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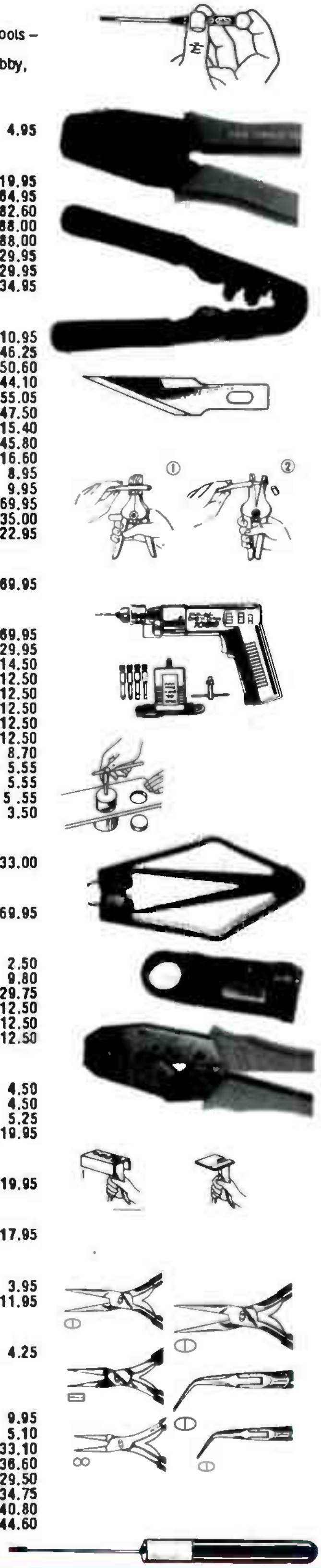

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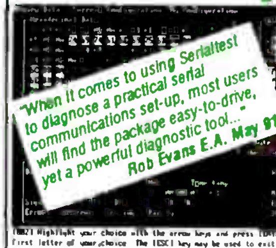

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Volume 54, No.4

April 1992

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE — ESTABLISHED IN 1922

"One of the most daring space missions..."

This month, NASA astronauts plan to use their new shuttle Endeavour for one of the most daring orbital space missions ever attempted: capture and repair of the ailing 3.9 tonne INTELSAT VI F-3 satellite — in orbit. Kate Doolan explains, in our story starting on page 18.

Is there any dangerous radiation in YOUR home?

Nowadays there's growing concern about possible risks from low level electromagnetic radiation — but what about nuclear radiation, with its much better known risks? Peter Jensen has been investigating, and his results are well worth reading (see page 28). This month Peter Phillips also describes a low cost Geiger Counter project, to allow you to check your own home for possible risks. For this, see page 76...

On the cover

Rob Evans' design for the Playmaster 30+30W stereo amp of August 1988 has been so popular that Dick Smith Electronics has revamped it, in an elegant new case. So if you're after high quality sound on a low budget, check it out — see page 64. (Photography by Phil Aynsley)

Video and Audio

Features

Projects and Technical

Professional Electronics

Columns and Comments

Departments

Electronics

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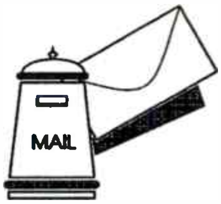
LETTERS TO THE EDITOR



Audio problems

With reference to the letter from your correspondent 'John' in the December issue, when listening to short wave under difficult reception conditions I find it much better to use headphones with a limited frequency response. This is because the highest and lowest frequencies contribute little to the intelligibility of speech.

If your 70 year olds with 'audio problems' used 'high-fi' headphones, I suggest they try using cheaper ones with their response concentrated on the mid-frequencies required for speech. Alternatively a suitable audio filter to limit the upper and lower frequencies may help.

J. Emery,
Bullcreek, WA.

Comment: Many thanks for your suggestion, Mr Emery. We'll see if we can't describe a small bandpass filter that could be used for this purpose.

Dynaudio designer

Thank you very much for Louis Challis's review of the Dynaudio Image 3 loudspeakers in the December issue, and the compliments for our design work. However, the credit for the design process was not quite accurate.

The Elecoustics' part of the Image 3 project was mainly handled by David Connor who conducted the majority of the acoustic design, from briefing through to listening. Glenn Leembruggen was involved in the listening sessions and provided stimulating feedback during the technical design process.

David Connor and
Glenn Leembruggen,
Elecoustics,
Summer Hill, NSW.

Postage rates

Having just read your January editorial I am dismayed that you find yourself in this position and was frankly surprised that, given a postal increase is inevitable — unfair that it is, you cannot cover this charge with an increase in cover price without prejudicing your current circulation numbers.

Having purchased your magazine for over 20 years both from news-stands and more recently by subscription, I for one do not intend to stop as I regard price as secondary to quality when deciding what magazines to purchase. I may be in the minority and maybe the vast majority of your readership is that fickle that they would stop buying if the cover price rose, but I hope not.

The above is not meant to be condoning Australia Post's outrageous increases, and I have written to my local MP. But if you do end up having to increase your cover price, I will understand — and keep buying.

Clive Allan,
Glen Waverley, VIC.

Young people and electronics

As a regular reader of *EA* since 1952 and probably like many of your readers, I have watched with interest 'from the side' as various topics have been discussed over the years. However, your recent editorial concerning the lack of young scientists and engineers in Australia has prompted me to contribute this letter.

I have yet to meet a colleague who didn't spend much of his youth disembowelling various pieces of electronic gear, and had we not gone through this exercise I wonder just how many engineers and scientists we would be without now.

I consider myself fortunate to have three of my four children employed in these highly technical areas and am convinced that this is partly due to my own enthusiasm for dismantling and modifying equipment in front of them in the early days. They later became very adept at finding equipment and experimenting themselves.

Unfortunately, with the ever-increasing scale of integration of electronic equipment, the opportunity for similar pastimes in 1992, is severely limited.

It is not particularly interesting to pull apart a modern clock because it appears there is not much of interest inside to play with. Even the humble telephone has been crammed with micro-electronics. A brief examination of the micro-miniature components used in current VCR's, CD players, radios, TV's, computers and peripherals clearly depicts the overall situation.

A label which has recently become common — 'no user adjustable parts

[illegible]

inside' really means 'this is a throw-away item and you won't learn much by pulling me apart'. So disused equipment, which previously provided some initial sparks of interest for young people now has little of its previous fascination.

Obviously the situation cannot be changed, but maybe the gap can be filled by other means.

Together with highly technical and specialised articles, *EA* has, over the years, done a fine job in creating technical interest in many youngsters and has probably assisted many to their current highly technical and rewarding careers.

Perhaps *EA* could further its role in encouraging young engineers and scientists by producing a series of articles dealing with the dismantling of suitable (common) surplus equipment and simple projects/experiments based on components therein.

Progressive companies who manufacture this type of equipment might even provide details of obsolete models which could also be published. This would certainly be good PR for the company concerned, possibly even making some equipment obsolete ahead of schedule.

John Dods,
Lower Templestowe, VIC.

Comment: Thanks for your suggestion, Mr Dods. We'll see if it's feasible.

Omega frequency standard

A few days ago I completed the 'Omega' frequency standard you published in the April/May 1987. What a fantastic project! It's the answer to a frustrated hobbyist's prayer. It does exactly what it is supposed to do, and what's more I can't fault it in any way!

About 18 month's ago, I built the 1988 Playmaster 30-30 hi-fi amplifier. Our gramophone records, magnetic tapes and compact discs never sounded so good.!

Late last year, I built 'Pest-Off'. We don't know if the cockroaches like it or not — they don't hang around long enough for us to know!

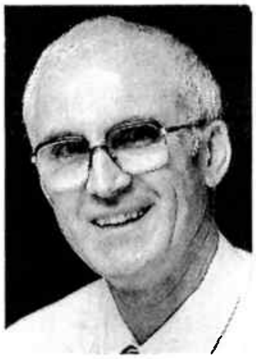
Terry Robinson, VK3DWZ,
Woodend, VIC.

Comment: Glad to know you've had such good results, Terry. The Playmaster 30-30 Amp has just been represented, by the way — see the article on page 64.

DROP US A LINE!

Feel free to send us a letter to the Editor. If it's clearly expressed and on a topic of interest, chances are we'll publish it — but we reserve the right to edit those that are over long or potentially libellous.

EDITORIAL VIEWPOINT



Australia Post's price hike: thanks for your support

I've received many encouraging letters of support from readers, following my editorial in the January issue about Australia Post's new 'Print Post' scheme and its dramatic impact on special interest publishers like ourselves. My grateful thanks to all of the readers concerned, and especially to those who have written to their local MP to protest against the massive rate increases.

It's good to know that *EA* has so many loyal readers. Quite a few people wrote that they'd even be prepared to pay a certain amount more for their *EA* subscription (within reason, of course), rather than see the magazine go under. In these days of economic recession that's nice to know too, although we'll do our best to ensure that it doesn't become necessary.

At this stage Australia Post doesn't seem in the least inclined to rethink its new scheme, despite the strong protests by small publishers and their subscribers. Perhaps the bureaucrats concerned are assuming that the fuss will die away now, and they can simply proceed as originally planned. But if so they're wrong, because as I write this, many further moves are planned.

Before the end of February, the Independent Publishers' Association will be launching a press campaign directed at both Mr Keating and Australia Post. Apart from anything else, the campaign will point out the incredible contradiction between on one hand Mr Keating's pressure on the ACTU to drastically curtail wage rises, and on industry to minimise price rises — to maintain our current low rate of inflation — and Australia Post's enormous price hikes on the other.

A very large number of magazines — including those published by non-profit organisations — will also be sending their subscribers a petition form, with a request for it to be signed by as many concerned people as possible, and sent to Mr Keating.

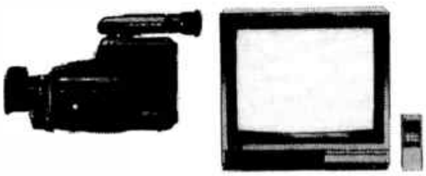
As you might expect, publishers have also been investigating possible alternatives to using Australia Post. And after negotiations with the Australian Newsagents' Association, the latter has apparently made an in-principle decision for its members to use their 'authorised territory' system to provide home delivery of subscription copies of magazines — including magazines that are not normally sold over the counter. But ironically even this could be foiled by the Trade Practices Commission, which is currently moving to dismantle the 'authorised territory' system.

So the fight isn't over yet, and there's still a long way to go. In fact the impression I get is that Australia's smaller publishers have only just started to fight, despite what Australia Post's bureaucrats may have assumed. Which is just as well, because if the AP 'Print Post' scheme is allowed to proceed unchallenged, many of Australia's valued special interest publications (both commercial and non-profit) could well be priced out of existence.

We still need your help, of course. So if you find a petition form, in *EA* or any of your other favourite Aussie magazines, please get as many signatures as possible and send it in. Help protect Australia's publications against the dreaded Australia Post — with your help we might just win!

Jim Rowe

What's New in VIDEO and AUDIO



High end CD player from Teac

Teac has introduced a new 'authentic' compact disc player, the CD-Z5000. Continuing Teac's philosophy to be different to other suppliers, the CD-Z5000 offers a black alloy fascia with a centre mounted disc tray mechanism.

Incorporating the latest 18-bit technology, the CD-Z5000 employs Teac's proprietary ZD-II circuitry. This technology employs a feature long known in the professional digital recording industry as dithering. This involves random digital noise being added to the digital signal prior to the D/A conversion, then subtracted later on.

Teac's ZD-II circuitry moves the dither into the ultra-sonic range, making it inaudible to the human ear. The result is improved bit uniformity and linearity over the entire 18-bit range. This results in conversion errors being dispersed, not localised at specific signal levels.

The CD-Z5000 employs a total of four 18-bit D to A converters, used in push-pull pairs.

The 18-bit eight times oversampling digital filter transfers unwanted sampling harmonics into the ultrasonic range and allows for a more gentle analog filtering.

Other features include a motorised volume control, an extensive 33 button infrared remote controller offering control over all the CD-Z5000 features, including volume control and display on/off.

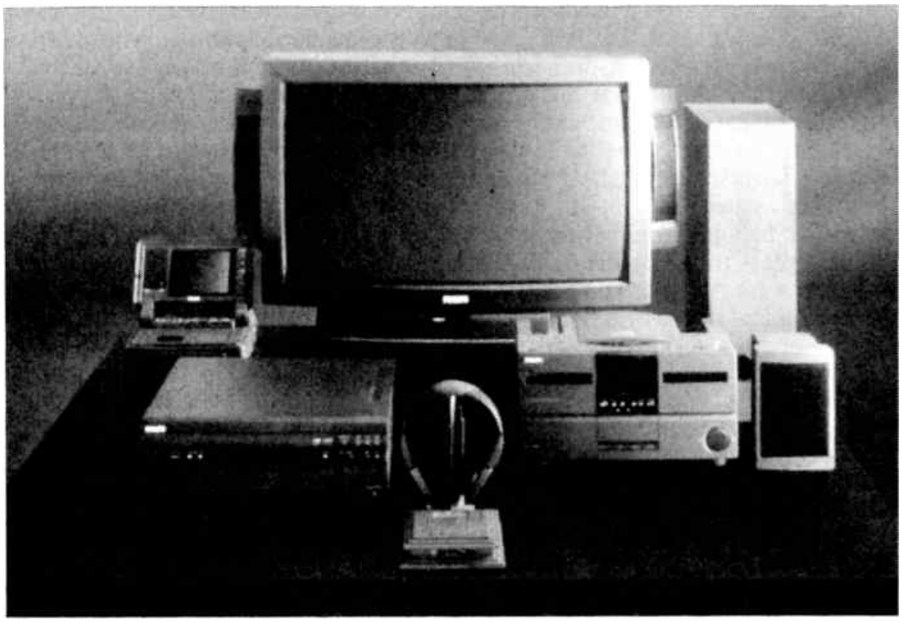
The CD-Z5000 is covered by a five year national parts and labour warranty and is available at selected Teac dealers throughout Australia. It has a recommended retail price of $799.

