of the frequency range, degrading to around (1.00% + 0.03%) at the low end and (4.00% + 0.50%) at 300kHz. The 34401A's true-RMS rectifier circuit can cope with crest factors of up to 5:1 at full scale, with the crest factor error for non-sinewave signals increasing to around 0.40% of reading at 5:1. The input impedance for AC voltage measurements is 1M in parallel with 100pF.

There are seven ranges for resistance measurement, with nominal full scale readings ranging from 100Ω to 100MΩ in decade steps. The rated 24-hour accuracy at 10k is (0.0020% of reading + 0.0005% of range), extending to (0.010% + 0.001%) after one year. These figures are for 4-wire measurement, or for 2-wire with lead nulling; without lead nulling there is typically an additional error of 0.2Ω.

There are four DC current ranges, with nominal full scale figures of 10mA, 100mA, 1A and 3A respectively. The basic 24-hour accuracy at 100mA is (0.010% + 0.004%), extending to (0.05% + 0.005%) over one year. The voltage drop or 'burden' varies from a maximum of 100mV on the lowest range, to a maximum of 2V on the 3A range. For true-RMS AC current only two ranges are available, with nominal full scale readings of 1A and 3A respectively. Basic 24-hour accuracy between 10Hz and 5kHz at 1A is (0.1% + 0.04%), with the same figure also applying over a one year period.

Of the remaining three basic measurement ranges available on the 34401A, one is for frequency/period measurement. This has a range of from 3Hz to 300kHz, and will accept input signals with amplitudes from 100mV to 750V. The rated 24-hour accuracy is 0.006%, extending to 0.01% over one year. The two remaining ranges are for continuity testing (essentially a 1000Ω resistance range, with adjustable threshold), and for diode testing (which measures forward voltage drop at 1mA test current, on a 1V range). The accuracy tolerance band for DC:DC ratio measurements is essentially equal to the sum of the figures for the two individual measurements.

How we found it

Thanks to the marketing people at H-P Australia, we were able to spend a few days trying out the first sample of the 34401A to land in the country. And as you'd expect from the foregoing, we found it a very impressive instrument.

Physically it seems to be quite solidly made, and intended to withstand any normal wear and tear. We sneaked a look inside the case, and found evidence of a lot of careful planning to combine efficient manufacturing, reliable operation and ease of servicing.

Virtually all of the circuitry is mounted on either the main horizontal PCB or a small vertical PCB immediately behind the front panel, and as seen in the interior photo all of the critical areas are shielded.

In terms of performance, I should be candid: we don't really have access at *EA* to calibration equipment good enough to check whether an instrument of this grade meets its specs. However when compared with the reference instruments we *do* have, there was no hint that the sample 34401A did anything other than meet its quoted specification.

We found it commendably easy to use via the front-panel controls — both in terms of setting up for basic primary measurements, and also use of the menu system for configuring its many secondary functions. In the limited time available we couldn't actually achieve satisfactory 'remote' operation via the RS-232C port, but this was probably due more to our own inexperience in programming in 'SCPI', coupled with problems in sorting out the differing needs of the 34401A and our PC's in terms of RS-232C 'handshaking', than to any shortcoming of the DMM itself.

Incidentally the user manual that came with the sample 34401A was a 'preliminary' version, with some of the chapters still in the 'to be added...' form. Our impression is that the final version of this manual will give rather more information on SCPI programming, and thus provide more guidance in this area for 'tyro's like us'. Perhaps if we had waited until the final manuals were available, we would have had fewer hassles...

From the preliminary version, it would certainly seem that the final user manual is likely to be a very helpful guide not only to using the instrument itself, but also to using this grade of instrument for making the most of its potential for accurate and reliable measurements.

All up, then, we found the H-P 34401A a particularly satisfying instrument. It combines high accuracy and reliability with a very comprehensive range of features and facilities, making it far more than simply a high-end bench multitester. As well being suitable for demanding field servicing and development lab applications, it would obviously also be well suited for use as a key component in cost-effective automated production test systems.

In our opinion H-P is to be congratulated for the fact that the 34401A provides all of these features and capabilities for a list price of only $1300. Considering that there are currently a number of 4-1/2 digit DMM's without either RS-232C or IEEE-488 interfaces, costing more than this figure, the 34401A certainly sets a new standard in bench DMM performance/cost. It's a very worthy addition to the new H-P range of affordable instruments.

Further information on the 34401A is available from H-P Australia's Customer Information Centre, by calling (008) 033 821. ❖

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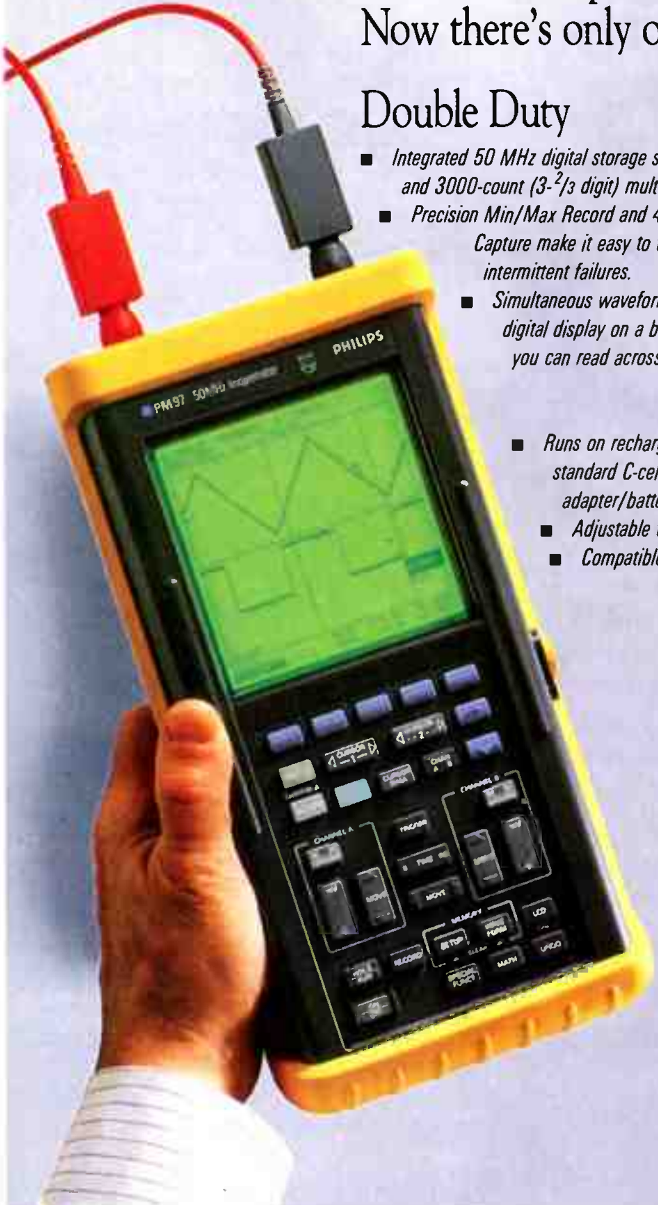

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NEW PRODUCTS

As in previous Annual Digest issues, we have a much wider survey of new products here than in a normal issue. And they're divided into basic categories, to make it easier for you to find those in which you're most interested. Note that video and audio, solid state devices and computer products are presented separately, in their own sections of the book.

TEST & MEASUREMENT

Semiconductor test system

iPTest can be configured to test a wide range of semiconductor components including the following: bipolar transistors, MOSFET transistors, power transistors, intelligent switches, voltage regulators, smart power to 32 pins, diodes and rectifiers, surge suppressors, SCRs and triacs, and arrays to 24 pins.

The system has single or multisocket capability for high current, high voltage and forward and reverse bias SOA tests, and can be dedicated to a particular component type or as a multiple product, multiple function system with analog, logic and stress test capabilities.

Test modes are software configured. Unlike other discrete component test systems, iPTest allows the user freedom to create custom test modes which are additional to all the normal parameters provided for standard component types.

The powerful software is Pascal based and has a menu-driven test plan generation with library storage.

All tests are measurements, and a 16-bit A-D converter ensures precise high speed measurements which means less tests than with conventional 'go/no-go' systems. Automatic error corrections are standard features.

For more information circle 241 on the reader service coupon or contact Electronic Development Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999.

HF wattmeter

Unlike normal average reading HF wattmeters, the Revex W502 from Dick Smith Electronics provides accurate Peak Envelope Power (PEP) metering even when complex transmitter modulation waveforms (such as SSB) are present.

The unit provides accurate RF power and SWR measurements over the 1.8 - 60MHz frequency range, making it suitable for the testing of transceivers and antennas used in the amateur, commercial, military and CB areas. In the POWER mode, you can select from 20, 200 or 2000 watt ranges, while the SWR meter scales have been calibrated separately for readings taken at low and high power levels. The use of LED indicators for average/PEP operation, as well as an illuminated meter movement, simplify the overall operation.

For more information circle 242 on the reader service coupon or contact Dick Smith Electronics, PO Box 321, North Ryde 2113; phone (02) 888 3200.

New handheld Fluke DMM's

The Fluke 70 Series II family of handheld multimeters now consists of eight models, including three new meters and enhanced versions of the existing five models — all combining innovative features.

Two new high performance models, the 79 and 29, can check capacitance from 10pF to 9999uF — ideal for testing large electrolytics and eliminating the need for a dedicated capacitance tester.

An innovative frequency function can simultaneously display frequency, ranging from 1Hz to 20kHz on the digital display, and AC voltage on the analog bar graph. This allows users to see how much potentially hazardous voltage is present when making frequency measurements. A new 63-segment bar graph updates as fast as the eye can follow, and simulates the functionality of an analog needle for watching trends, peaking and nulling. In addition, the models 79 and 29 have 'smoothing', which displays the running average of eight readings, providing stable readings even with fluctuating signals. The same models also have a proprietary Lo-ohms function, which provides 0.01 ohm resolution with high noise rejection to sense very small resistance changes.

For further information circle 249 on the reader service coupon or contact Philips Scientific & Industrial, 25-27 Paul Street, North Ryde 2113; phone (02) 888 8222.

Handheld data-loggers

The AM7002 series six channel data-loggers are the latest addition to the reliable range of Anritsu handheld instruments. Three models are available: temperature thermocouple input, DC voltage input, or temperature and voltage selectable for each of the six channels.

Features of the instrument are high speed sampling, (6ch/sec), large memory capacity and simultaneous display of all channel readings. The LCD display can be switched off for prolonged battery life during unattended data collection.

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The unit also offers up to three months measuring on batteries, high impedance between channels, isolation of the communications circuit and easy 12-key operation.

Computer interface for downloading and manipulation of data is via RS-232C, and software for IBM PS/2 communication is available. Standard memory capacity is 15,000 data items, with optional 60,000 data items available. The baud rate is selectable from 1200 to 9600bps.

For further information circle 244 on the reader service coupon or contact Electromark, 36 Barry Avenue, Mortdale 2223; phone (02) 533 3322.

Two channel service scopes

Meguro Electronics has released a range of two channel oscilloscopes that are especially suitable for service work. Compact and lightweight, the MO-1240 series contains a battery and charging unit for situations where a mains supply is not available, yet still weighs only 5.5kg. Recharging the battery takes just two hours.

There are three models in the range, MO - 1241A/1242A/1243A, covering bandwidths of 20, 40 and 60MHz respectively. All have a sensitivity of 1mV to 5V/division. For readout convenience, voltages, time differences and frequencies

can be displayed on the CRT screen in digital form. Additional convenience for service engineers is the provision of video synchronisation on both horizontal and vertical as standard, along with the simultaneous display of set values (volts/div and time/div) and voltages, frequencies and time differences.

For further information circle 247 on the reader services coupon or contact Anitech, 52/2 Railway Parade, Lidcombe 2141; phone (02) 749 1244.

TV field strength meter

The Metrix VX600S TV measurement receiver performs three main functions: field strength measurement for radio, TV and satellite broadcasts; TV monitoring for video and sound quality checking; and spectrum analysis for the control of specified and adjacent ranges including satellite.

For TV monitoring, the VS600 reproduces the normal television picture. It is possible to shift the picture to the right hand side of the screen and simultaneously display the line trigger pulse in the remaining 25% of the screen space. Thus any TV shadows etc., can easily be identified.

Field strength measurements are displayed in the form of a white bargraph stripe at the top of the screen. The length is proportional to the value of the input signal in dB. The sound inputput is a complementary help in finding the maximum and consequently, adjusting, the antenna for best reception.

The spectrum of the TV band can also be displayed to assist with antenna installation. Using a built-in marker it is possible to adjust frequency, using the built-in digital frequency display on the front panel. An expansion mode simplifies reading of the video-sound carrier spacing and detection of other signals in adjoining channels.

For further information circle 248 on the reader service coupon or contact Elmeasco Instruments, PO Box 30, Concord 2137; phone (02) 736 2888.

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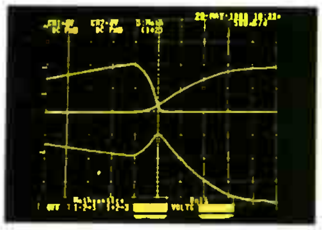

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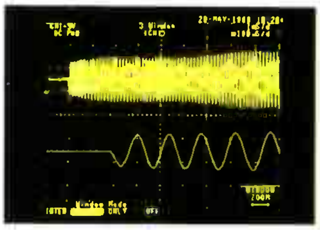
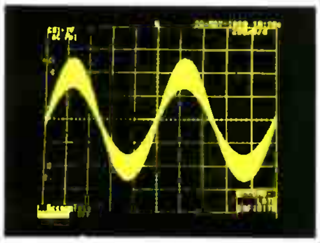
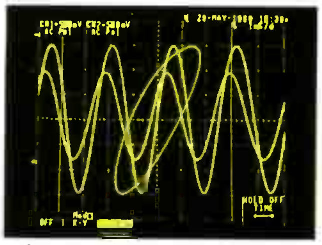


Zooming and Scrolling enables magnification up to 1000times and display scrolling to left and right



Data Accumulation superimposes several samples by changing intensity with time. Persistence is adjustable from 0.1 to 50 seconds



Simultaneous Real Time X-Y and V-T display e.g. phase + 2-channel waveforms can be observed simultaneously

READER INFO No. 23

Yokogawa DL1200A Series High Performance Digital Oscilloscopes

- 4 signal channels (2mV sensitivity each)
- 100MHz analog bandwidth
- 100MS/s, 8-bit single shot resolution
- 5GS/s repetitive signal resolution
- 128k word memory per channel
- Comprehensive trigger modes
- Optional Printer and RS-232C interface

The DL1200A Series forms part of a range of sophisticated new oscilloscopes from Yokogawa.
Call for detailed brochures and specifications

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Tasmania : Meacon Systems (002) 48 1000
Specialist Representatives: Techfast (02) 988 3865 A.T.E. (03) 543 8041

World Radio History

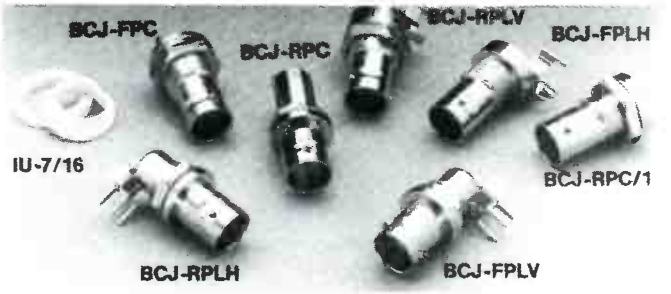
COMPONENTS

Surface-mount BNC connectors

Canare has released a line of 75 ohm PCB mounting BNC connectors, tailored to OEM requirements for surface-mounting, extra-widebandwidth computer graphics and high definition video equipment.

It is claimed that these are the first PCB mount type BNC connectors that are truly 75 ohm, with a frequency response from DC to 1GHz with less than 1.1 VSWR, and exceed the specifications of any other PCB type BNC connectors available commercially. The connectors feature a low profile design and are available in a variety of front or rear chassis mounting formats, with vertical, horizontal, straight and flat SMT studs. High compression white ABS plastic bushings accommodate panels from 1.2 to 3mm.

For further information circle 243 on the reader service coupon or contact Amber Technology, 5 Skyline Place, Frenchs Forest 2065; phone (02) 975 1211.



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READER INFO NO. 24

High frequency capacitors

With self resonant frequencies typically above 1GHz for popular RF capacitance values, and with a Q above 2000, CDE type MC capacitors are the answer for high frequency applications like flight radio and cable television.

The natural mica dielectric retains its high-Q to many megahertz, so higher and higher frequency applications are limited by the circuit inductance, not the capacitor.

Readily available in tight tolerances down to +/-0.25pF or +/-0.2.5%, type MC capacitors save you when your SPICE-computer simulation says use exactly '51pF'.

Their inherent stability and the availability of tight tolerances makes them also suitable for precision capacitor applications like digital microwave filters.

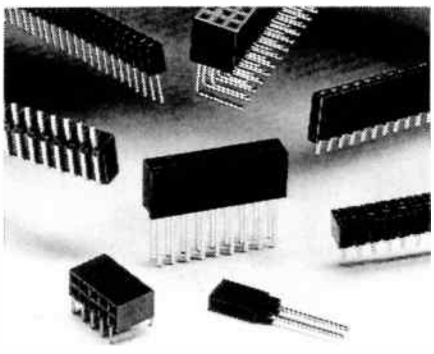
Unlike many ceramic chips, type MC chips will not crack or suffer other damage when you solder them to printed circuit boards. No cracks results from severe thermal shocks up to 270°C, and nickel/silver terminations provide superior solderability.

For further information circle 245 on the reader service coupon or contact Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044; phone (02) 516 3855.

Sockets for .025" headers

Samtec's expanded line of socket strips for .025" (0.64mm) headers now includes six different series with many standard options. Most are also easily customised for special applications.

Standard SSW series strips are available with a choice of low insertion force contacts, solder tails, single, double or triple rows, and straight or right-angled styles.



SSQ Series features .025" square tails for wire-wrapping applications.

New low profile SLW series strips are only .180" (4.57mm) above the board, while the elevated ESW series range from .435" (11.05mm) to .735" (18.67mm) tall for high clearance.

The box type BCS series provides horizontal and perpendicular mating with single or double row.

For further information circle 250 on the reader service coupon or contact NSD Australia, Locked Bag 9, Box Hill 3128; phone (03) 890 0970.

SMT test adaptors

Emulation Technology offers a large collection of VLSI and surface-mount adaptors and accessories, enabling quick debugging and connection of test equipment to high density IC packaging.