New Philips range of premier products

To celebrate reaching its 100th year of operation, Philips has launched a new range of advanced 'no compromise' high end audio and video products.

Dubbed *The Philips Collection*, the range includes products selected for their combination of technology, performance, specifications, features and design elegance. All the products are designed to meet the expectations of the most demanding customers.

Initial products in The Philips Collection include the Matchline EDTV 100Hz colour TV set, featuring an 80cm screen with enhanced definition and 100Hz refresh to remove flicker; the AZ 9712 CD Tower Sound Machine, with detachable two-way speakers and controls and drive access neatly concealed behind doors in the vertical front panel; and the AZ 6819 Cordless Personal CD Player, which provides private headphone listening with the convenience of fingertip control coupled with freedom from the restrictions of connecting cables.



Other initial products are the AE 3905 Pocket-size World Receiver, a fold-open compact receiver with PLL quartz digital FM radio and quartz clock, incorporating an LCD panel showing a world map with time zones and cities; and the LFH 0696 Pocket Memo, a personal dictation unit incorporating the 'Work Flow Management System'.

Philips was founded in Eindhoven, Holland in 1891, by Gerard Philips. By the turn of the century it was one of the largest manufacturers of electric lamps in Europe. It subsequently expanded into X-ray tubes, radio valves and TV picture tubes, and then into broad-range electronics.

Today the company has a leading place in almost every area of electronics, and has made many 'milestone' contributions to the technology — including the audio compact cassette and compact disc.

Alpine to licence DCC

Philips Car Stereo International and the Japanese company Alpine Electronics Inc., have reached an agreement about a licencing contract for Digital Compact Cassette (DCC) technology. Philips, as the inventor of DCC, will lincence the DCC technology to Alpine, providing the technical information required for the design and manufacture of in-car DCC products.

The agreement also includes the exchange of technology, products and production facilities in the field of CD changers. Alpine will supply mechanisms and electronics assemblies for CD changers to Philips.

Both Philips and Alpine see the agreement as a first step towards creating long term global strategies for penetrating new emerging markets, and for increasing business volume.

Grundig VCR has inbuilt tape catalog

The new Grundig VS960 VPT/VCR is claimed to be going to change the way video recorders are made and used in the future. It features an inbuilt notebook style computer which is said to make tuning, programming and tape cataloging a breeze. All operating steps and information about filing and filed data appears on screen. This can all be done with an easy to use (and hold) remote control handset.

The Grundig Archive/Tape cataloging system is claimed to spare users from the drudgery of searching through racks of cassettes, with a 'dead easy' system of tape cataloging which includes a summary page, the details and content of every filed tape, with cross reference facilities.

The units sports no less than seven heads. This includes a flying erase head for slick, smooth insert and add-on editing. Each head has a specific function to optimise the picture and sound quality, ensuring the best results when recording, replaying, previewing (with a job-shuttle function on both VCR and remote) and editing.

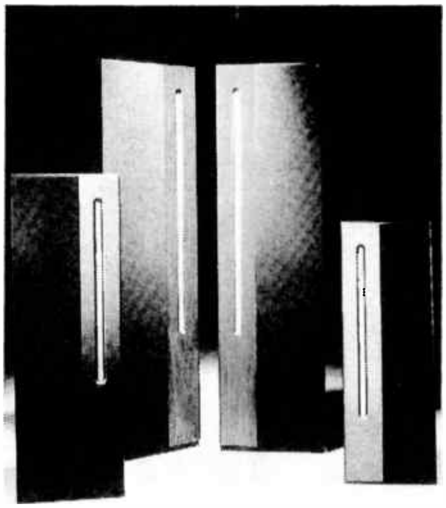
The 960 also features Hi-Fi Stereo, VPS scanning, eight programmable recordings over 365 days and 49-station input allocation positions. It comes complete with a 104 page operator's manual, the size of which is claimed to be testament to the versatility of the unit and not to any operational complexities. RRP for the Grundig VS960 VPT is $1769.

For further information contact Southern Cross Electronics, 28 Kent St, Belmore 2192; phone (02) 750-3166.

New ribbon hybrid speakers from Apogee

Apogee has now introduced the Centaur Major and Centaur Minor speakers. Continuing on in the firm's previous Centaurus theme, both models comprise a mid/high range ribbon coupled to a bass woofer. This hybrid technique allows the speakers to be driven by amplifiers of only 50 watts output, to recreate impressive sound levels.

The Centaur Major and Minor look similar to traditional Apogees, but stand more square and have their ribbons standing vertically along side black grills instead of the familiar see through mesh. Both models are also less critical of room placement, requiring as little as 12" of space from the back wall.



The Centaur Minor comprises a 26" dipole ribbon that is coupled to a 6-1/2" woofer, crossing over at 800Hz with a gentle 12dB/octave slope. It stands 100cm tall, 35cm wide and 22.5cm deep. The 6-1/2" woofer features a 1" voice coil, the cone being of minteral-filled polyproplene with a synthetic rubber surround. Overall frequency response is from 40Hz to 20kHz.

The Minor is rate at 6 ohms (nominal) with a 4 ohm minimum, Apogee claiming that 107dB peaks are capable at 4m using a 50-watt amplifier. The Centaur Minor is available in black with metallic grey finish.

The Centaur Major stands 163cm tall, 46cm wide and has a total depth of 30cm. It uses a larger 40" dipole ribbon, coupled to a 10" woofer and crossing over at a much lower frequency of 450Hz. This woofer is claimed to go down to 31Hz and can be coupled to an amplifier of between 80 to 200 watts.

The ribbons are of the Kapton-backed Apogee type using proprietary high energy strontium ferrite ceramic magnets. Ceramic magnets possess almost ideal magnetic properties offering extremely high flux density and the ability to retain their magnetic energy also indefinitely.

The Centaur Major is price at $9395 and the Minor from $3995. Both are covered by a three year warranty and are available at selected Apogee dealers.

Double cassette deck allows Dolby 'trimming'

Yamaha has introduced a new double cassette deck, designated KX-W952, which provides improved performance and more convenience features than the model it replaces — the KX-W900.

The new model incorporates auto-reverse, Dolby B/C, HX Pro, infrared remote control and 'Play Trim', a feature allowing playback adjustment for the inconsistencies which can occur when playing a Dolby noise reduction encoded cassette that has been recorded on a different deck.

Yamaha has also incorporated a number of new construction changes which improve the performance of the KX-W952. The chassis base is constructed of Yamaha bulk-mold compound, shaped to dampen any vibration or resonance and filled with glass fibres and other proprietary materials to further reduce any residual effects.

For added isolation, the new model uses a heavy-duty chassis and extra-large anti-vibration feet.

The new KX-W952 is a true twin deck, not just a double-deck. It is actually two identical cassette decks housed in one chassis.

Auto-reverse operation is a feature of both sections, as are Dolby B and C noise reduction, and Dolby HZ Pro headroom expansion. One touch twin recording permits simultaneous recording using both decks.

It can be activated by the touch of a single button located in the middle of the front panel. Other transport features include music search, random programme play, and intro scan.

A 44-key wireless remote can operate almost all functions of both sections independently and includes a power on/off key.

The K-W952 features Yamaha's Euro-styled rounded front panel edges. The new deck is also compatible with other Yamaha RS system remote components. It can be operated via the remote control keypad from any Yamaha RS receiver or other control component. It has a suggested retail price of $999. ❖

This Year's Winter CES In Las Vegas

Not long back from his annual fact-finding tour around the globe, Louis Challis reports that he was unexpectedly impressed at this year's Winter Consumer Electronics Show. Judging from the many new products in evidence, the world's consumer electronics firms are gearing up to drag us all out of the recession — by enticing those who still have disposable income to spend on CD-I players, DCC or CD recorders, cellular phones, car audio systems with even higher power output, and TV's with even larger screens...

One could be forgiven for thinking that with America, Japan, Europe and Australia in a state of economic decline, manufacturers would have 'pulled their horns in' — and that the Annual Winter CES in Las Vegas would be mirroring the 'gloom and doom' that I observed in London and New York. Forget it!

Nothing could be further from the truth, in fact. The 1992 Winter CES (like the plethora of poker machines that abound in Las Vegas), was clearly planned to make you forget that some 10% or more of the US and Australian populations don't have enough to eat — let alone spare any thoughts for what's new in the world of consumer electronics.

This year's Winter CES was once again an eye-popping event, with close to 50% more floor area at the Las Vegas Convention Centre (LVCC) than ever before, and with enough new products on show to ensure that even if you had four days at the LVCC, you just *couldn't* cover it all.

While there was more floor space than in previous years, one noticeable absence from the rank of exhibitors was the Sony Corporation — and with no official statements and not a word in any of the CES daily journals, you can well imagine that their absence had some tongues wagging. Following my return from America, there is still no plausible explanation!

Apple for consumers

This year's keynote speaker was none other than John Sculley of the Apple Corporation, whose imaginative address on the future redirection of his highly successful company's interests and efforts had everybody sitting up in their seats. Sculley painted a graphic picture of how Apple would diversify into a much wider consumer market, with exciting and even provocative new products aimed at visual

[illegible]
CES in Las Vegas

and audible communications — which of course had even more tongues wagging.

Although John Sculley is no stranger to the world of Consumer Electronics, his choice of topic, quite apart from the fact that he had been invited to speak, seemed a little out of keeping with the normal direction of CES — until you had time to digest what he was foretelling. Even then, I found myself wondering how Apple is possibly going to achieve the expected impact through 'new and exciting technologies', as Mr Sculley stated they would!

Now although it's doubtful that you have heard anything about it until now, during the last six months Apple Computer has been finalising what I perceive to be one of the most innovative and exciting consumer-oriented multimedia products that they have yet developed. Their latest systems allow you to process video pictures, as well as the related audio sound tracks, with the same degree of flexibility that you have now come to accept and expect from your 'written word' orientated word processing computer software.

Imagine that you have available some form of video picture input which you may wish to edit by adding, deleting, inserting, or even merging, in an analogous way to written text editing on your word processor. Phooey, you may say — that requires complex, expensive and 'state of the art' studio equipment, which if you could do it, would surely require special training.

Well, six months ago your negative response was probably quite accurate, and if you'd wagered on it, you'd have come up with a winner. But as of January 1992, you would have surely lost that wager. As I discovered in America, both the hardware and software are now available for a figure of less than A$1000 — excluding the cost of the Macintosh computer. More significantly, this now provides the amateur with an almost astounding multimedia professional processing capability, which has to be seen to be believed.

Admittedly the *Quick Time* software was released at the Mac Expo in San Francisco, five days after John Sculley presented his address. But all the clues that you needed, to realise that there were even more important announcements in the offing, were there in his spoken words — roneoed copies of which were available as you walked out the hall.

Philips impressed

Of course there were some other big players at CES, the most impressive of whom was undoubtedly Philips. On the evening before the CES actually opened, Philips gave a media presentation to more than 200 journalists, and projected an almost 'larger than life' image. While I had expected that the thrust of their presentation would be directed at DCC, such thoughts were quickly dispelled when Vernon Clifton, Vice President of Telemarketing for Philips Consumer Electronics Company, displayed CD-I (or CD-Interactive) and Philips' 'Imagination Machine' — which is the catchy name they have adopted for their CD-I player.

The 'Imagination Machine' is the name Philips has given to its CD-I player, and it created quite a lot of interest on their stand.

The Imagination Machine had already been displayed to the media three months earlier in late October 1991, at the historic Ed Sullivan Theatre in New York. But it would appear that relatively few journalists were invited to the release, and consequently the media coverage was relatively poor.

The Imagination Machine is simply the next progressive step in a carefully orchestrated digital development program, which Philips set in motion more than a decade ago.

The first product off the rank was the stereo CD itself, which holds 60 or more minutes of high quality stereo music. Next came the CD-ROM, which provides almost instantly accessible data storage and which holds upwards of 550 megabytes of text or 500 sharp pictures.

At about the same time (circa 1984), when Philips, Sony and Matsushita released CD-ROMs, they also produced their first developmental CD-V's. These hold 10 minutes or more of sparkling video and matching stereo sound tracks. CD-V was an exciting development, but as Philips and its partners soon discovered, the market for that product just did not grow at anywhere near the projected rate — and worldwide sales were disappointingly slow and low.

In the 10 years since the CD was developed, Philips and the firms which have affiliated with them have experienced some notable successes, and some rather disappointing setbacks. Their

Not surprisingly, Philips was also demonstrating DCC — now at the stage of production models. Again, it attracted a lot of interest.

most recent development in the form of CD-I takes a vastly different tack.

In order to achieve volume sales and thereby achieve market penetration, they knew they had to offer what people really wanted. But what *do* people really want? In order to find the answer to that question and to ensure that the new software would not lead them into another false trail, Philips Interactive Media commissioned the Roper Organisation (a respected firm of Marketing Consultants) to carry out an 'in-depth study'.

Their report, entitled *A study of America's attitudes towards electronic home entertainment and compact disc interactive* has not been released, but some extracts have.

The study, not so surprisingly, found that while the American public was generally eager for new products, the majority of parents interviewed expressed a strong desire to be able to exercise more effective control over the entertainment options available to their children. Even more pointedly, they wanted *education and entertainment to go hand in hand.* What I found noteworthy was that only about half of the total sample interviewed expressed a desire to have CD-I at home (although apparently some 70% of young adults under the age of 30 expressed a similar desire).

So what is CD-I? Well, CD-I innovatively combines video, text, graphics and animation through the use of hardware, software — and importantly, the existing family TV set. The player is basically a variant of a CD-V unit, to which is attached a 'thumbstick' remote control — not unlike the sort of controls attached to the home computer or a Nintendo video game. The special remote control has been designed to fit conveniently in one hand, although a separate 'Troller' track ball controller suitable for very small children is also available.