Emulation pods and adaptors designed for PGA, LCC, PLCC, PQFP and Slam-pack enable connection to test equipment supplied with just one type of pod. Generally the cost of the adaptor is less than the cost of a new emulator pod to suit the various surface mount devices.

'Bug Katchers' provide easy connection of test equipment to surface mount ICs and can be supplied with generic or custom overlays to identify each pin's functionality.

The design is such that no additional resistance or capacitive effectives are inroduced to distort readings. 'Adapt-A-Socket', 'Burn-in Sockets' and 'Adapt-A-Boards' are also available.

For further information circle 255 on the reader service coupon or contact PP Component Sales, PO Box 580, Bayswater 3153; phone (03) 764 5199.

Metallised polyester capacitors

Samhwa Electric has released two new series of non-inductive metallised polyester film capacitors. The EB series are in the well known box (MKT) type construction, with 5mm lead spacing.

They are available on tape for automatic insertion, with a capacitance range 1 - 1000nF, voltage 50-100V DC, and tolerance 5%/10%. The TK series come with a stacked (multi-layer) construction, which allows small physical dimensions and 5mm lead spacing. They are also available on tape for automatic insertion. The capacitance range is 10 - 1000nF, 50V DC.

For further information circle 252 on the reader service coupon or contact VSI Promark Electronics, PO Box 578, Crows Nest 2065; phone (02) 439 8622.

Laser coded tantalum chips

In response to a need for component level manufacturing traceability, Kemet Electronics is adding a new line of laser-marked information on every moulded tantalum chip they manufacture.

This fourth line of information is the 'Print Week Code', a three digit code which represents the year and week the parts were actually laser marked.

This year is represented by a single digit ('1'=1991, '2'= 1992, etc) while the week is represented by two digits (01-52).

This information coupled with the specific part type and customer, will enable Kemet to narrow down the potential specific manufacturing batches to those actually printed during the week indicated on the part. This can be done even after the product has been separated from the reel and mounted on a PCB.

For further information circle 251 on the reader service coupon or contact Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044; phone (02) 516 3855.

Surface-mount DIP sockets

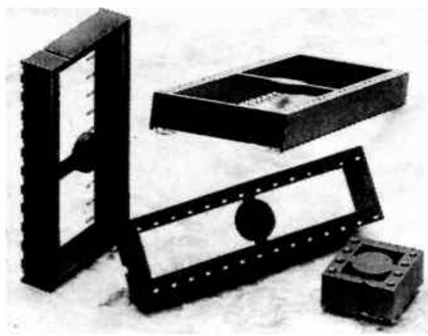
New DIP sockets from Samtec have lead sockets and insulators designed specifically for surface mounting.

Three finger contacts that approach screw machined contact quality, are stamped and formed with soft beryllium copper, and then heat treated to optimise stresses and spring properties. The slotted solder tails help to cope with the additional stresses that surface mounted connectors experience during mating cycles. Tails can be turned under the socket or away from it.

All contacts are oriented in the body to ensure consistent insertion, withdrawal and normal forces. Contacts are selectively plated — gold on the contact area, tin on the tail.

High temperature Liquid Crystal Polymer insulators can be used in most infra red and vapour phase soldering processes, at temperatures up to 230°C for 30 seconds. The body features a large pick up target on the centreline of the connector automated pick-and-place assembly.

For further information circle 253 on the reader service coupon or contact NSD Australia, Locked Bag 9, Box Hill 3128; phone (03) 890 0970.



World Radio History

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READER INFO NO. 8

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A valuable reference for the industry. A veritable who's who for the industry. $160.

3. *The Cellular Installation Handbook:*
An invaluable guide to the installation of cellular phones. 220 pages $75. Review EA August 1990.

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10 Welsh St Southport, 4215
PH (075) 914 956
FAX (075) 914 848

READER INFO NO. 25

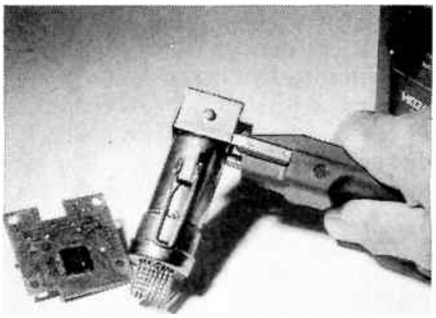
NEW PRODUCTS

TOOLS

Hot air desoldering

Scope Laboratories has released a hot air desolder/soldering system.

Designated HOZAN HS600, this non-contact desoldering unit directs hot air at LC pins through an array of pipes in each clip-on nozzle. These needle pipes are curved in some nozzles, to direct hot air beneath LCC chip carriers. An interchangeable nozzle is available for each SMD LC package.



It is claimed that the non-contact system is far more forgiving of operators, with less risk of board damage and no risk of leakage current. A desoldering time of around seven seconds is typical. The station is portable and the ceramic air heater is rated at 300W. Control of air flow, and air temperature between 100°C and 390°C, is provided.

For further information circle 254 on the reader service coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566.

SMD removal and replacement

Australian soldering equipment specialist Royston Electronics has released a relatively low cost system for replacing surface mount devices. Notoriously susceptible to thermal and electrical damage, surface mounted quad packs and QFPs have until now needed expensive, specialised machines for removal and replacement.

The Royston system comprises a temperature-controlled ESD-safe reflow tweezer, which can be operated from any one of Royel's Thermatic power units, and a digitally-controlled pre-heat unit which maintains a pre-set thermal ramp-up profile. A sensor attached to the substrate, or device, ensures degree by degree control during the reflow process.

The device is released from the circuit board at the solder liquidus temperature — to restrict the formation of intermetallics, and without excess heat degradation of either substrate of device. Replacing the component can be achieved by reversing the process, with reflow of the solder performed with the use of a handheld and directed hot air jet. The equipment required costs no more than $2500 to $3000 — one tenth of the cost of many other SMD machines on the market.

For further information circle 256 on the reader service coupon or contact Royston Electronics, PO Box 328, Mount Waverley 3149; phone (03) 543 5122.

PLCC extraction tool

OK Industries has introduced a new PLCC extraction tool for the SMT assembly and rework market. The EX-5 is designed for single-handed extraction of 20 pin to 84 pin PLCCs from any socket.

The tool is spring-loaded and the single hand design requires no pulling. By simply squeezing the handle the EX-5 lifts the chip from the socket. The EX-5 is of plastic and metal construction and is ESD safe.

For more information circle 257 on the reader service coupon or contact Electronic Development Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999.

Bandolier counter

The Kwickcount B530 Universal Bandolier Counter from OK Industries is capable of counting axial or radial components, and accommodates a wide variety of bandoliers. The four digit display counts from 0 to 999 and is powered by a 15 hour battery pack. A division switch enables counting to expand to 99,999.

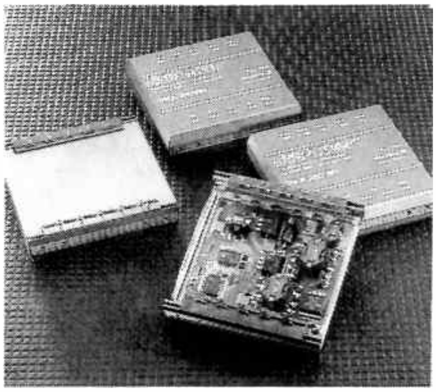
For more information circle 259 on the reader service coupon or contact Electronic Development Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999.

World Radio History

POWER SUPPLIES

DC/DC converter has floating outputs

Ericsson Components has introduced two dual-output 30W DC/DC converters with true floating outputs. Designed for 24V DC systems, the PKA 2323PI and PKA 2325PI offers 2 x 12V DC and 2 x 15V DC outputs respectively.



The two separate outputs can be used for balanced 12V DC or 15V DC applications as well as separated requirements, i.e., logic and drive circuits.

They can also be series or parallel connected to provide 12/15V DC or 24/30V DC supplies, making the converters versatile standard components for a wide variety of applications. The output current is 2.5 and 2A respectively, and the unit is power limited to a maximum of 30W by means of a primary power control independent on the balance between outputs 1 and 2.

The converters use bybrid technology, 300kHz switching frequency and offer 85% efficiency. They have a power density of 4.8W/in3 with natural convection cooling, and a MTBG>200 years at +45°C ambient.

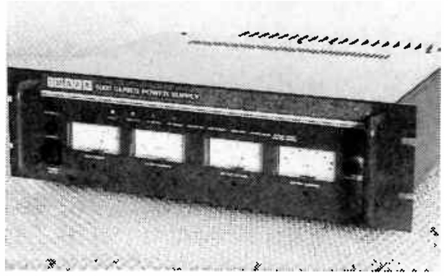
Input to output isolation is 500V DC and the converters offer full output power without any derating over a -45 to +85°C ambient termperature range and a 19-36V DC input voltage rating.

For further information circle 260 on the reader service coupon or phone EC Capacitors, (03) 462 855.

Linear 13.8V power supplies

Imark Communications has released a range of Australian designed and manufactured regulated power supplies, for use with high powered transceivers or in service workshops and manufacturing factories.

There are four basic models available in



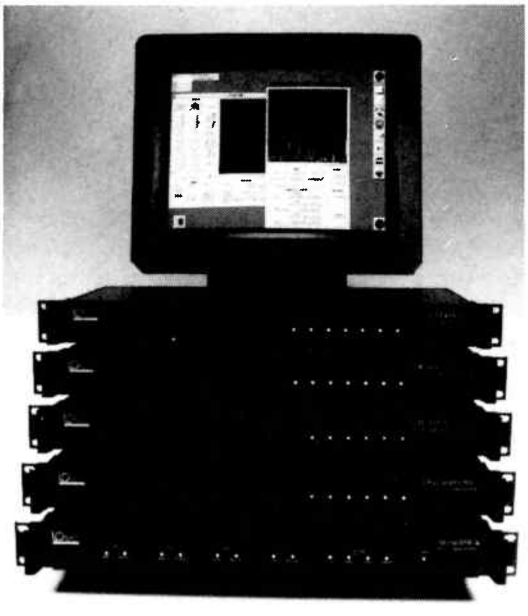
the 5000 series, depending on the current rating required: 10, 20, 30, or 40A continuously rated. Then there are two styles available — a bench top model and a 19" rack mounting model.

All models are also available in a basic version or a deluxe version. The basic versions are supplied without meters and with only the minimum of controls. The deluxe version includes full metering and all control features. The 5000 series power supplies operate from the mains supply and incorporate a linear design for reliability.

It features solid state devices, with short circuit, overload and over-voltage protection.

For further information circle 263 on the reader service coupon or contact Imark Communications, 2/75 Mark Street, North Melbourne 3051; phone (03) 329 5433.

Data Acquisition Instruments



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Compare our new IEEE Data Acquisition Instruments to traditional instruments, plug-in boards and VX1 systems. You'll find that our high channel density, isolation, easy configurability, and proven technology are all available at a lower price per channel.

Couple them with our IEEE 488 hardware and software for IBM, Macintosh, Sun, NeXT and DEC computers, and you've got a complete Data Acquisition system.

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World Radio History

NEW PRODUCTS

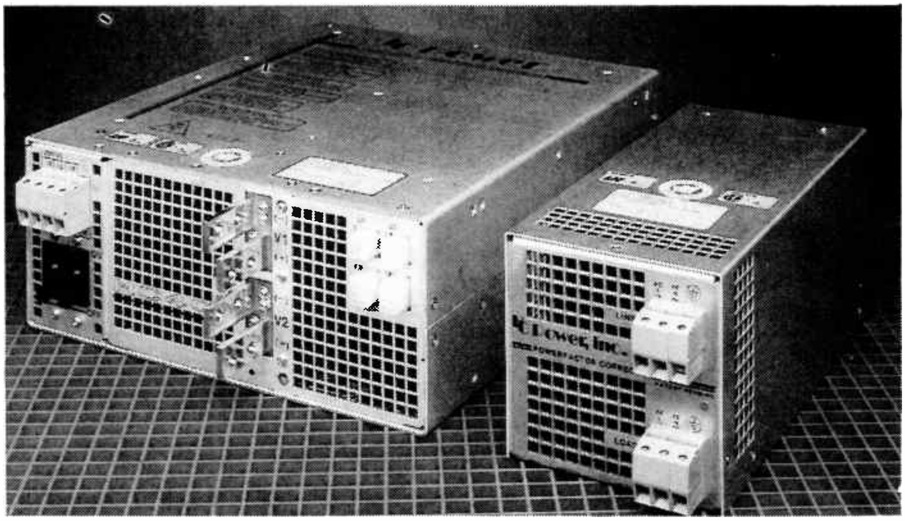
Uninterruptible power supply

NEC Australia has released PurePower UPS, a 1kVA intelligent uninterruptible power supply unit. The PurePower UPS is online, and therefore constantly provides regenerated, clean, uninterrupted power to Unix systems.

Nor is there any interruption if there's a partial power loss to a cmputer system. The PurePower offers a static bypass switch that provides immediate transfer to AC power lines if an internal fault or overload is detected.

Unix users also have an option called UPS Watchdog Interactive. Once installed on an SCO Unix system, this option enables the computer and PurePower UPS to communicate with one another, to verify current conditions. If any abnormality occurs, either the computer or UPS unit can initiate commands to ensure system integrity. The communiation is performed via an RS-232 cable connected to the computer system's serial port.

For further information circle 265 on the reader service coupon or contact NEC Australia, 20 Rodborough Road, Frenchs Forest 2086; phone (02) 930 2150.



4000W switching power supply

HP Power has released its 'Super Power' 4000 watt, single and dual output hi-rel MOSFET switchers. This powerful solution to the need for high reliability, compact size and low cost per watt supplies is ideal for 'N + 1' or 'Hot Swap' redundant power systems.

Incorporating the latest advances in switchmode power technology, the HC-40 incorporates absolute current sharing when units are operated in parallel. The HC-40 also features no minimum load, 180 - 264V AC single or three phase, 1.2 - 48V DC output, and shutdown on overcurrent. PF correction is available on single phase outputs.

For more information circle 264 on the reader service coupon or contact Dewar Electronics, 32 Taylors Road, Croydon 3136; phone (03) 725 3333.

Transient protection

Critec has released a range of user-installed lightning and surge-protection products incorporating 'Earth Potential Equalisation'. This Professional Series range will overcome the many problems associated with uncommoned earthing. Critec's units are designed to accept ANSI/IEEE C62.41-1980 and AS 1768-1991 transient input levels on both power and data circuits.

The use of transient absorption circuitry, designed to meet the highest industrial standards, has allowed the Critec Professional Series to absorb voltage surges as high as 6kV with current pulses exceeding 3000 amperes. This means a total energy dissipation in excess of 150 joules. Protection is provided against transverse and common mode surges in both the power and data circuits.

The flexibility and simplicity in design allows for over 30 powerline and signal line protection product combinations. Lightweight and compact, the Professional Series devices are available as either a powerline filter or a combination power and signal line protection device.

For further information circle 266 on the reader service coupon or contact Critec, GPO Box 536, Hobart 7001; phone (02) 73 0066.

Rechargeable battery packs

Eveready Australia is now producing rechargeable batteries specially designed for remote control toys. The batteries, which come in packs of six, are assembled in Australia and are the latest addition to Eveready's extensive rechargeable battery range. They are suitable for a range of remote-controlled toys powered by 9.6V batteries.

For further information circle 262 on the reader service coupon or contact Eveready Australia, 30 Harcourt Parade, Rosebery 2018; phone (02) 667 0444. ❖

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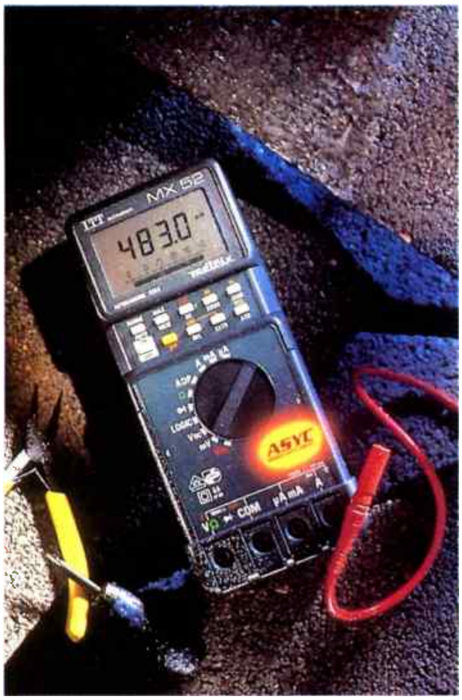
Eight Advanced Features Make Metrix ASYC® Series Safest



Check these 8 important safety features only found in the Metrix ASYC Series

- *Advanced housing design has screw-free assembly and is waterproof through a patented low-pressure, double seal design.*
- *Housing is moulded in VO-grade self-extinguishing material*
- *VDE/GS certificated to international standards*
- *Safe flexible test leads with shrouded plugs and large cross section conductors to reduce heating during high current measurements*
- *Battery and fuse compartment are fully sealed, both internally and externally using a patented double seal design*
- *Access to battery and fuse is only possible after removing test leads*
- *SECUR'X lead locking device prevents leads from being disconnected accidentally*
- *Safety alarm gives an audible warning if measured signal exceeds specified range (10A ac or dc, 750Vac, 1000Vdc)*

4 YEAR WARRANTY

Quick Selection Guide

Model	MX20	MX50	MX51	MX51EX	MX52	MX52S
Basic Accuracy	0.5%	0.5%	0.1%	0.1%	0.1%	0.1%
Bargraph		●	●	●	●	●
Zoom Mode[1]		●	●	●	●	●
Zero Mode[2]		●	●	●	●	●
Live Trend Memory[3]		●	●	●	●	●
Logic Function		●	●	●	●	●
Min/Max Recording			●	●	●	●
Store 5 readings			●	●	●	●
Relative Mode			●	●	●	●
RMS Conversion					●	●
Frequency					●	●
dB level					●	●
High Accuracy(0.1%) 4-20mA				●		●
Intrinsic Safety				●		
EEx ib IIC T6						
HBC fuse protection	●	●	●	●	●	●

1. Zoom mode gives 5x magnification 250 segment sliding scale bargraph display
2. Zero mode functions as centre-zero meter for rapid polarity change measurements and zeroing
3. Live Trend mode digital display shows stored value, bargraph shows absolute value (ie simultaneous display of current and stored values)

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World Radio History

READER INFO NO. 31

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

15GHz amplifiers

To compliment its existing range of wideband amplifiers, Anritsu has announced the release of two new models which significantly extend the frequency range of the series.