There are some critical differences between the existing CD-V player and its discs, and the CD-I player and its discs. Because the primary thrust of CD-I is information, its data-related statistics are vastly different from the regular CD or CD-ROM. The standard 125mm diameter CD-I disc can store 650 megabytes of data, which allows it to replay:

- Up to 250,000 typed pages of text; or
- More than 7000 photographic quality images; or
- An astounding 72 minutes of full screen, full motion animation (which is directed primarily at computer game-like applications) with up to four planes of visual effects; or
- 19 hours of speech.

Last but not least, these new CD-I players are fully compatible with Kodak's photo CD media, about which I will have more to say later.

Among the DCC products displayed on the Philips stand were a high level recorder, fitted with Dolby B and C noise reduction, a car stereo system fitted with the radio data system (RDS), and a 'personal portable' recorder.

Depending on the application, the sound quality on your purchased CD-I software will vary considerably. Three different options are planned, apart from the conventional one offering hi-fi stereo CD quality. One alternative offers 144 minutes of high quality sound, but with more restricted bandwidth (described as 'A level' sound). Another alternative is for 258 minutes of moderate sound quality (described as 'B level' sound), and last but still quite impressively, you can have 567 minutes of speech-quality sound (described as 'C level' sound).

As you have most probably guessed, CD-I has been aimed firstly at children's games, as an alternative to computer games and 'stand-alone' Nintendo type games systems. They have simultaneously aimed at satisfying the education market, which computer games can accommodate, but which the Nintendo games just do not begin to address. While the 'education software' currently available is obviously meagre, that situation is rapidly changing, and some 200 new and attractive software titles should be in the pipeline by the time you read this article.

Initial suggested selling prices for CD-I 'Imagination Machines' suitable for NTSC formatted software will be of the order of $1,000 in the USA. PAL versions are expected to arrive in Australia in mid-1993, and are likely to be considerably more.

Production DCC's

The second important product line that Philips released at their media gathering at the Sahara Hotel were the production versions of their DCC (digital compact cassette) recorders, players, portable players, and automotive radio DCC players. But here they were not alone, as Matsushita also released production versions of DCC under its Technics and Panasonic brand names.

Not so surprisingly, there are now some 60 other companies who have signed on the dotted line to produce hardware or software for the new format. One notable exception from the 'star studded lineup' was Sony Corporation (although I have no doubt that they too will finally succumb to the inexorable pressure).

The DCC equipment being displayed by Philips (see photo) is as impressive as the quality of the sound that it now produces, although it must be noted that the quality achievable is not as outstanding as that provided by either conventional CD or DAT.

Technics/Panasonic were careful to describe both of these systems as being 'each a star in its own market'. Technics described DAT as being 'the medium for professionals and audiophiles who demand nothing less than the ultimate', while they were careful to point out 'DCC has overwhelming advantages in the mass consumer market'.

It was my observation that while DCC is potentially an outstanding consumer product, it nonetheless exhibits a number of technical compromises and related limitations which are inherent in its design philosophy.

Whether those limitations prove to be audible or manifest themselves in some other detrimental way yet remains to be seen.

What did impress me was the quality of the four major DCC products which Philips was ready to market, and in particular the portable DCC 'Walkman style' players and recorders — which are positively mouth-watering. These portable players have a ready market, and will revolutionise portable hi-fi in a way that portable CD players or even portable DAT players are currently incapable of fully matching.

The most innovative aspect of the portable DCC players is their integration of a four-second storage delay loop between reading the digital data and the digital-to-analog decoding of the output, so that movement-related segments of lost signal can be re-read and corrected to ensure that you are oblivious to motion related software glitches or defects.

'Digital' speakers

The third exciting Philips product release at the Sahara Hotel were the Philips 'Digital Loudspeaker' systems, which integrate powerful digital signal processing (DSP) circuitry and the associated amplifiers within the loudspeaker enclosure. Philips claim that by keeping the signal in the digital domain as long as possible, near-perfect sound reproduction is achieved with the new Philips Digital Speaker System.

Philips claim that these DSP systems are capable of compensating for a wide range of transducer frequency, phase and related crossover deficiencies, and thereby effectively optimise the speaker output linearity to within ±0.5dB over the 40Hz to 20kHz frequency domain.

As you will realise, this is theoretically vastly superior to the performance capable of being achieved by conventional analog speaker techniques. They were displaying their DSS930 speaker systems with a suggested retail price of US$1,200/pair, but the scope of the information available whetted one's appetite — without convincing you that the product had really achieved a breakthrough in terms of real listening quality.

One other Philips speaker development worthwhile noting is their final acceptance of a marketing trend which most of their competitors had long ago accepted, in the form of 'in wall' speaker systems. These now constitute a sizeable proportion of the US market, as they do in other countries.

The Philips FB425 'in wall' speaker system is a well engineered product, with which they can now compete head-on with large numbers of other innovative manufacturers such as Sonance, KEF, Boston Acoustics and other well respected European and American manufacturers.

Recordable CD's

A sister company, Marantz of America, as well as the Pioneer Corporation of Japan (which has had close technical ties with Philips of Einhoven since the mid-1970's), were both displaying recordable CD's — as was Sanyo Corporation.

The Marantz CDR-1 recorder with a price tag of US$7000 is a production machine, not a prototype, and can be purchased in the US right now. The Sanyo model 9280 offers re-recording and re-writing capabilities, which the other two recorders currently do not.

The CD recorders being offered were clearly affordable, and provide yet a further home recording media which will be clearly attractive to a segment of the audiophile market. The matching recordable compact discs are readily available from TDK, with a suggested US selling price of $70 each. At that price I had no qualms about bringing one back in expectation of soon being able to obtain one of these recorders for review purposes.

The Marantz and Pioneer CD recorders use the 'once recordable' discs, which offer some unique and attractive features. These include the ability to record sequential tracks at different times, and to store a temporary index which is only finalised on a separate set of tracks once the full data content is known and recorded on the disc.

DAT, mini CD

Competing against the CD recorders and the latest DCC recorders, for high quality audio applications are a range of new DAT recorders, from a number of other Japanese firms.

These include Nakamichi, Aiwa, Sanyo and Toshiba amongst others, all of whose products offer tremendous flexibility and great potential.

Lined up against these products is Sony's Mini Disc system, which offers the same user convenience and speed of access on par with a conventional CD. More significantly, the Sony Mini Disc potentially offers a superior flexibility, comparable fidelity, smaller size and general con-

The DSS930 'Digital Loudspeaker' was the third new product that attracted attention on the Philips stand.

On display at the Sanyo stand was the firm's new CD-MO magneto-optical CD recorder. Unlike the other CD recorders currently available, it offers re-recording and re-writing capabilities.

venience which is either on par with, or in some critical areas (like wow and flutter), possibly even superior to DCC. The catch with the Sony Mini disc is that as well as being smaller and neater, I suspect it may prove to be more expensive than DCC.

There is of course intense rivalry between the proponents of the two systems. I suspect this rivalry may well be behind Sony's notable absence from CES. The comment I have received from Sony Australia is that Sony USA is 'organising its own Technical Show' a little later in the year, and of course we all await that show with more than just a passing interest.

Cellular, hi-tech phones

One range of products of potentially wider interest were the cellular telephones and other consumer cordless telephone systems, which are proving to be one of the fastest growing markets in the USA as they have been elsewhere in the world. The quest for instant communications has spawned an absolute plethora of new minuscule and lightweight cellular telephones — some of which are so small that the term 'pocketable' is no more quite as fitting nor as apt as it was even last year.

What surprised me were the number of foreign manufacturers who were offering products for the US market. Think of a Japanese, Korean, Taiwanese or even a European hi-fi products manufacturer, and its even money that they were displaying a brand new cellular or radio telephone system designed for the American market.

A significant proportion of those manufacturers also make conventional telephones, which have suddenly achieved a new level of flexibility as well as other user-friendly features, the majority of which I was oblivious of until I arrived at the CES.

The new catch cry in the American market right now is 'caller identification', which I only discovered at a journalist breakfast organised by BellSouth Services, who you may be interested to note are one of the shareholder firms in Optus Communications, Australia's new competitor for Telecom in the telecommunications market.

BellSouth Services has released a range of 'caller identification' compatible telephones, which — where the telephone company (and State laws) permit — offer you the ability to interrogate and display the phone number of your caller before you even pick up the receiver. More significantly where there is no 'caller ID number' transmitted, you are thereby at liberty to reject all such calls.

I found the concept of 'caller ID' intriguing, because whichever way you look at it, there could be few good reasons for anyone to object to their phone number being transmitted and identified, at a receiving location.

The telephones which BellSouth Services were displaying were neat, visually attractive, inexpensive by Australian Standards, and precisely the type of phone that I would have liked to use in Australia. You can imagine my surprise, when they presented each of the journalists, including yours truly, with a working caller ID phone at the end of the session.

An additional series of products which BellSouth Services released were their multi-channel cordless phones, which incorporate an 'auto-scan' feature. This searches for the clearest noise-free channel from the 2-10 channels available, in order to reduce interference.

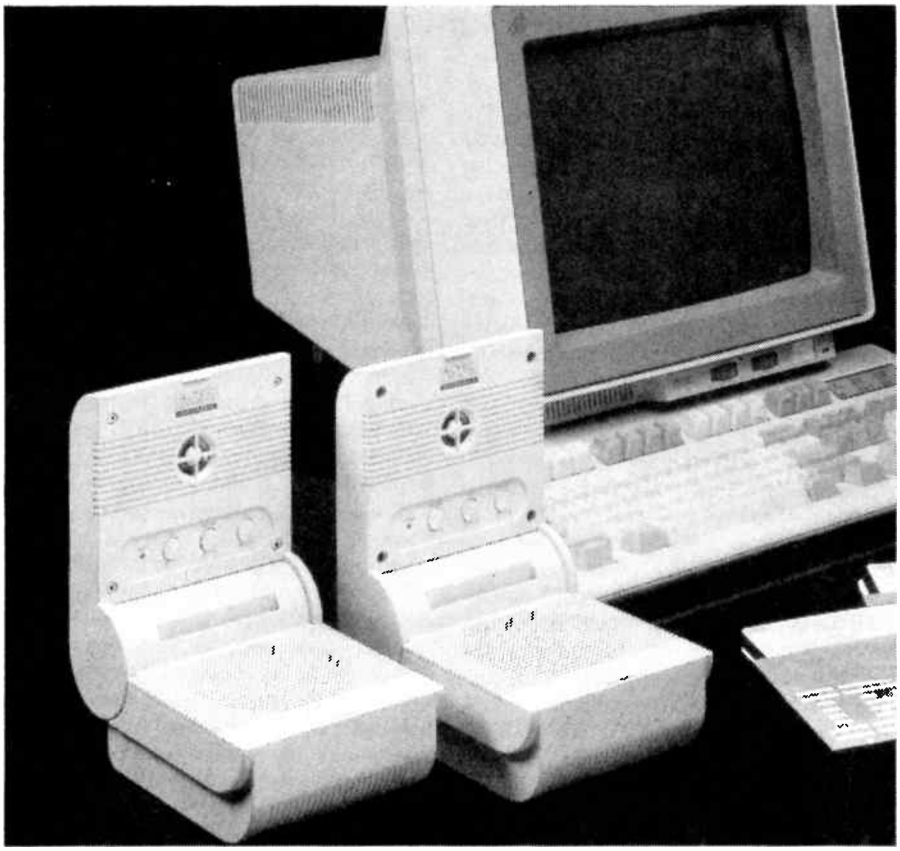
The sound quality you then receive on your remote telephone is just as clear as the signal you would receive on the hard-wired base phone to which your mobile phone has been connected.

Altec and Big Blue

As I moved around the CES on the first day of the Show, I arrived at the Altec Lansing exhibition space just in time to hear what proved to be a momentous presentation. Altec Lansing were announcing that they had joined forces with 'Big Blue' (IBM Corporation), to release a computer (or multimedia) orientated loudspeaker system which has been specifically designed to work in conjunction with computers, to produce a comparable sound quality to that which you

Cordless phones were very much in evidence at the Show. BellSouth released their new multi-channel cordless models, which automatically scan for a clear channel.

Also visible in large numbers were cellular phones, which are steadily getting more and more compact. These tiny models are from Pioneer.



Altec Lansing was displaying its ACS-300 computer speaker system, developed in conjunction with IBM. It provides very impressive sound capabilities for use with computer based presentations.

have grown accustomed to hearing from your hi-fi CD player.

What we were being shown were two types of self-powered electronically controlled satellite speakers, which could be placed on the table next to the computer, on the wall behind the computer, or fixed to the side of the display monitor.

These separate (stereo) speaker systems are then supplemented by an additional optional sub-woofer, which can be placed under the desk or elsewhere in the room, and through which the quality and frequency bandwidth of the reproduced sound would no longer constitute an acoustical limitation for the computer-based system.

The Altec Lansing Computer Speaker Systems type ACS-300 are remarkably attractive, and as I had cause to note, were exceptionally good. Although the demonstration was conducted under less than optimum conditions, the results of that demonstration were most impressive, and Altec Lansing had no cause to make any apologies. I asked whether Altec Lansing's agreement with IBM precluded them from marketing these speakers through other manufacturers, and was somewhat surprised to discover that it did not!

One of the most critical features of the Altec Lansing computer speaker systems are the quality of their RFI and magnetic shielding — which allows them to be placed right up against the side of the monitor with no adverse affects. I noted with interest that the ACS-300 separately powered sub-woofer incorporates a double porting system, which I suspect uses the technology developed by Bose Corporation.

Car audio

Considerably more space was devoted to 'car audio' at this year's Winter CES than I would ever have dreamt possible. In practical terms, there was more space allocated to car audio than is currently available in the largest Convention Centre in Australia.

The outdoor section (LVCC Parking Lot A) where the stationary displays of (nauseatingly loud) car and van mounted hi-fi systems occupied close on one hectare — over three acres — of display area, and was readily identified the moment you approached it.

You could feel, rather than hear the low frequencies from the multitude of outdoor built-in low frequency speakers and sub-woofer systems, from a distance of the order of 500m or more. In fact as most of the attendees approached the area they tended to slow down, with quite a few perceptibly changing direction to avoid what I found to be one of the more unpleasant aspects of the Winter CES.

Even with good earplugs properly fitted, you were still likely to be at some risk as the peak sound pressure levels from most of the mobile displays were now well in excess of 140dB. As I discovered, the official record holder in this year's high-powered mobile auto competition stakes can top 150dB, along with virtually all of the 'runner-ups'. If you are listening to levels of that order on a regular basis, you are most probably already deaf — or if you weren't, you soon will be!

Even inside the South 2 Hall, where there were hundreds of exhibitors displaying high powered car audio and car security systems, the sound levels tended to be unpleasantly high. The pervading feeling was that an earthquake had com-

You want MORE power in your car stereo system? Okay, buddy — how about this one? It can generate over 150dB. The only problem is, you need an extended wheelbase pick-up van to house it...

menced, and had miraculously continued beyond the first violent groans of the earth.

An interesting point is that there was now just as much emphasis on protecting your car (and its contents) as there was in providing car audio. And although there were some wonderful exhibits and some mouth-watering examples of superlative hi-fi systems in cars, ranging from Ferrari's to Rolls-Royces, there are relatively few of us who would wish to allocate half the car, or all the boot space to such whimsical purposes.

Car DSP systems were almost everywhere, and although Yamaha and subsequently Sony have long since pioneered and developed exciting car DSP concepts, loads of other manufacturers such as Sanyo, Alpine, Pioneer, Panasonic, Mitsubishi, Kenwood, Clarion and simply loads of others have now joined the august fraternity manufacturing car DSP systems.

Last year there were only three manufacturers of multi-disc boot mounted automotive car CD players. This year Sanyo, Kenwood, Pioneer and a number of others have joined that fraternity too. I was very impressed by the Sanyo system, and it will be interesting to see if they elect to bring some of their newest car audio products to Australia. Up to this point of time they have limited themselves to only one outlet in each State, and with only a small proportion of their product range.

Kodak's Photo CD's

One of the most off beat products to be released at the CES was the Kodak Photo CD System, which is theoretically attractive, but potentially something of a 'wild card'. Their system is based on the premise that once you process your photos, either negative or positive, you will be prepared to purchase a photo CD which when plugged into either a Philips Imagination Machine or a Kodak PCD 870 photo CD player, will allow you to view the contents of that roll of film as coloured pictures on your TV set.

Kodak photo CD purchasers receive their photo CD discs in the familiar CD jewel case, at the front of which is a numbered index print of each photo — plus the date, to allow rapid identification and subsequent photo display.

What about the ordinary photos you ask? You can have them too, at virtually no extra cost. The cost of providing photo CD's wasn't actually spelt out in the Kodak media releases, but is currently thought to be somewhere around US$70.00 — with a capacity of the order of 100 photos per disc.

Two other noteworthy products at this year's Winter CES were Sanyo's pro-active environmentally friendly stance of introducing a complete line of reusable/rechargeable batteries, which are accompanied by the first manufacturer's Mailback Recycle System. This allows consumers to mail worn out NiCad batteries back to Sanyo for recycling — rather than dumping them in the garbage, or otherwise discarding them so as to further pollute the environment.

Although the concept is laudable, what worried me was what percentage of those lucky purchasers would be able to find the Mailback container when it is finally needed, some 1-5 years down the track. And will Sanyo continue to recycle the batteries, when they receive them, or will *they* merely dump them? If they do the latter, it will be a charade.

The second noteworthy product was the Faroudja Line Doubler, which takes a conventional NTSC, S-VHS, Hi-8 or RGB video signal and converts it into a line doubled, artifact free high resolution signal. As I observed, the quality of the picture provided by this process exceeds the quality of the standard 625 line PAL display with which we are all familiar, and is only marginally inferior to an HDTV (High Definition Television) display when viewed on a large screen (direct view) TV display or projection monitor.

Although at first I thought the Faroudja Line Doubler LD100 was just another gimmick, like so many others at the CES I reassessed my viewpoint on viewing the quality of the video signal which it produces. Frankly I'm no longer convinced that it is a gimmick. I have no doubt that this is one concept which will ultimately be adopted by other manufacturers, as an effective means of overcoming some of the disabilities of both 525-line NTSC and 625-line PAL, when displayed on large TV screens.

In summary

The 1992 Winter CES at Las Vegas produced a plethora of other new consumer products, like large screen back-lit liquid crystal displays on both the Casio and Citizen stands — both of which have the potential to revolutionise home TV's as well as portable computers. As I see it, 'everyman's dream' of a large flat TV display flush with your bedroom or living room wall is now at hand.

We are standing at the threshold of a new era of consumer electronics, where communications will be integrated with technology and entertainment in a way that few would have ever dreamt possible.

1984 may have come and gone, but George Orwell and his predecessor Jules Verne, as well as many of their wonderful concepts have either already arrived, or are simply standing in the wings ready to make their grand and dramatic entrances. ❖

[illegible]

Moffat's Madhouse...

by TOM MOFFAT

GUI? Phooey!

This is a story about computers. Yes, I know that this isn't a computer magazine, but it's unlikely any self-respecting computer magazine would publish what you are about to read here. It would be seen as absolute heresy, because I intend to question the direction computer development is taking. Commercial pressures say we must move ever ahead to bigger, more sophisticated, and more expensive computer systems. But do we really need to?

Dedicated computer people have been trained (brainwashed?) to always demand the biggest and best. But you *Electronics Australia* readers are most likely 'electronikers' — realists, who see a computer as a tool instead of a status symbol. You (we) see the computer as a means to an end, instead of the end itself. Our computers are usually hooked up to something such as radio gear, or they're used to replace a typewriter, or (horrors!) to play games.

Our computers are NEVER placed on spotless desks next to a trendy pot plant, like in the current computer ads. Instead of wearing a Country Road shirt and tie and trendy braces and round wire-rimmed glasses, the guy behind the keyboard is more likely in shorts, a T-shirt, and thongs. (*Speak for yourself, Tom — I hate thongs! — Ed.*)

Instead of the slinky black woman wearing a man's suit looking over our shoulder, we probably have a matronly office worker telling us that another of our creditors is on the phone.

It seems that most of the industry sees its user base as the fancy desk and pot plant brigade, and the shorts and thongs segment doesn't exist. Or if they do, they're ignored.

Reason: they don't spend much money. They're quite happy with what they've got; it works fine for their purposes; if it ain't broke, don't fix it. So let's concentrate on selling to the pot plant brigade where there's lots of corporate or government money (yours and mine) to be spent. And what's the hottest seller at the moment? GRAPHIC USER INTERFACE!

Buzz, Buzz! That's the sound of a hornet's nest, folks. We've just whacked it with a great big broom handle, and in a moment all hell is going to break loose. Are we about to actually CRITICISE Graphic User Interface? Yup.

Graphic User Interface is usually abbreviated as GUI. This is pronounced as 'gooey' for very valid reasons. Using it on anything other than the very latest, fastest, and most expensive computer is like tripping along through a bowl full of molasses.

GUI refers to that system where you make your program do things by pointing a mouse at a little picture on the screen and pressing a button on the mouse. You don't have to be able to type; you don't even have to know the name of the program. This is similar to going to the loo in a foreign airport. You don't have to know the word 'men' in Spanish or Arabic, you just look for the little icon of a man on the door and then you can go in there and whizz away with confidence.

The antithesis of GUI is CLI, meaning 'Command Line Interface'. Here the computer presents you with a prompt such as 'C_', and you then use the keyboard to type in the name of your program, sometimes followed by what you want it to do.

For instance if you wanted to use your word processor called 'Edit' to work on a document called 'Story' you would type EDIT STORY and hit the Enter key, and the editor would instantly pop up on the screen with the words of STORY displayed for your perusal.

To do the same thing under GUI, you would first have to wait for the GUI program itself to come to life (slowly). You would then see several pictures or 'icons', including perhaps one of a little typewriter. You would move the mouse pointer to the typewriter icon and click the mouse button twice.

Next the word processor would be loaded in, ON TOP OF the GUI which stays there as well (goodbye, memory). The word processor would then display a menu of files on the disk, and you would shove the mouse pointer to the word STORY and click the button again. STORY would now be loaded, ready for action.

It's interesting to note that there is much polarization over whether GUI or CLI is 'best'. You have GUI people and you have CLI people, and there appears to be little middle ground between them. You may have discovered by now that I am a CLI person, and I just can't take to GUI at all. I get confused and frustrated by mice. Other people swear by GUI's and think that people who refuse to use them are the same people who refuse to use flush toilets.

But even some very pro-GUI people are starting to have second thoughts, even in the prestigious American computer magazine *BYTE* which has been plugging GUI's for all they're worth (along with trendy pot-plant desks and slinky black women in men's suits).

One *BYTE* commentator perpetrated the ultimate outrage when he wrote "I'm getting the very uneasy feeling that GUI's are actually the biggest con job that the computer industry has ever put over on us".

Eh? How could this be? Well, there are a couple of key words in the previous paragraphs — 'slowly' and 'memory'. If you can be convinced that GUI is indispensable for you, you'll probably find it it pretty 'gooey' running on your existing computer. And if you've got a lowly one megabyte of memory that seemed gigantic when you bought the machine, you'll find that 'out of memory error' is a daily feature of your life.

How to overcome these problems? Buy a new computer! Ahh — another sale for the beleaguered computer industry, and YOU have helped Australia's economic recovery (or perhaps Taiwan's economic boom).

You now have a $3500 computer instead of a $1500 computer. It still runs your word processor called Edit, although a lot of flashy stuff happens in the GUI before Edit comes to life. So Edit itself now looks a bit dull.

Perhaps it's time to upgrade to Edit Version Five or whatever, written specially to run in the GUI. You spend a few hundred dollars more, you install Edit Version Five only to find that it now uses twice as much space on your hard disk as the earlier version. And as well, it runs SLOWER!

Golly! Well, the salesman says that to speed up your program you're going to need an even *faster* computer. And as well, all this new GUI software demands a lot more memory and more disk space. So let's upgrade to a $5000 computer with a double-sized hard disk and six megabytes of memory. Now you find that Edit Version Five runs much faster — almost as fast as Version One did on your $1500 computer. And that, my friends, is 'progress'.

As for that speed question, there are certain advantages in some applications. For instance desktop publishing requires an awful lot of things to happen in a big way, and it seems to take forever on an earlier 'AT' class computer. Same goes for computer-aided design work.

If you're designing a house or a bridge, you frequently want to 'regenerate the screen' to get an overall look at what you've done so far. This involves lots of internal calculation, and it's pretty frustrating to sit there as the new picture dribbles onto the screen line by line. Here a fast computer certainly *is* justified.

Most of the software I use is small and blindingly fast, particularly the 'Video Display Editor' word processor I use for all my magazine writing. Most of this is done on my trusty and horribly obsolete Toshiba XT-class laptop. This is just like my trusty and horribly obsolete Holden station wagon; I intend driving them both until they fall apart.

The Video Display Editor does its stuff in the blink of an eye on the XT laptop. It doesn't appear any faster on a '386 machine, because you can't get much faster than the blink of an eye!

The occasional speed problem does crop up. I've recently started using a big mathematics program to calculate the orbits of satellites for a weather satellite project I'm working on. You can tell it to work out the dates and times of all the passes of the NOAA 9, 10, and 11 satellites, receivable in Tasmania, for the next week.

The program then goes away and cogitates; waiting for a result is like watching grass grow. Buy a new computer? No, I just set the laptop working and then come back after lunch to collect the finished product. No time lost there at all.

Maybe we've been a bit coy about brand names here. The original GUI came from Apple Computer as the operating system for the ill- fated Lisa, and later for the popular Macintosh. IBM decided they had to have a 'point-and-click' system to match the Mac, so Microsoft came up with a system called *Windows*. In the Amiga world, the GUI is called the *Workbench*.

In the IBM and Amiga at least it it quite easy to short-circuit the GUI and revert straight to a CLI system. This is the first thing I learned when I got an Amiga to do project development on — how to nobble the Workbench. On the IBM you can get rid of the GUI by simply not starting it up. Apparently this happens quite a lot. A recent statistic pointed out that only one third of people who own *Windows* actually use it.

Windows is now 'bundled' with many new computers; in other words you get it for free, as part of a package deal. Is this generosity, or is there some hidden motive? Is it intended that new down-market 'AT' machine owners get the message that *Windows* and all its application programs would run oh-so-much better if they upgraded to a 386 or 486 computer?

Perhaps it's a bit like supplying a free sample of heroin with a purchase of marijuana, to get you hooked on something a bit more flash.

Applications! Well, *Windows* exists, so we MUST have applications to use it. Big fat sluggish applications, offspring of things that were so slick and elegant in their DOS/CLI versions.

I heard the other day that the popular and excellent PCB design packages from Protel would be henceforth available in *Windows* only. I was on the phone to them in a shot, to learn that yes, future product development was *Windows*-based only, but they certainly weren't going to kill their existing CLI-based programs like *Autotrax* and *Easytrax*. They're going to wait and see what the market does.

As for myself, I've got Protel *Easytrax* and *Schematic* running on my AT-class computer, and I wouldn't use anything else for PCB and circuit design work. A mouse sits nearby, idle, because I prefer to drive the editing cursor around with the cursor keys instead of a mouse.

I'm a perfectionist and I like to physically click the keys six times to move the cursor six tenths of an inch along the PCB. Then I KNOW it's where I want it. I guess it gives me a feeling of security.

Windows does have certain advantages for program developers; for instance there is a standard printer interface so they don't have to write drivers for every printer in the land. But developers shouldn't forget the guys in shorts and thongs who populate the small businesses of this world.