The A3H2150 operates over the frequency range of 100kHz to 15GHz, with a typical gain of 20dB, whereas the A3H2120 operates at 12GHz, also with a typical gain of 20dB.

These devices have flat gain and group delay characteristics, thereby ensuring faithful amplification of ultra-high speed pulse waveforms as well as ultra-wide bandwidth signals.

For more information circle 271 on the reader service coupon or contact Alcatel Australia, 58 Queensbridge Street, South Melbourne 3205; phone (03) 615 6666.

Enhanced S-VGA chip

Cirrus Logic has introduced a single-chip CL-GD5410 High-Resolution VGA Colour and Monochrome Graphics Controller, incorporating a Direct Colour RAMDAC and dual-frequency synthesiser for high performance, workstation quality (1024 x 768 pixels) colour graphics. It has a minimum configuration of three integrated circuit, which occupy less than three square inches.

The dual frequency synthesiser provides separate CRT timing and video memory clocks. The internal RAMDAC is a full VGA-compatible palette DAC that also supports the Direct Colour capability, allowing up to 64K colours per pixel to be displayed.

The 15 or 16 bits per pixel Direct Colour mode (32K or 64K simultaneous colours) bypasses the colour look-up table and provides optimum colour accuracy. Paint programmes and image processing applications will benefit from this capability.

The CL-GD5410 features a video memory FIFO and CPU FIFO for maximum performance and support of the enhanced Super VGA resolution of 1024 x 768 pixels operating at 65MHz. With this dual FIFO architecture, the CL-GD5410 allows the CPU to queue up data without holding up the CPU.

Two other features, Fast Page Mode and independent display and video memory timing, also increase video subsystem performance.

The Fast Page Mode takes full advantage of lower speed, more cost-effective memory to speed up access to the display memory DRAMs, and supports the bandwidth of high resolution displays.

Independent display and video memory timing optimises performance by allowing clocks to operate at the optimum speed for the selected display and the memory timing to accommodate the wide variety of cost sensitive DRAM configurations.

FM IC with signal indicator

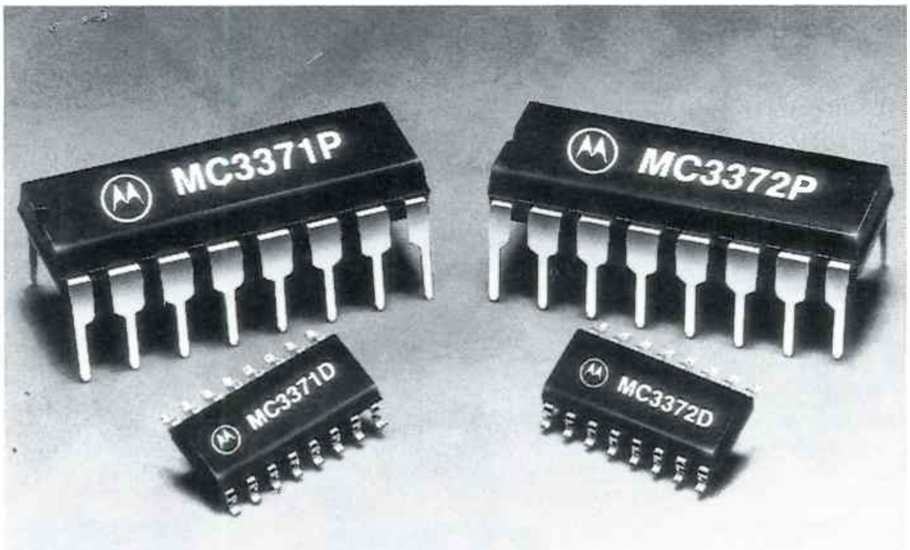
Motorola has added two new low-cost, low power FM IFs to its range of RF communication ICs. The MC3371 and MC3372 have evolved from a family of RF devices which were introduced earlier. Like their predecessors, these devices are basic low cost, single conversion narrowband FM IF receivers, but they have the added feature of a Received Signal Strength Indicator (RSSI).

The MC3371 is designed for use with parallel LC quadrature detector components, while the MC3372 can be used with either a 455kHz ceramic discriminator or parallel LC components.

These ICs find use in a wide range of applications, including low cost cordless telephone receivers, IF/detectors in analog cellular phone or land mobile radios, VHF marine or weather radios, and low cost short range radio data links. Additional applications include security alarm receivers, electrical RFI noise 'sniffers', baby monitor receivers or radio-controlled toys.

The MC3371 and MC3372 both feature a multipurpose local oscillator, a double balanced mixer, a high gain limiting RF amplifier quadrature detector, an active filter, squelch, and an RSSI output with over 60dB range. Both devices operate with inputs well beyond 100MHz.

For more information circle 274 on the reader service coupon or contact Motorola Australia, 673 Boronia Road, Wantirna 3152; phone (03) 887 0711.



64K CMOS E^2PROMs

EXEL Microelectronics has released a 64K bit parallel CMOS E^2PROM.

The XL28C64, organised as 8K x 8-bits, provides access times as fast as 120 nanoseconds and low power consumption, while retain-

World Radio History

Vertical mount 4MB DRAM

A 4Mbit DRAM in a new vertical mount package that enables electronics manufacturers to sequeeze 32M bytes of RAM — or 64 packages — into a credit card sized area on a circuit board has been announced by Texas Instruments.

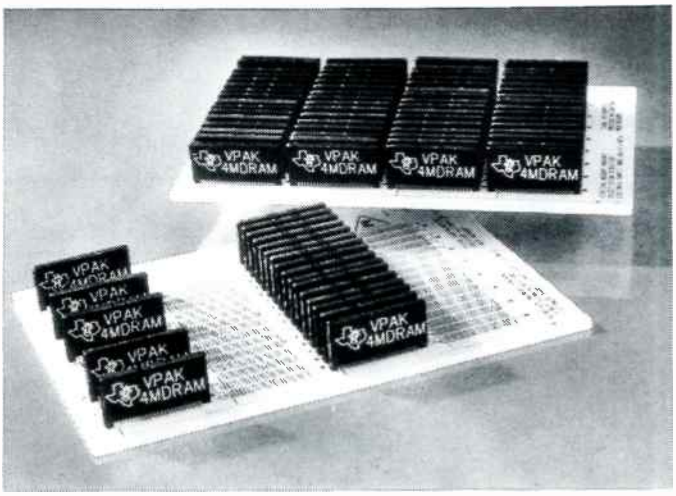
The vertical mount package, or VPAK, was pioneered by Texas Instruments. It is an extremely thin vertical package that is also surface mountable.

As a result, the VPAK is well suited to manufacturers who want to install high density chips, like the four Mbit DRAM into their systems mechanically, using an automated assembly process. The

four Mbit DRAM VPAK is expected to appeal to manufacturers of electronic equipment with highly integrated and compact systems, such as laptop and notebook computers.

Manufacturers using the four Mbit DRAM VPAK can fit up to seven times more RAM into a given area than manufacturing using DRAMs housed in conventional packages, such as DIPs, SOJs or TSOPs.

For more information circle 273 on the reader service coupon or contact Texas Instruments, 6 Talavera Road, North Ryde 2113; phone (02) 878 9000.



ing full compatibility with 64K E^2PROM industry standards.

In addition the device supports both Page Mode operation and Data-bar Polling capability to minimise write cycle wait times.

Data-bar polling minimises the write cycle wait period by providing an end of cycle indicator for each write operation instead of waiting for a default time-out. Used together, these features can speed the effective byte write cycle to less than 78 microseconds per byte.

The XL28C64 guarantees 10 years of data retention and 10,000 non-volatile write cycles per byte.

The self timer, data latches and inadvertent write protection are integrated onchip, as well as a page wide input buffer. The device operates on a single 5V power supply and consumes less than 100uA of standby current.

Bias resistor transistors

Motorola has relesed its new Bias Resistor Transistors (BRT's), which can simplify circuitry and reduce component count. A BRT is designed to replace a signal

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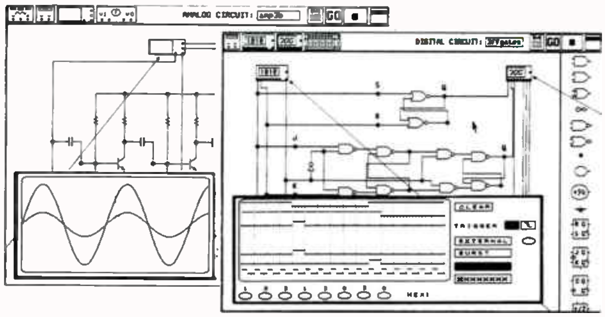

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READER INFO NO. 2

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transistor and its external resistor bias network. Each BRT contains a single transistor, with a monolithic bias network consisting of two resistors: a series resistor and a base-emitter resistor. BRT's eliminate these individual components by integrating them into a single device.

They can be used in any application requiring a small signal transistor and an external bias network.

The BRT's are available in both NPN and PNP. The NPN devices are designated MUN2211-2213 and the PNP parts are MUN2111-2113. They are packaged in the SC-59 package which is designed for low power surface mount applications.

For more information circle 272 on the reader service coupon or contact Veltek, 22 Harker Street, Burwood 2125; phone (03) 808 7511.

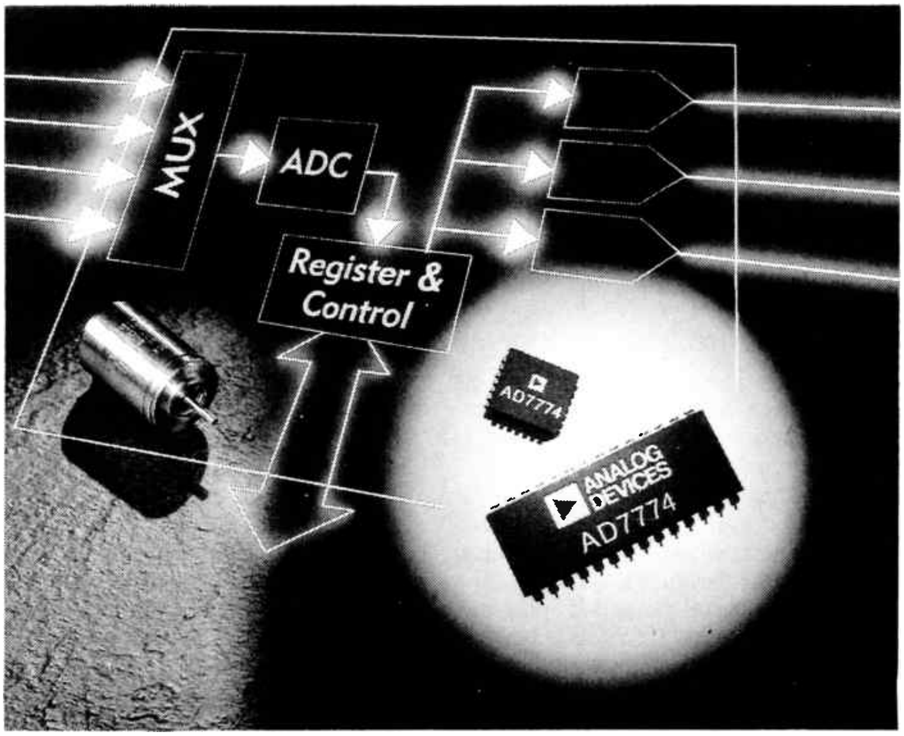
5W DC/DC converter

Newport Components has extended its range of DC/DC converters by launching its highly cost-effective NMX series, a product which is EMI compatible and increases Newport's DC/DC capabilities from 2W to 5W.

The new NMX series uses the industry standard 2" square package and caters for input voltages of 5, 12 and 24V, and regulated output voltages of 5, 12 and 15V, and is available in both single and dual output configurations.

The devices offer regulation better than 0.5% and isolation of 500V with typical efficiencies of 70%.

For more information circle 275 on the reader service coupon or contact Alpha Kilo Services, PO Box 180, Lane Cove 2066; phone (02) 428 3122.



LC²MOS I/O port

Combining multiple analog/digital (ADC) and digital/analog (DAC) converter channels (along with necessary support circuitry) into one 28 pin IC, Analog Devices' AD7774 is specifically designed for applications in closed-loop motion control and servosystems, such as hard-disk drives.

This device includes a four-channel 8-bit ADC (sharing two track/hold amplifiers), three DACs (two 8-bit and one 11-bit), analog output amplifiers, internal reference circuitry, and microprocessor interface.

Fabricated in Linear Compatible CMOS (LC²MOS), the AD7774 allows either independent or simultaneous sampling of inputs. Three key operating parameters can be independently set: the midpoint of the ADC transfer function (bias), the input voltage swing of the ADCs (span), and the midpoint output voltage of the DAC (bias).

By adjusting these biases and the span, the converters are optimised for the application, especially in situations where only a positive supply rail is available; it allows the input and output voltages to be referenced to a point other than analog ground.

For more information circle 281 on the reader service coupon or contact NSD Australia, Locked Bag 9, Box Hill 3128; phone (03) 890 0970.

Solid state current sensor

CP Clare Corporation has introduced a family of solid state optically-isolated current sensors with application in a wide range of instrumentation, control and telecommunication functions.

Available in a variety of configurations, the family provides current sensing capability of up to 100mA, without external shunting resistors.

The current sensors can be used safely with power supplies up to 50V, making them ideal for electronic instrumentation. Standard input-to-output isolation is rated at 2500V. Versions are available with 3750V isolation as well.

Styles are available with single transistor or Darlington transistor outputs. Current transfer ratios range from 100 to 750%, depending upon specific product type.

For more information circle 276 on the reader service coupon or contact IRH Components, 32 Parramatta Road, Lidcombe 2141; phone (02) 748 4066.

High speed 2 Megabit SRAM

The new 8F8259C from EDI is a very high speed 2Mb CMOS static RAM organised as 256K x 8.

The low cost device is based on two high speed 256K x 4 static RAMs, mounted on a multi-layered epoxy laminate (FR4) substrate, with access times from 20 to 55ns.

The 32 pin 0.6" DIP pinout adheres to the JEDEC standard for 2Mb devices, ensuring upgradeability with future monolithics.

All inputs and outputs are TTL compatible and operate from a single 5V supply. The device is fully asynchronous, requiring no clocks or refreshing for operation.

The 8F8259C typically consumes 170mA operating, which drops to 1mA in standby. It is ideal for applications that require a large array of very high speed SRAM that ensures upgradeability from 128K x 8 up to 512K x 8 devices.

For further information circle 280 on the reader service card or contact K.C. Electronics, phone (03) 467 4666. ❖

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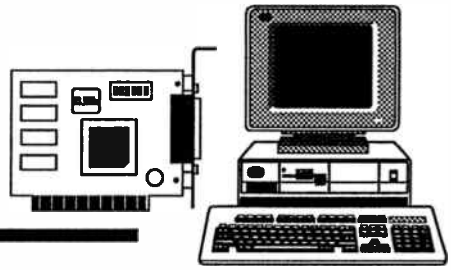
Computer News and New Products



HDD's for new Apple Quadra 900

Hewlett-Packard has announced a family of high-capacity Small Computer System Interface-2 (SCSI-2) 5-1/4" and 3-1/2" internal disk drives for the new Apple Macintosh Quadra 900.

The new drives offer formatted capacities from 422MB to 1.355GB and are specifically designed to provide additional internal mass storage for data-intensive applications. One full-height or two half-height internal mass storage for data-intensive applications. One full-height or two half-height HP SCSI-2 high performance disk drives can be placed inside the central processing unit.

The small 3-1/2" form factor offers 422MB of formatted capacity with an average seek time of 12.5 milliseconds and an asynchronous-burst transfer rate of 1.5MB, which provides fast, reliable data transfer. The 5-1/4" disk drive mechanisms offer formatted capacities of 1.355GB, 1070GB and 677MB. These drives have a 13.5 millisecond seek time and an asynchronous-burst transfer rate of up to 1.5MB.

For more information phone Hewlett Packard on (008) 033 821.

Low cost laser printer

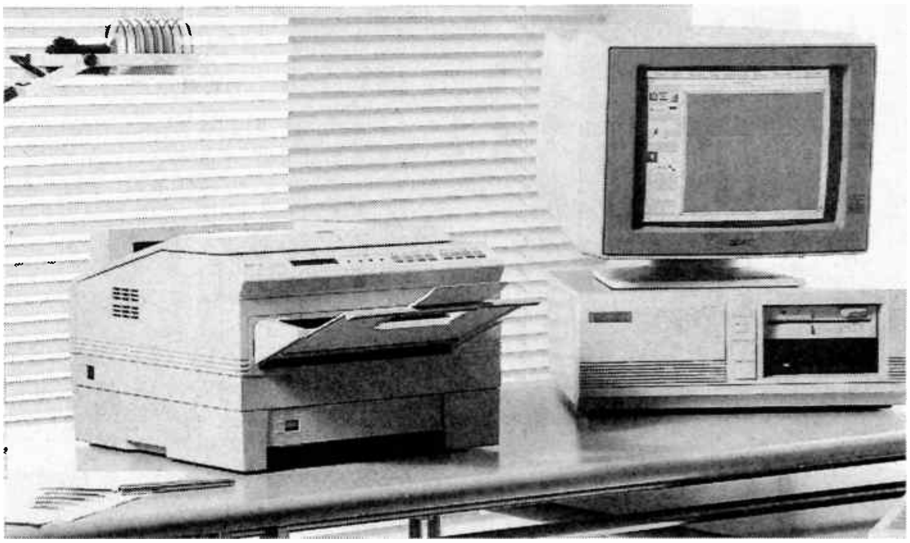
Siemens has launched its lowest cost ever laser printer. The new 4ppm machine is priced at $1995.

Called the MT904, and including HP LaserJet IIP emulation, the new printer also has one of the smallest footprints in its class, measuring 36.5 x 40.5cm. It is being targetted as a personal printer for users requiring laser quality, low noise and a low price tag. The printer life is 150,000 pages at a daily workload of 125 pages per day.

The machine includes 14 HP compatible resident fonts and 512kB of memory as standard. 1MB memory upgrades are available up to a total of 2.5MB.

A single slot is provided for HP compatible plug-in fonts. Optional emulations include IBM Proprinter, Epson FX and Diablo 360.

For more information circle 161 on the reader service coupon or contact Siemens, 544 Church Street, Richmond 3121; phone (03) 420 7254.



Australian subsidiary for Aldus

Aldus Software is the new Australian subsidiary of Aldus Corporation. After a year of local presence with a skeleton establishment team, the company has opened new corporate offices in Sydney's northern suburb of Pymble.