I know for a fact that lots of excellent design work comes out of 'obsolete' computers in garages and back rooms, and there's no way those people are going to jump out and buy a new computer just to run new software. They'll quite happily stick with what they've got. If it ain't broke, don't fix it! ❖

"One of the most daring space missions ever planned":

CATCHING & REPAIRING A SICK SATELLITE - IN ORBIT

This coming month, NASA astronauts are planning to use their new shuttle *Endeavour* to carry out one of the most daring orbital space missions ever attempted. The goal is to rendezvous with the ailing 3.9-tonne INTELSAT VI F-3 satellite, spinning in orbit 550km above the earth, capture and attach it to a new rocket motor — weighing over 10 tonnes. Hopefully the pair will then be moved away from *Endeavour*, and the new motor used to take the satellite to its correct geostationary orbit.

by KATE DOOLAN

April 1992 is the time and low Earth orbit is the place, for one of the most daring space missions ever planned and flown. Astronauts aboard the new space shuttle *Endeavour* will retrieve, repair and reboost back into orbit a communications satellite that would have become space junk and re-entered the Earth's atmosphere, if not reached in time.

The INTELSAT VI F-3 satellite, which belongs to the International Satellite Organisation (INTELSAT), was launched into space by a commercial Titan 3 rocket on 14 March 1990 from the Cape Canaveral Air Force Station in Florida. The launch was flawless, but problems started soon after the rocket and satellite reached Earth orbit. After insertion into a low orbit, the apogee and perigee kick motors were supposed to ignite, to boost the satellite into a geosynchronous orbit. However, due to a wiring error in the Titan rocket, the satellite remained attached to the Titan second stage — leaving the satellite stranded.

To prevent the INTELSAT/Titan configuration from re-entering the Earth's atmosphere, ground controllers had to separate the satellite from the perigee

kick motor which was attaching it to the Titan second stage. The satellite was then manoeuvred to an orbit of 554 kilometres using its hydrazine and nitrogen textroxide thrusters.

Once the satellite was stabilised, the governing body of INTELSAT had several decisions to make about the future of the satellite. Given the satellite's cost of US$115 million, they were reluctant to write it off and let it re-enter the Earth's atmosphere. Representatives from INTELSAT, the National Aeronatuics and Space Administration (NASA) and the Hughes Aircraft Company — who were the manufacturers of the satellite — met to discuss the options for a retrieval or reboost mission.

Two basic recovery options were studied and discussed, the first option being retrieval and return of the satellite to Earth where it would be refurbished and relaunched on another rocket. The second option available was retrieval, repair and reboost directly from the satellite's present orbit.

It was decided to go ahead with the second option, because of monetary considerations and fewer technical problems with repairing the satellite in orbit. To relaunch the satellite would cost close to US$120 million, and in any case there would be problems in getting a launch vehicle to fit INTELSAT's timetable.

In June 1990, INTELSAT awarded NASA a contract of US$97 million to carry out the retrieval, repair and reboost of the satellite by the space shuttle in early 1992. Another contract was also awarded to Hughes for the construction of hardware needed for the spacewalks that would be taking place.

Before the mission received final approval, INTELSAT wanted to assess the possible damage to the satellite's solar panels in low Earth orbit, by atomic oxygen. A sample of an INTELSAT solar panel was attached to the Remote Manipulator System (RMS) arm on the shuttle *Discovery*, for the flight of STS 41 in October 1990. The sample on the arm was positioned away from the shuttle for 20 hours, to determine the extent of any oxygen corrosion. After the mission, the sample was assessed and the 'all clear' was given for the 1992 flight.

The INTELSAT VI series of satellites comprises five commercial communication satellites, which are designed to provide voice, video and data services to Earth stations located in 180 countries. Each of the satellites is constructed with 48 transponders — 38 in the C-band and 10 in the Ku-band. Each satellite has a capacity of 24,000 simultaneous two-way telephone circuits and three television channels.

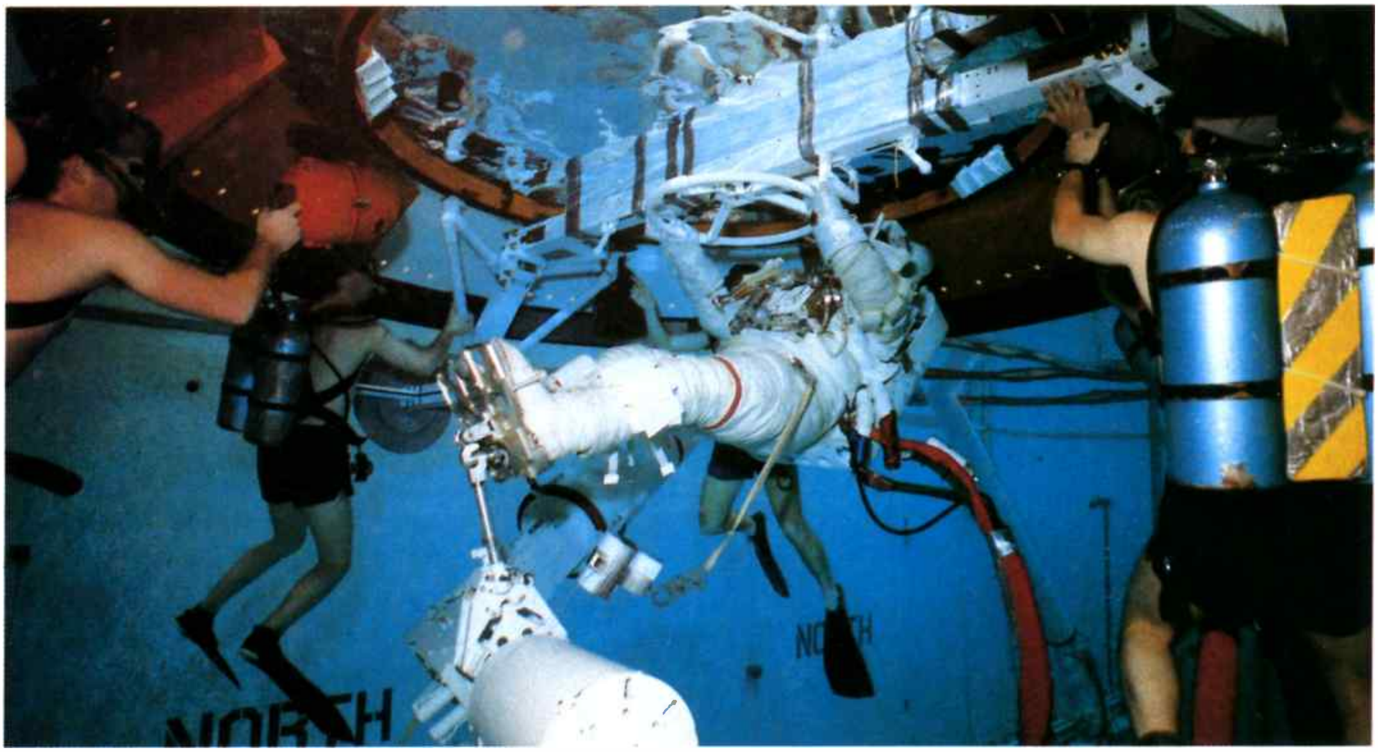
In this shot taken during the preparation of an INTELSAT satellite similar to the VI F-3, the 'capture bar' which will be used by astronaut Pierre Thuot is visible on trestles in the foreground.

When fully deployed, each satellite measures 12 metres high, three metres in diameter and weighs 3900 kilograms. The satellite series also incorporates satellite switched time-division multiple access technology, which enhances the connectivity and flexiblity of transponder use.

New shuttle

The space shuttle orbiter *Endeavour* is the replacement for the shuttle *Challenger,* which exploded six years ago. The replacement orbiter was given the

Catching and repairing a sick satellite - in orbit



In a 25' swimming pool at the Johnson Space Centre's weightless environment training facility (WET-F), Astronaut Thuot practices attaching the capture bar to the appropriate end of an INTELSAT satellite. During the mission he will be attempting the same operation in space, while attached to the end of 'Endeavour's' remote manipulator arm.

go-ahead by the White House in August 1987, and incorporates several new features including a drag parachute for landings, improved flight computers, more storage space for crews and a state of the art flush toilet — which hopefully will not break down as has happened on previous missions! Another improvement for the *Endeavour* is the installation of equipment so that the orbiter can fly extended missions, initially, of up to 16 days and later for 28 days.

The crew of STS 49 was named in December 1990 and is commanded by Dan Brandenstein, the Chief of the Astronaut Office, who has flown in space three times previously. The last flight that Brandenstein flew on was STS 32, which saw the spectacular retrieval of the Long Duration Exposure Facility in January 1990. The pilot for the flight is Kevin Chilton, who has been an astronaut since 1987 and is making his first spaceflight. There are five mission specialists on the flight and they have all flown in space before: Tom Akers, Rick Hieb, Bruce Melnick, Kathy Thornton and Pierre Thuot.

The launch is currently scheduled for the second week of April. *Endeavour* will launch in the early morning from the Kennedy Space Centre in Florida, for a mission of seven days. In case of weather difficulties or scheduling problems on the flight, an extra two days have been allowed. The first four days of the flight will be spent on conducting checkouts of the spacesuits to be used, the Remote Manipulator System arm and scientific experiments.

The reboost mission hardware will be stored in the payload bay of *Endeavour* and includes a new perigee kick motor (PKM) which is built by United Technologies. It weighs 10,430 kilograms

Astronaut Pierre Thuot is pictured here atop a crane examining an INTELSAT satellite similiar to the one he will be seeking to capture during the forthcoming rescue mission.

and is a solid rocket motor. A satellite capture bar and guides, foot restraints and handrails are also included. Using a 'control box' rendezvous technique, the INTELSAT VI F-3 and the *Endeavour* will be manoeuvred into the 'control box' area — that is, a volume extending over six degrees of arc in a 380 to 390-kilometre orbit with an inclination of 28.35°. The INTELSAT VI F-3 must be in the 'control box' area by 46 hours into the STS 49 mission.

Six hours before the approach of the *Endeavour*, the satellite will be spun down to less than 0.25 revolutions per minute (RPM). After the spindown is completed, the satellite will be commanded to move into a safe configuration with the shuttle.

Half an hour before the capture of the satellite on the fourth day of the mission, astronauts Pierre Thuot and Rick Hieb will enter the payload bay of the *Endeavour* to prepare for the installation of the new perigee kick motor.

Tricky operation

When *Endeavour* comes to within 30 metres of the satellite, Thuot will anchor his feet into a portable foot restraint at the end of the RMS arm and Tom Akers inside the shuttle's cabin will carefully manoeuvre Thuot — who will be standing up on the arm with the capture bar in his hand — over to the satellite. The capture bar will be used to latch onto the satellite so it can be returned to the shuttle payload bay.

Using the 'steering wheel' handle located at the middle of the capture bar, Thuot will grab the satellite and stop its rotation. Thuot has stated that he will only require two or three kilograms of force over 12 seconds to stop the 3900 kilogram satellite. This procedure will also involve lining up the capture bar pads to connecting slots on the satellite.

Once the satellite is stationary, the RMS will attach to a fixture on the end of the capture bar and return both Thuot and the satellite to the payload bay. The satellite will then be moved to the docking adaptor and from there, Rick Hieb will assist Thuot in installing the perigee kick motor onto the satellite. After clearing the work area, Thuot and Hieb will return to *Endeavour's* crew cabin and the satellite complete with new motor will be ready for redeployment.

Relaunching

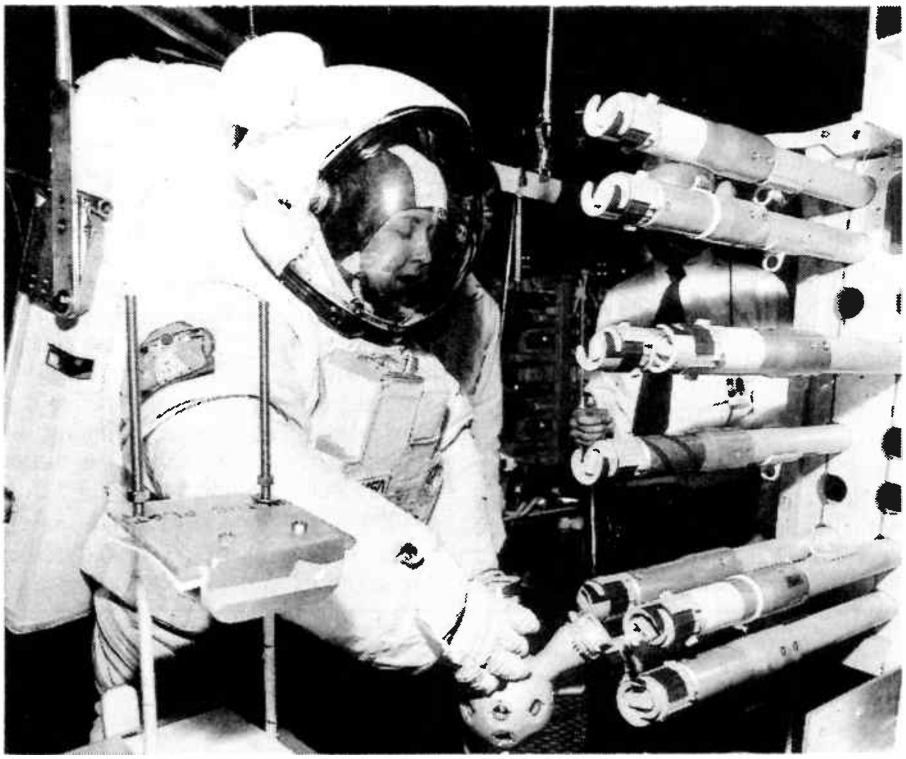
After the orbiter obtains the correct altitude, a switch will be thrown in *Endeavour's* flight deck and the satellite will be propelled from the payload bay at the speed of 0.2 metres per second and a rotation of half a revolution per minute. After the satellite is a safe distance from *Endeavour*, INTELSAT ground controllers will establish a command link with the satellite through the INTELSAT telemetry ground station network, and increase the satellite's rotation to 10 revolutions per minute.

INTELSAT controllers will later increase the satellite's rotation to 30 revolutions per minute and the perigee kick motor will be fired. This will send the INTELSAT VI F-3 to a geosynchronous orbit over the Atlantic Ocean, where it is expected to start operations in mid-1992. For the remainder of the STS 49 mission, the astronauts will be concentrating on making another two space walks.

On flight day five, astronauts Kathy Thornton and Tom Akers will make a spacewalk, in which they will demonstrate procedures that can be used in the construction of Space Station *Freedom* in the later part of this decade.

This will involve building structures, evaluating self-rescue devices and technique and using the RMS arm to assist in the construction of a truss structure.

On flight day six, Thuot and Hieb will make another spacewalk and complete the procedures that Thornton and Akers started the previous day.



Astronaut Kathy Thornton is pictured here practicing procedures that will be used in the assembly of the space station. An exercise for the same project is being carried out during the April mission to repair the INTELSAT bird.

Down to Earth

Seven days after the launch, *Endeavour* will land at the Edwards Air Force Base in California. Or if there is bad weather at that landing site, it will land at the Kennedy Space Centre.

When *Endeavour* is back at Kennedy, it will be prepared for its second flight in September —a Spacelab mission that will be entirely dedicated to Japanese experiments. Of interest to spaceflight observers will be the first flight of a married couple, together on the same flight. A Japanese scientist will also be flying.

Endeavour's first flight will be one of the highlights of International Space Year 1992, and should be one of the most exciting flights every seen. It will also see the *Endeavour* take its place in the shuttle fleet as a worthy successor to its predecessor *Challenger.*

The author wishes to thank Michael Newsom of INTELSAT, the Public Affairs Office and Astronaut Pierre J. Thuot of the Johnson Space Centre for their assistance in the completion of this article. The photographs are courtesy of INTELSAT and Lisa Vazquez at JSC. ❖

Automotive engine control - 3

In the second of these articles we had a look at the overall system used for engine management, and the nature and make up of the sensors and actuators used. In this article we will look at the goings-on inside the engine controller itself, and what one might expect to find if you opened one up.

by TONY MERCER

The form the inputs to the controller take are either an on/off signal, represented by a high or low voltage which indicates some state (i.e., throttle closed or open, engine number one cylinder at top dead centre etc.), or a varying voltage representing some quantity such as air temperature, manifold atmospheric pressure etc. It could also be a high or low voltage representing quantity, by how *long* it is high or low — such as the pulse length generated by the distributor signal.

Fig.3.1 shows how the pulse length varies for a six cylinder car spinning at two different engine speeds. This signal from a Ford Falcon is called the PIP (profile ignition pulse) signal — other manufacturers have the same signal, but called something else — and is derived from an electromagnetic pick-up from the distributor.

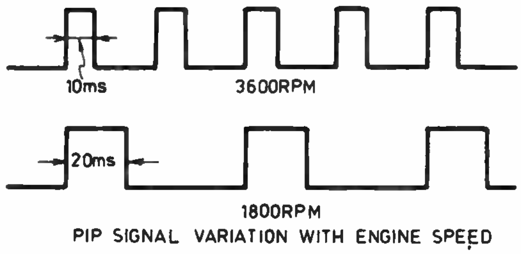


Fig.3.1

There are three positive-going pulses for each engine crankshaft revolution. As can be seen the time period for each pulse varies as a function of how fast the crankshaft is revolving.

When the controller needs to compute the activation time for the fuel injection solenoids (remember that the amount of fuel injected into the cylinders is controlled by how long the fuel injection solenoids are turned on), it performs a mathematical operation on the information from the appropriate sensors. In the speed density mode it needs to determine the engine speed, and it does this by measuring the distance between the pulses originating either from the distributor or the flywheel.

It next multiplies this by the capacity of the engine and divides this by two (because fuel is only injected for half the cycle; the other half is combustion and exhaust). This number is then influenced by the manifold absolute pressure, intake air temperature, and all the other factors that must be taken into account for the correct air/fuel mixture. Perhaps the sensor that measures the oxygen in the exhaust is used, if conditions are right for it.

As you can see there is a mathematical expression or formula needed, in order for the fuel quantity to be calculated. Once this is done the controller will need to determine how long the injectors need to be opened for, after it has considered such things as battery voltage, fuel pressure etc.

Then it waits for the correct moment in time — again considering the battery voltage, engine speed etc., and opens the solenoids. Finally it closes them again, after the calculated time has elapsed.

While the above described the speed density method of calculating fuel quantity, I think you can see the sort of operations the controller needs to carry out for any other method of arriving at this figure.

The controller then is a *computer* designed to perform these complex and rapid mathematical operations — all carried out in a strict sequence, and with the results of one mathematical operation effecting the output of the next. These mathematical operations consist of things like add, subtract, multiply, divide — with a few logical operations such as compare, AND and OR thrown in for good measure. Some of the characteristics of the data input that are of importance in the operation of the controller are the *data bandwidth* (rather like the rate of change in values); the *dynamic range*, or the ratio of values from highest to lowest; and the number of different data types that are needed.

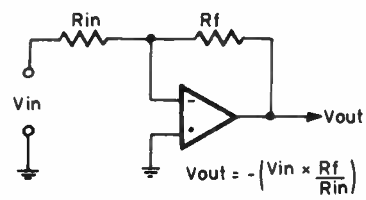


Fig.3.2

What has to be understood is that if a four-cylinder engine is spinning at 4000rpm, the time between ignition cycles can be computed as:

4000/60 = 67 revs per second

The reciprocal of 67 is 0.015, or 15ms (milliseconds) for each engine

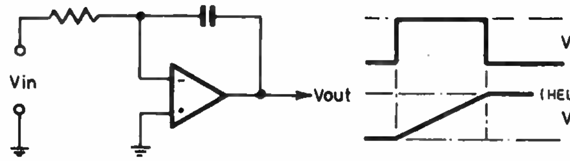


Fig.3.3

[illegible]

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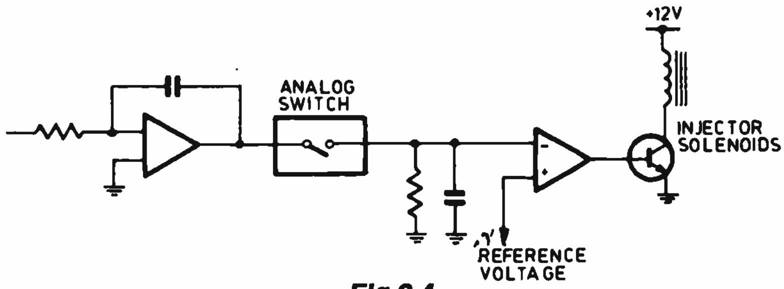

Fig.3.4

(MSB)			(LSB)	Weighting	Significance
0	0	0	0	0	No fuel (empty)
0	0	0	1	1	4 litres
0	0	1	0	2	8 litres
0	0	1	1	3	12 litres
0	1	0	0	4	16 litres
0	1	0	1	5	20 litres
0	1	1	0	6	24 litres
0	1	1	1	7	28 litres
1	0	0	0	8	32 litres (half full)
1	0	0	1	9	36 litres
1	0	1	0	10	40 litres
1	0	1	1	11	44 litres
1	1	0	0	12	48 litres
1	1	0	1	13	52 litres
1	1	1	0	14	56 litres
1	1	1	1	15	60 litres (full)

Fig.3.5

revolution. The engine will need two ignition cycles for each revolution (each cylinder fires on every second revolution), which means the calculations for ignition timing and fuel injection requirements need to be performed within 7.5ms or better.

Considering the volume of calculations needed and the shortness of time available, some mighty fancy processing will need to be going on.

Analog approach

In days of old, when nights were cold, etc., the controller took the form of an *analog* computer using operational amplifiers to process the input signals. An operational amplifier can perform multiplication between an analog voltage Vin and a resistance Rf, using the configuration shown in Fig.3.2.

What needs to be understood is 'just what the voltage represents', when trying to figure out what such a multiplier is trying to achieve. The voltage Vin and resistor Rf each represent a *number*, or the value of a parameter (like engine speed, or air temperature), and it is these numbers that are being manipulated. Addition, subtraction, division, integration and differentiation, comparison, etc. are all performed using variations of the circuit shown in Fig.3.2. The analog computer is made up of combinations of these components, in a giant mathematical algorithm.

You may be wondering how an analog computer could use a pulse from the distributor, whose length varies as a function of engine speed, in order to obtain this parameter. Simple — it uses an *integrator*, as shown in Fig.3.3. During the positive section of the input pulse the output voltage will rise continuously until the pulse either finishes, or the output of the op-amp reaches the power supply voltage. When the pulse has finished the output is held in a sample-and-hold circuit, where its value can be used for the next stage.

So how does this kind of analog computer hold the solenoids on for a set amount of time? The computer merely plonks the voltage corresponding to the length of time onto a capacitor, that is discharged through a resistor. The capacitor voltage is compared to a reference voltage in an op-amp set up as a comparator, and while it is higher the output will open the solenoid. When the capacitor voltage goes lower than the reference the op-amp output will fall, closing the solenoid (Fig.3.4).

The analog computer is very quick in operation and so satisfies one of the operational criteria. Unfortunately it suffers badly in so far as costs go, in relation to other ways of achieving this end, and also in reliability. It also has problems in precision, and so struggles to operate on fine values of data.

The motor car is a very hostile environment, temperature and vibration wise, and the costs associated with improving the analog computer's reliability tended to make it un-

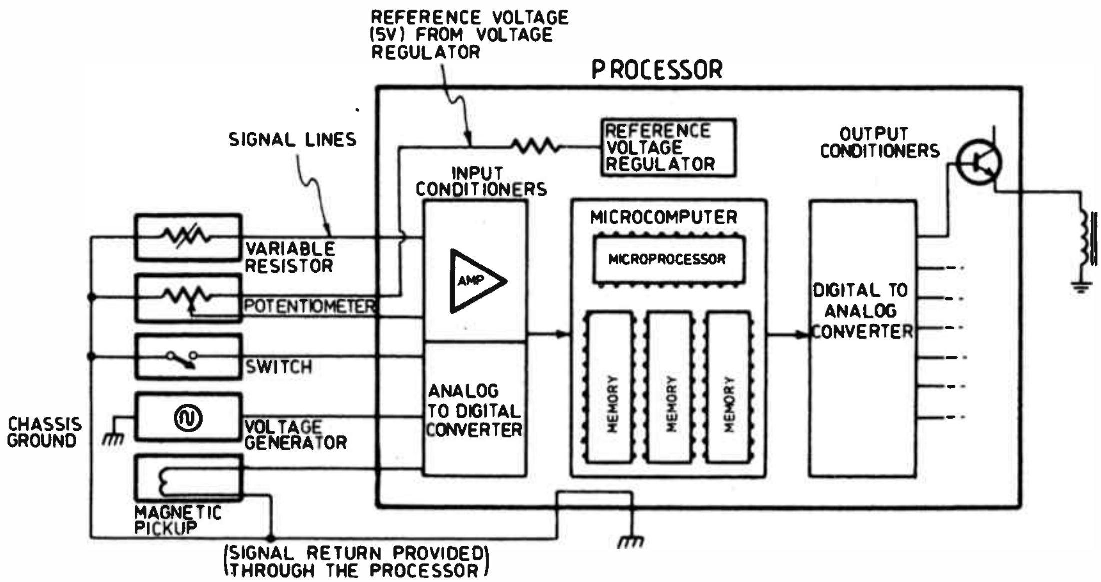

Fig.3.6

[illegible]

economical. Its other handicap was the way it was programmed. Its 'program', which was the mathematical algorithm and the sequence in which these were carried out, was usually hard wired and very difficult to change.

Digital approach

The day of modern engine management arrived when digital circuits were manufactured at a cost that enabled them to be used in this application.

You would no doubt be familiar with the incredible disappearing cost of digital electronics, and the impact this has had on the price and performance of consumer equipment. The other advantages are the reliability of this form of electronics, and the ease with which a digital computer can be reprogrammed or have changes made to the mathematical algorithm needed for the control function.

However using a digital controller is not all sweetness and light. The main problem is the requirement to convert the sensor signals from an analog voltage or current into a form that the digital controller can use. Instead of the controller recognising that six volts from the throttle sensor equates with a half-way state, it now needs an actual number. It needs to see this input variable as a *binary* number (a number system where only two digits are used, 0 or 1, in a large sequence — see Fig.3.5 for the digital number system).

To do this it uses a device called an *analog to digital converter*, and once the processing has been done the controller's output will need to be converted from digital back to analog in a device called (you guessed it) a *digital to analog converter*. This process was not required on a system using an analog computer and is an additional cost and complication.

In the last of the articles in this series I will be looking at what is coming up in car electronic systems, where the sensors will be generating digital signals and the controller will be outputting digital signals for direct control.

Fig.3.6 shows the block diagram for a digital engine controller, which is a computer containing the usual things that computers contain: RAM memory for holding the results from calculations, ROM memory holding the program and constants data for such things as volumetric efficiency and look-up tables, a central processing unit that executes the instructions, and finally input/output (I/O) ports that handle the sensor and actuator data and interfacing to the outside world.

So how does a digital computer measure the pulse length from a distributor, in order to determine engine speed?

One way is to make use of the time it takes to execute instructions. The central processing unit has the ability to perform all sorts of instructions such as adding two numbers, input and output of data variables from I/O ports, decide if one number is bigger than another, change programming sequences etc. Each of these instructions takes a precise amount of time to be performed, or *executed* (sounds like we are killing them).

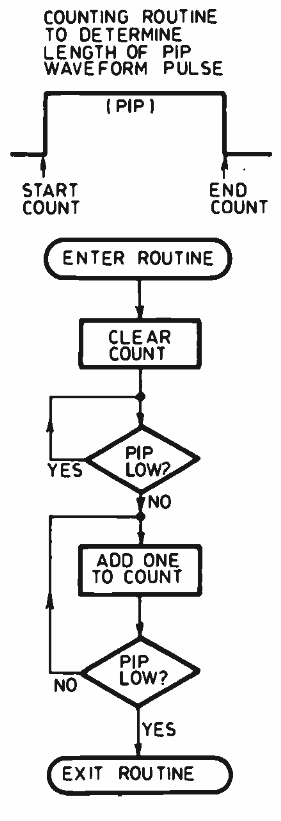

Fig.3.7

When it comes time for the controller to determine engine speed, it will go to a *subroutine* or sub-program, and test the pulse coming into the controller. It first starts off by clearing a counter. It then tests the signal coming in. If it is at 0 volts, it will wait until it goes to 3 volts. Once this has been done it will add a 1 to the counter and then test the pulse again (Fig.3.7).