Adlus Software now has its initial management and marketing team in place, and has broadened its distribution base for its full range of Apple Macintosh and PC software products. While joint distributor InfoMagic will remain a distribution for the full range of Aldus software titles, Aldus Software has appointed Tech Pacific as a second distributor to focus on PC products in the short term. Dual distribution is expected to help reduce prices of Aldus products, bringing them more into line with US pricing. The company hopes to achieve close to parity within the next 12 months.

For more information circle 162 on the reader service coupon or contact Aldus Software, 20 Bridge Street, Pymble 2073; phone (02) 427 3143.

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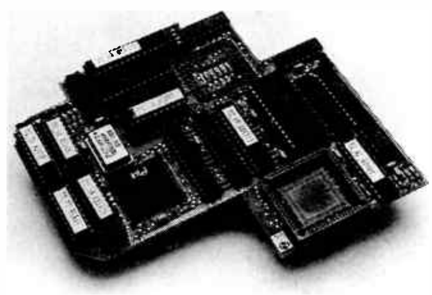
386SX upgrade for PS/2 models



Hypertec has released the Hyperace 386SX accelerator/processor upgrade boards for the IBM PS/2 model 30-286 and 50 computers. The boards provide the functionality of an 80386SX processor along with a significant increase in processing speed.

The aim is to enable users of 286 machines to access the latest comprehensive operating systems and applications software, such as OS/2 and Windows 3.0, which perform best with an 80386 processor. The Hyperace 386SX includes a 20MHz Intel 386SX processor, 64KB 'zero wait state' cache RAM and support for the 80387SX maths coprocessor. It simply replaces the existing 80286 processor board — no cables, installation software or software drivers are required. The recommended retail price is $825 excluding tax.

For more information circle 167 on the reader service coupon or contact Hypertec, 408 Victoria Road, Gladesville 2111; phone (02) 816 1211.

Learn piano via a PC

The Miracle hardware/software combination from DSE can teach you to play the piano for less than $700.

The system is made up of a four octave (49) professional keyboard and software. The keyboard connects to a computer (IBM compatible PC, Nintendo or Amiga) and the software teaches you to play the piano through a combination of graphics, sound, words, examples and reward.

The full-size keys are velocity sensitive, which means that if you press a key softly it plays the note softly — but if you press the key strongly the note is played loudly. The keyboard can also play any one of 128 digitised instruments of effects, including piano, harpsichord, violin, flute and guitar.

The keyboard is MIDI (Musical Instrument Digital Interface) compatible and has built-in stereo speakers as well, so that you can link the sound to an amplifier or headphones.

There is even a 'recording studio' in the PC version, which works like a full eight track system — allowing you to record up to eight separate instruments and accompany yourself. The Nintendo version sells for $599, while the PC and Amiga versions sell for $699.

For more information contact Dick Smith Electronics, PO Box 321, North Ryde 2113; phone (02) 888 3200.

Low cost scope card

The Compuscope LITE is a high speed data acquisition card for the PC-XT/AT, for capture and storage of analog data.

Two channels are provided at eight bits resolution, capable of 40 million samples/sec on channel A, or 20 million samples/sec over channels A and B, with 7MHz full power bandwidth. Trigger source can be through channel A or B, external or from keyboard, with capability for post, mid or pre-triggering on positive or negative slope. A test output is also provided, being 0-0.9V square wave at around 100kHz.

The software can output the data to printer or disk, in binary or ASCII files, with capability of communication through modems, Ethernet, token ring etc. Software modules are available for doing mathematical analysis of data, plus driver software for most popular compilers.

For more information circle 163 on the reader services coupon or contact Boston Technology, PO Box 415, Milsons Point 2061; phone (02) 955 4765.

Multi-function optical disk drive

Claimed to be the first multi-function optical disk drive subsystem in the world, the Omnistor 654MB will accept both WORM (write once, ready many)

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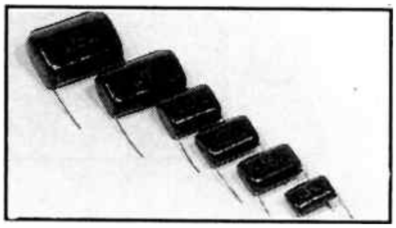

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and eraseable MO (magnetic optic) type media. It is made by Computer Upgrade of California.

The optical disk subsystem emulates a standard Winchester drive to the host operating system, with no other foreign device drivers. It can run standard systems diagnostics, and the user can boot from it.

The drive uses an ANSI/ISO standard 654MB multifunction 5-1/4" optical disk drive and the Omnicache SCSI cache interface. This interface gives an automatic file-index date/time stamp for archival audit. The run length encoded data is compressed, offering increased storage from 654MB to 1GB on each WORM or MO cartridge.

For more information circle 164 on the reader service coupon or contact Anitech, 52/2 Railway Parade, Lidcombe 2141; phone (02) 749 1244.

Solid state disk emulator

Model 8 M20 from Interworld Electronics is a non-volatile memory board designed to be a replacement for mechanical disk drives.

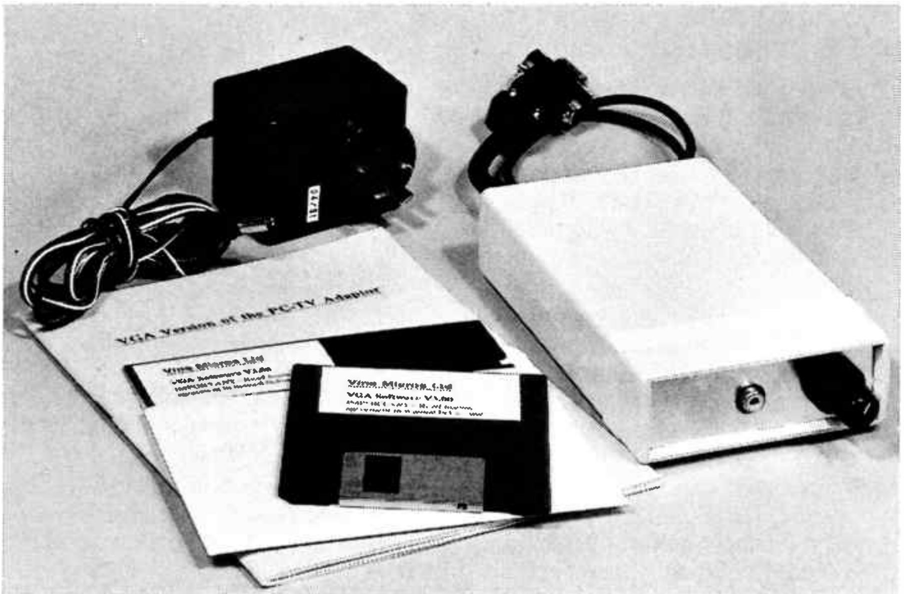
The 8M20, which has an operating temperature range of -40 to +85°C, will operate reliabily in environments that are unsuitable for standard disk drives.

The 8M20 can use battery backed-up CMOS RAM for general read-write use or EPROM for low cost read-only file use. It can use EPROM and CMOS RAM on the same card for greater flexibility. Onboard firmware emulates a standard fixed disk controller, and allows booting from the disk emulator.

The 8M20 has two separate banks of 12 sockets. Each bank can take up to 1.5MB of SRAM or EPROM, allowing up to 3MB storage capacity.

Up to four boards can be installed in one system, allowing up to 12MB of solid state disk capacity.

For more information circle 170 on the reader service coupon or contact Interworld Electronics and Computer Industries, 1G Eskay Road, Oakleigh South 3167; phone (03) 563 7066.



VGA to PAL video adaptor

The Vine Micros PCTV VGA Adaptor converts VGA-RGB video into interlaced composite PAL, allowing an IBM-compatible computer to provide video for display on a standard TV receiver or monitor, or recorded on a standard VCR. This makes it possible for a PC to be used for presentations, training, video titling and point of sale display.

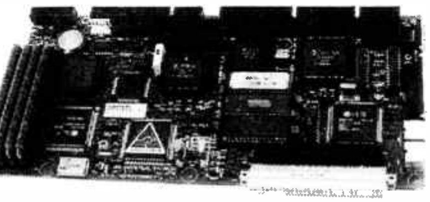
The complete PCTV VGA Adaptor package consists of a small converter unit which connects between the computer's normal VGA card and the standard video monitor, a plug-pack power supply, matching driver software and a user manual. The software allows the display to be switched between the standard VGA monitor and the PAL TV or VCR, as desired

The Adaptor provides both direct composite PAL, video and UHF modulated output, on channel 36 (591.5MHz). Screen modes supported by the Adaptor include 80 x 25 text mode (16 colours), 640 x 200 (2c), 640 x 350 (16c), 640 x 480 (2c), 640 x 480 (16c), 320 x 200 (256c), 640 x 480 (256c) and 800 x 600 (16c).

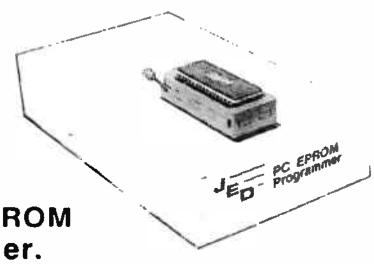
The basic driver software consists of a pair of TSR's which allow not only video mode switching, but control of a variety of display parameters as well.