This will continue until the pulse goes low again. The count value produced is therefore a measure of the length of time the pulse was high — as a multiple of the processor's instruction time. A small number would indicate a shorter value, corresponding to high engine revs, and a larger number the opposite. This counter value is now used in a further subroutine to determine the actual engine speed, either using a mathematical algorithm or a look-up table.

The execution time of the computer's instructions can also be used in order to time the opening of the injection solenoids. Once the required time has been determined, and it is time for them to be opened, a subroutine is entered and the 'open time' value is inserted into a counter location.

The solenoids are then opened and the counter is progressively decremented. When the counter reaches zero, the time is up and the solenoids are closed and the routine is exited (Fig.3.8).

Special processors

The thing that is of interest here is the type of processors used.

As was said before, the controller needs to operate at a cracking pace in order to achieve its objectives. What is needed then is a processor that can perform a limited range of operations in a very short time.

To this end you would not expect to find under the cover of one of these beasties an example of the microprocessors used in a personal computer. For example the 80286 used in IBM AT-compatible computers does not have the sort of instruction set and hardware needed for efficient programming in this sort of application, and anyway its flexibility would be largely wasted.

Instead organizations such as Intersil, Texas Instruments and Hitachi have produced 'reduced' or 'specialised instruction set' computers that run a reduced or specialised set of instructions, at higher data rates. These computers are characterised by their being able to operate two data buses — one for instructions and one for data — at the same time.

They also have hardwired multiplication and other arithmetic and logic operation instructions, which remove the need to perform these time-consuming operations using subroutines.

In addition they have very fancy hardwired *interrupt* schemes, including some involved inter-register transfers. These types of processor enable the timing of engine speeds and solenoid openings to be carried out using on-

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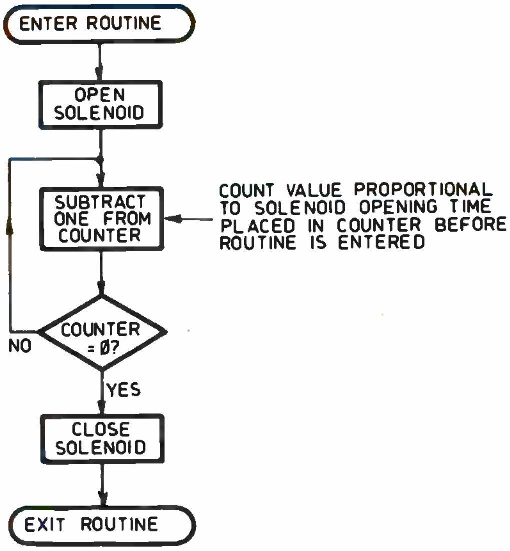


Fig.3.8

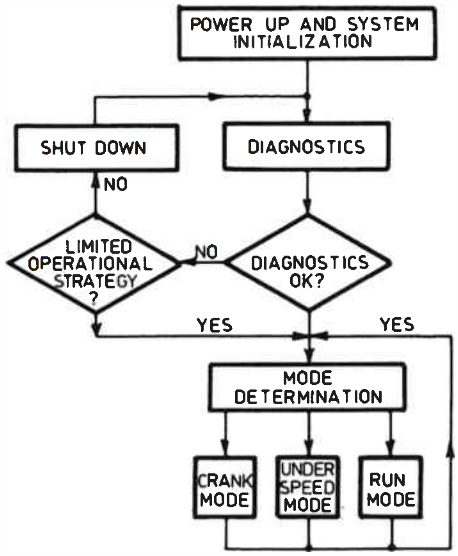


Fig.3.9

board hardware, in a much more efficient manner than the system described above using counting subroutines — which waste valuable computing time, time that could be used for background tasks.

The TMS 320C10 from Texas Instruments is an example of just such a specialised processor, developed for this application. Texas Instruments calls this chip a Signal Data Processor (SDP), and its claim to fame is its ability to number crunch a particular form of data. It would probably not be suitable for use in general data processing applications.

The new Ford EB Falcon uses an Intersil dedicated processor — a 16-bit processor running at 10MHz, and with four data buses. If you have an automatic transmission, you will generally find there's another processor running it.

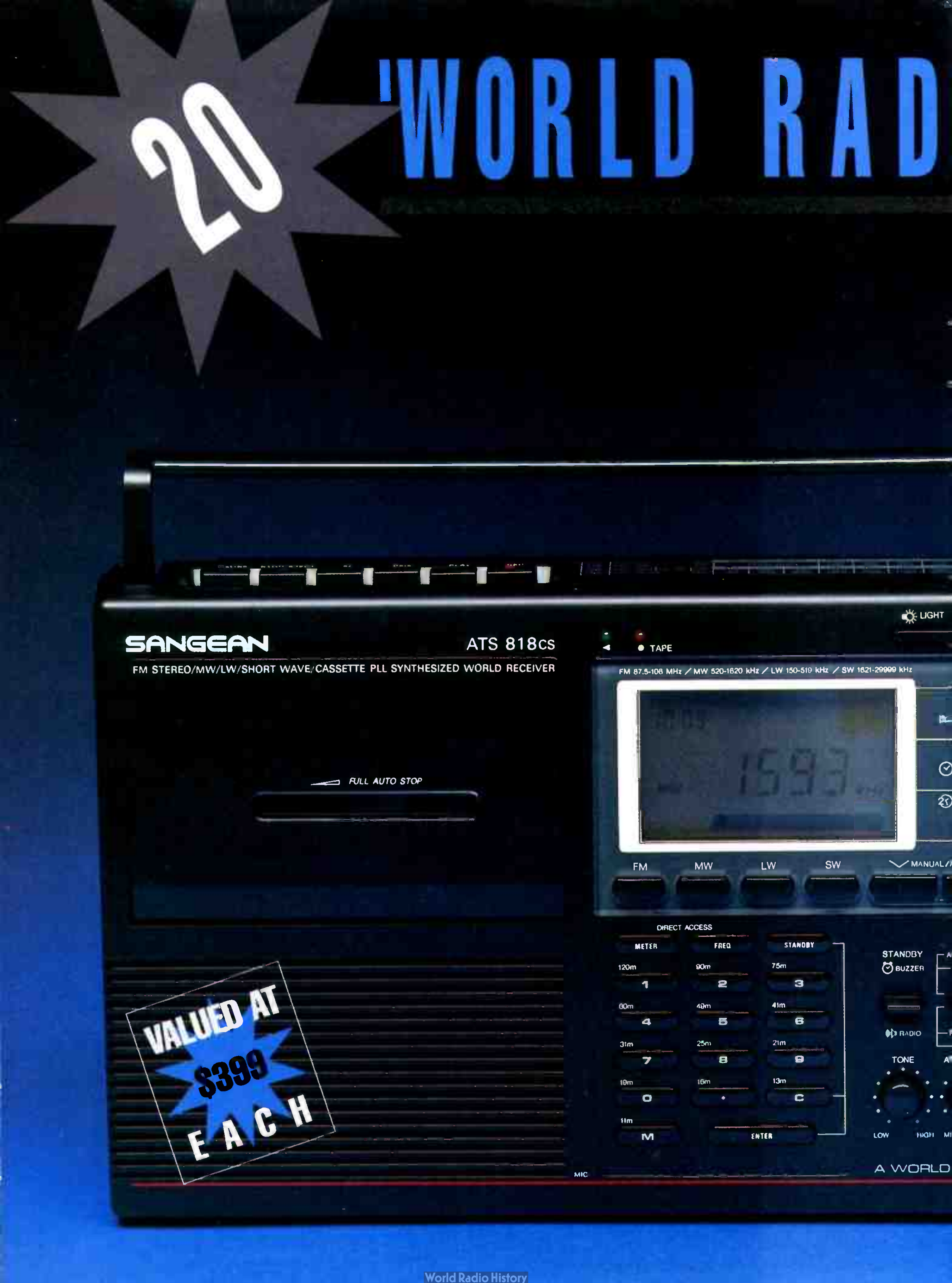
When the key is turned on, the computer will start at a preset point in its program and *initialise* itself ('wake itself up'). It runs a diagnostic on its internal organs and then checks to see if the outside world is as it should be. Once this is done it then enters a mode selection routine. These modes are particular time events in the engine management cycle — engine crank, idling, cruise, etc. — and cause the various sensors and actuators to be handled in a different manner.

As was mentioned before, the fuel injection solenoids are actuated in a different sequence when the car is cruising to when it is accelerating; the oxygen exhaust sensor is not used if it is not hot enough or the car is not in a cruise mode. These modes of operation are determined by the control program looking at the various sensors once a particular mode subroutine has been entered (Fig.3.9).

So much for the guts on broadly what is happening under the lid of the black box. In the next article, I will be looking at how these systems are repaired — or why they are considered to be unrepairable by some, as the case may be.

(To be continued) ❖

MAKE OBSOLETE


20
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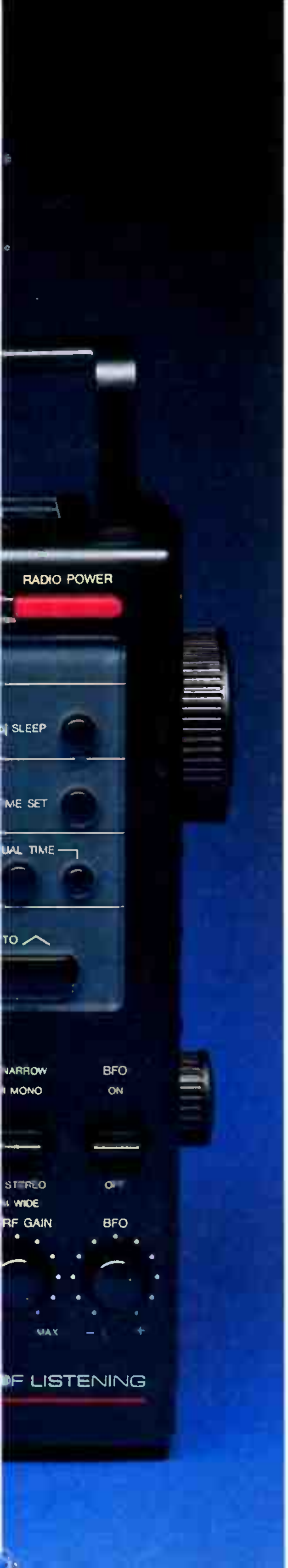

There's a special bonus for anyone subscribing to Electronics Australia with ETI, or renewing/extending their existing subscription over the next three months: by arrangement with Dick Smith Electronics, we have no less than 20 of these exciting new Sangean ATS 818CS multi-band digital tuning radios to be won! Each radio has a normal retail price of $399 – giving a total prize value of $7980.

Who is eligible to win one of these excellent receivers? Anyone who subscribes, or extends/renews their subscription to Electronics Australia with ETI, between March 25 and June 25, 1992.

The Sangean ATS 818CS is a compact portable unit which combines a multi-band digitally tuned communications receiver with a high quality cassette tape recorder. The radio section has full PLL synthesised tuning, and operates over the following frequency bands:

LONG WAVE: 150 – 519kHz
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The ATS 818CS includes a built-in dual time clock, allowing display of both local and universal time; direct-access keypad to permit instant tuning of any desired frequency; 45 programmable memory channels; built-in scanning facilities; a rotary tuning knob, with selectable fast or slow action; adjustable IF bandwidth; a BFO for Morse and SSB reception; a manual RF gain control; a tone control; and a large LCD panel which provides fast and clear display of operating frequency (14mm high numerals), time, memory channel and signal strength. The LCD panel also has a back light which can be disabled when not required.

Other features are a 'key lock' switch, to prevent accidental flattening of the batteries; a connector for external antenna input, as well as a built-in telescopic rod antenna; a headphone jack; and a 'dial lock' switch to prevent accidental detuning from a critical frequency. The receiver also features both a built-in carrying handle and a tilting bail, to allow convenient table top operation.

Despite all of these features, the Sangean ATS 818CS measures only 296 x 192 x 68mm (L x H x D), and weighs only 2kg. It is fully microprocessor controlled, and uses 15 integrated circuits, 61 transistors, 8 FETs, 53 diodes and two LEDs. Operation is from either four 'D' size alkaline cells and three 'AA' size cells, or an external 6V DC power supply.

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1. The competition is only open to Australian residents authorising a new or renewal subscription to Electronics Australia magazine before last mail on 25.06.92. Entries received after closing date will not be included. Employees of the Federal Publishing Company Pty. Ltd., Dick Smith Electronics, their subsidiaries and families are not eligible to enter. 2. South Australian residents need not purchase a subscription to enter, but may enter once by submitting their name, address and a hand drawn facsimile of any coupons to the Federal Publishing Company Pty. Ltd., P.O Box 199 Alexandria, NSW 2015. 3. Prizes are not transferable or exchangeable and may not be converted to cash. 4. The judge's decision is final and no correspondence will be entered into. 5. Description of the competition and instructions on how to enter form a part of the competition. 6. The competition commences 25.03.92 and closes last mail on 25.06.92. 7. The draw will take place in Sydney on 29.06.92 and will be announced in a later edition of Electronics Australia. 8. The prizes are: 20 x Sangean ATS 818CS radios, valued at $399 each. Total Prize valued at $7980. 9. The promoter is the Federal Publishing Company Pty. Ltd., 180 Bourke Rd, Alexandria NSW 2015. Permit No. TC92/0000 issued under the lotteries and Art Union Act 1901; Raffles and Bingo Permit Board No. 92/0000 issued on 00/00/92; ACT permit no. TP92/0000 issued under the Lotteries Act 1964; NT permit No. 92/000.