The software is supplied on both 5.25" and 3.5" floppy disks, to suit virtually all systems. Recommended retail price of the Vine Micros VGA to PAL Adaptor is $550. Further details are available by circling 180 on the reader service card, or from Lako Vision, Suite 1, 45 Wellington Street, Windsor 3181; phone (03) 525 2788.

Australian Computers & Peripherals from JED... Call for data sheets.



The JED 386SX embeddable single board computer can run with IDE and floppy disks, or from on-board RAM and PROM disk. It has Over 80 I/O lines for control tasks as well as standard PC I/O. Drawing only 4 watts, it runs off batteries and hides in sealed boxes in dusty or hot sites.
It is priced at $999 (25 off) which includes 2 Mbytes of RAM.



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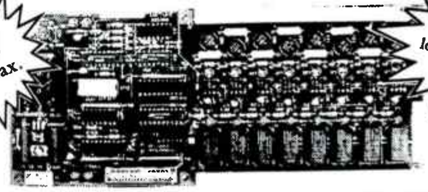

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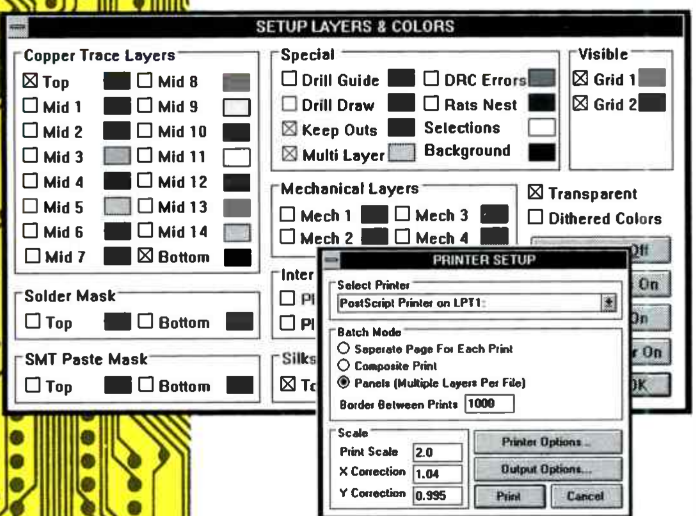

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READER INFO NO. 38

World Radio History

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Which of our many advertisers are most likely to be able to sell you that special component, instrument, kit or tool? It's not always easy to decide, because they can't advertise all of their product lines each month. Also some are wholesalers and don't sell to the public. The table below is published as a special service to EA readers, as a guide to the main products sold by our retail advertisers. For address information see the advertisements in this or other recent issues.

Supplier	State	A	B	C	D	E	F	G
Acetronics	NSW			●				
All Electronic Components	VIC	●	●	●	●	●		
Altronics	WA	●	●	●	●	●	●	●
Dick Smith Electronics	ALL	●	●	●	●	●	●	●
Electronic Component Shop	VIC	●		●	●	●	●	
Emona Instruments	NSW						●	
Geoff Wood Electronics	NSW	●	●	●	●	●	●	
Jaycar Electronics	Eastern	●	●	●	●	●	●	●
RCS Radio	NSW			●				
Rod Irving Electronics	VIC	●	●	●	●	●	●	●
Scientific Devices	VIC						●	
Sheridan Electronics	VIC		●	●	●	●		
Tandy Electronics	ALL		●		●	●	●	●
Wagner Electronics	NSW		●		●	●	●	

KEY TO CODING:

A Kits and modules
B Tools
C PC boards and supplies
D Components
E IC chips and semiconductors
F Test and measuring instruments
G Reference books

Note that the above list is based on our understanding of the products sold by the firms concerned. If there are any errors or omissions, please let us know.

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PLEASE NOTE THAT WE ARE UNABLE TO SUPPLY BACK ISSUES, PHOTOCOPIES OR PCB ARTWORK OVER THE COUNTER.

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ADVERTISING INDEX

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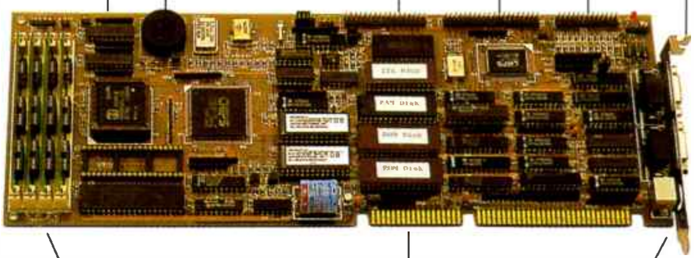
Our range of industrial hardware is growing at extra ordinary speeds

We have the hardware you've been looking for, at the price you'll want to pay.

1

ITK 203
Our new ITK 203 is the perfect embedded controller. It has two inbuilt Solid State disk drives which are exceptionally fast and allow operation up to 60 degrees Celsius. Drive A; is fully bootable and can hold up to 1Mb of program. Drive C; is a 128Kb battery backed Static Ram for holding of data. The ITK 203 is supplied with full documentation and all the S/W necessary to format the Solid State drives. Fully populated the ITK 203 draws less than 10 Watts.

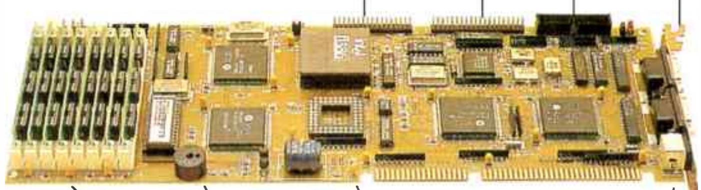


2

ITK 421
We are able to offer you the convenience of the ITK 203 as a ready to use 19 inch panel with inbuilt 9 inch VGA colour monitor. The two membrane keypads are decoded to provide a standard PC keyboard input. Add either the ITK 202 or ITK 203 for a complete industrial computer together with Solid State disk drives. Add other PC plug in boards such as data acquisition, digital I/O or Arcnet/ Ethernet – we have a good range to offer you.

3

ITK 202
The new ITK 202 offers all the power of a full 80386DX at speeds of 25 or 33MHz but drawing less than 7.5 Watts of power and rated to 60 degrees Celsius. All normal functionality of a complete 386 machine is included on this board. A special feature is the Watchdog timer that allows for program restart should a power glitch or other problem occur. Add an ITK Solid State disk drive board if rotating media not suitable. We can supply passive backplanes from 4 to 18 slots and 19 inch and Shoe-box chassis are available.



READER INFO NO. 20

When your industry relies on fast, accurate and reliable data acquisition and process control, APC is your vital link – call your nearest APC office for further up to the minute information.

APC
Automation & Process Control Services Pty Ltd

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Fax (08) 363 1736	Fax (03) 761 1367	Fax (02) 555 1048	Fax (07) 374 2749	Fax (002) 71 8185

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PLUG-IN MASTERY

THE ONLY ANALYZER TO HOLD 5 INTERFACE UNITS AT ONCE

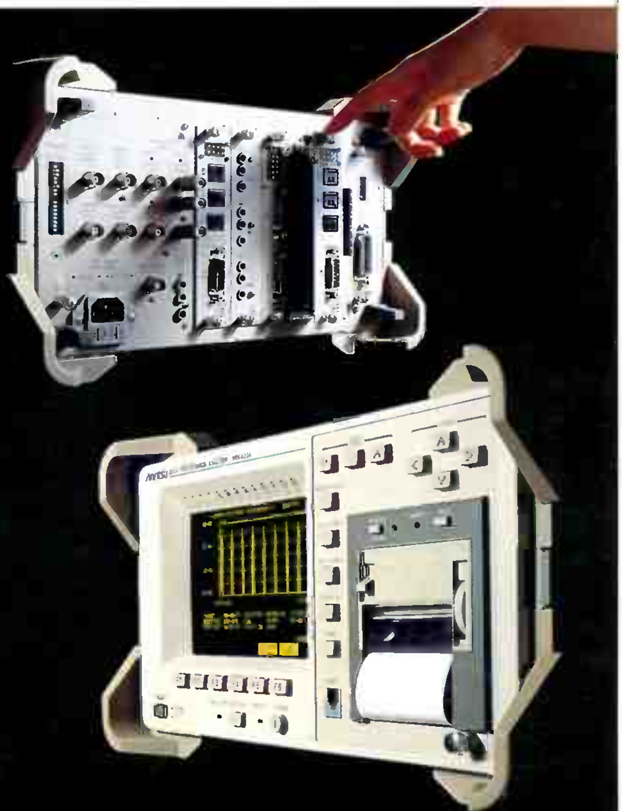
Data communications applications and traffic grow faster every year, spurred on by the increased availability of multimedia networks. Managing this diversity requires the versatility of Anritsu's new Data Transmission Analyzer MD6420A—the only one on the market that can hold up to 5 different plug-in interface or extension units at the same time.

But that's not all. There's no more worry about losing valuable online data and time when a power failure occurs, because the MD6420A saves test data in battery-protected memory. It also measures clock slips, for greater accuracy in any location. A new option even displays the histogram data automatically, freeing you from time-consuming graph plotting.

The MD6420A naturally conforms to the new CCITT G821, and offers an extensive variety of plug-in units to handle all types of interfaces, including digital lines from 50bps to 10Mbps. The printer is built in, and remote control via GPIB or serial interface is possible.

Plug into the new Anritsu MD6420A, where the best performance is backstage.

DATA TRANSMISSION ANALYZER MD6420A



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