Rediscovering radioactivity:

ATOMIC RADIATION IN YOUR HOME

Recently there's been much more awareness of the possible health risks posed by low-level electromagnetic radiation. But what about those old luminous watch, clock and instrument dials, many of which were based on radium-doped paint — mightn't these pose a health risk too? The author of this article has been investigating, and has come up with results that are both interesting and disquieting.

by PETER R. JENSEN, VK2AQJ

Over the last 10 years or so, there has been concern building up among some sectors of the public, regarding the possible danger to health of low level electromagnetic radiation. This is the type of energy produced by electricity as found in the ordinary house mains, and is generally known as non-ionizing radition.

This concern was well ventilated in a recent case in the Land and Environment Court of NSW, concerning a high tension electricity line running to the west of the Blue Mountains.

Not long after that, a Commission of Enquiry was held to determine the health implications of such non-ionizing radiation, with largely inconclusive results.

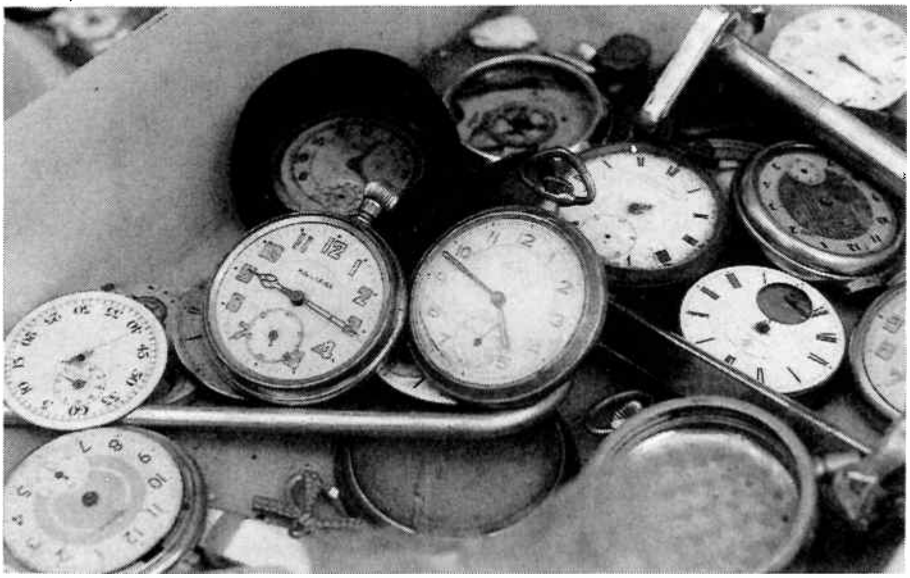
Given this level of public anxiety, and given the rather tenuous evidence of danger to health associated with non-ionizing radiation, it is rather surprising that *ionising radiation*, well documented as dangerous and produced by radioactive substances, has received so little attention in recent times. In South Australia during the latter part of the 1950's and into the 1960's, a considerable amount of electronic equipment was released onto the surplus market by the Government. This came out of the experimental work that had been conducted to monitor atomic weapons testing at Woomera, by the British.

At this stage, while not a licensed radio amateur, I was still intensely interested in things to do with electronics. When one day I was browsing through the collection of disposals equipment at the most famous South Australian dealer at that time — Canns, in the Norwood Parade — I came across a small grey coloured gadget. This turned out to be a Geiger counter made by Philips and, as it was relatively an inexpensive purchase, I handed over my money and took it away.

At the time there was really no good reason to own a Geiger counter — although 30 years ago, no doubt, everyone was a good deal more worried about radioactivity than they seem to be nowadays. Remarkable to relate, this device was found to be operational and was quite sensitive enough to pick up background radiation as the odd cosmic ray penetrated its Geiger-Muller tubes. It was provided with two such tubes, one mounted internally and the other as an external probe on the end of a cable, the two being internally selectable via a switch. Along with a number of other electronic items in my collection, this device crossed the Hay Plains to Sydney in 1965.

Since that time it has lain in a drawer, together with other electronic instruments in the author's collection.

ATOMIC RADIATION IN YOUR HOME



Out of curiosity, the author checked radiation levels produced by this collection of old fob watches on offer at Sydney's Glebe markets. The two luminous-dial models in the centre turned out to be surprisingly 'hot'.

Together with the author, it has steadily deteriorated with time. In fact some 10 years ago it appeared to be no longer functional. However with no immediate reason to check radiation levels, it stayed in that condition until quite recently.

Call for help

About a month ago a telephone call was received from a colleague, who was aware of the author's amateur radio licence and interest in electronic equipment of all sorts. No doubt he was also aware of the writer's 'bower bird' habits. The substance of the telephone call was to enquire whether the author possessed, or had access to, a Geiger counter — in order that the colleague might examine his favourite brand of synthetic coffee which was made in Poland.

This request was of course based on the knowledge that, during some time in the last four years, Poland has been liberally covered with the radioactive fallout products from the Chernobyl disaster. My colleague was quite interested to know if his coffee was even faintly radioactive, as the basis of a possible change to hopefully an uncontaminated substitute.

The answer to this enquiry was, of course, 'Yes' — subject to the caveat that some work was required to restore the Geiger counter to its former sensitivity. Assuming that this was possible to achieve, checking out the food product would represent an interesting little exercise in prudent consumption.

A superficial inspection of the Geiger counter suggested a relatively high degree of simplicity in its construction but, initially, servicing the device was made far more difficult by the seeming absence of any documentation showing its wiring layout or components.

After a number of telephone calls to Philips, and with the gratefully acknowledged assistance of the Service Manager here in Sydney, a schematic was made available from the Melbourne arm of the firm and the material faxed to the author.

This schematic is reproduced and, as anticipated, can be seen to involve an extremely simple device, making use of the earliest generation of solid state devices: the transistor. In the Philips Geiger counter the transistors are from the early Mullard series which included the OC44, OC70 and so on. These are now almost historical objects in their own right.

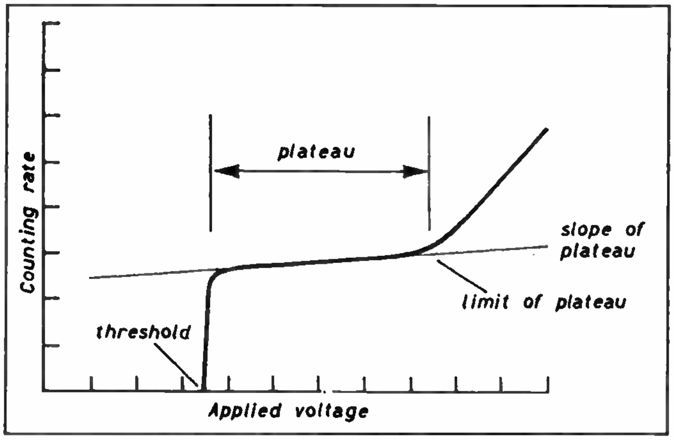
Further inspection of the Geiger counter revealed that all of the high value capacitors used in the high voltage supply to the Geiger-Muller tubes were of tubular non-polarised electrolytic construction. Suspicion could immediately be directed at these devices but, given the small number of capacitors in any case, the decision was taken to replace all such devices with modern polycarbonate and polypropylene substitutes.

As it turned out this decision was not that easy to put into effect because, over the years, high capacity, high voltage devices have been made largely obsolete with the proliferation of low voltage transistorised equipment. However, in the end, the combined forces of the 'three musketeers' of the amateur electronics industry — Dick Smith Electronics, Jaycar and Davred — were able to supply capacitors sufficiently close to the required value as to be considered satisfactory.

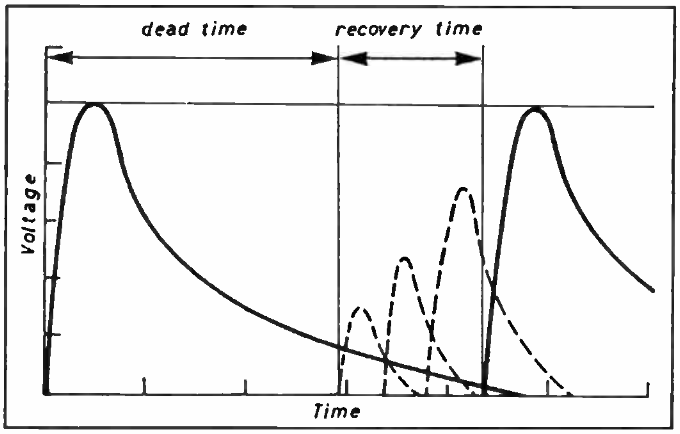
It was then possible to sit down with a soldering iron and replace virtually all the existing capacitors in one hit, with the pleasant result that the Geiger counter sprang to life once more — as soon as the Geiger-Muller tubes had the necessary 400 or more volts on their anodes. The success of the operation could be seen as the presence of background radiation was registered by the meter.

The accompanying 'click', which

A collection of old aircraft instruments displayed at a second-hand store on Sydney's northern peninsula. Some of these instruments also turned out to be quite 'hot', again by virtue of their radium-zinc luminous paint.



The counting rate of a Geiger-Muller tube, plotted against applied voltage. Over the plateau region, the rate is almost independent of voltage — but proportional to radiation.



After each discharge pulse, initiated by the detection of a radiation particle, the Geiger-Muller tube has a 'dead time' until its internal space charge diffuses.

would occur at intervals of 10 seconds or so , was another very pleasing record of the passage of cosmic rays and a sign of the restored sensitivity of the counter.

With this success, thoughts turned to other sources of radiation in the home, merely as a means of testing the sensitivity of the newly restored Geiger counter.

Not so long ago there was an interesting programme provided by the ABC, concerning the sad history of workers at a Canadian factory, known as the Radium Clock Company. This firm had, soon after the first World War, set up a business to put self-illuminated figures on the faces of clocks and watches, and had employed well over 100 young women in this task.

The material which had been used for this exercise was a combination of radium salts and zinc compounds. In the presence of the radiation emitted by the radium, the zinc compound would glow brightly in the dark.

At this time very little was known about the impact and long term implications of exposure to radiation from radioactive compounds, and the health of the girls involved in this industry was later very seriously affected. Over a horrifyingly short period, very many of them were to succumb to the awful impact of radium.

Many of the girls indulged in a particularly dreadful practice, to modern eyes: they would lick the tips of their paint brushes, with which the radium and zinc compound was applied, in order to achieve a sharp point — so as to more accurately follow the figures on the dials they were working with.

This practice soon led the local dentists to diagnose a work related syndrome, which they came to describe as 'Radium Jaw'.

This seems to have been a particularly swift and destructive form of bone cancer. Very many, if not all, of the girls who had worked on the dials in the Radium Clock factory seemed to have been affected sooner or later, by cancer in one part of the body or another.

Unfortunately the connection between the work and the morbidity and mortality rates amongst these workers was not made by the scientific community until many years later.

During the 1920's and 30's, radium continued to be used quite commonly as a means of making dials which would glow in the dark. The author was vaguely aware that this continued to be a common practice during the Second World War.

As it happened, some while ago the author had purchased at a second hand emporium on the Warringah penninsula a 1940's style military prismatic compass. This device had required a certain amount of maintenance work, including replenishment of the light oil (known as Intava) used to damp the dial, which was supplied by the firm, Edwin Bowers.

Needing a household object with a low level of radioactivity to provide the basis for a simple test, the military compass immediately suggested itself as a possible candidate.

Here is the elderly Philips Geiger Counter, purchased by the author many years ago from a disposals dealer in South Australia. After replacing all of the original capacitors, it was restored to useful life — but told a disquieting story...

Disquieting results

The results of the test were to say the least disquieting. Expecting at the worst a modest increase in the 'click' count from the Geiger counter as compared with the background level, I discovered that bringing the probe of the device close to the compass produced a roar rather like an avalanche of stones on a tin roof. Dr Strangelove would have been entranced, no doubt!

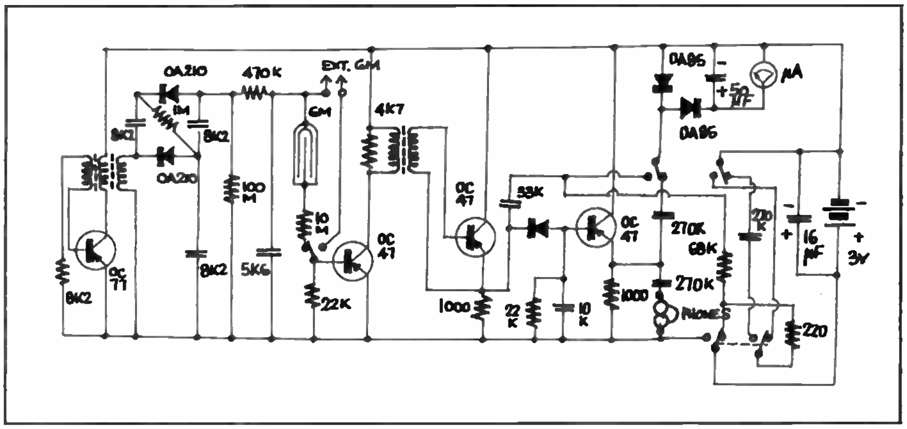
The meter on the Geiger counter gave a reading of about 30 milliREM/hour, when the probe was touching the face of the compass — although it was noted that as it was withdrawn, the count rate dropped with exponential suddenness.

Suspecting that this represented a relatively 'hot' device, and something requiring a degree of caution in handling, the compass was promptly consigned to a pewter (lead) cigar cylinder, resulting in a very comforting reduction in the count rate even when the probe was brought quite close to it (75 to 100mm).

There it remains, together with another compass from the era of the First World War and an Ingersoll Triumph boys' watch of the 1950's. These latter devices have, since the initial test, been found to be quite significant radioactive sources as compared with the prismatic compass.

Based on information provided by Professor Laurie Peak of the University of Sydney and also from the Department of Health, they will probably continue to remain in their lead sarcophagus for the foreseeable future.

This revelation of the existence of quite significant radioactive sources lurking in the home was rather like letting an evil genie out of the brass bottle. It also prompted the thought that a similar situation might well be found in many homes around Australia.

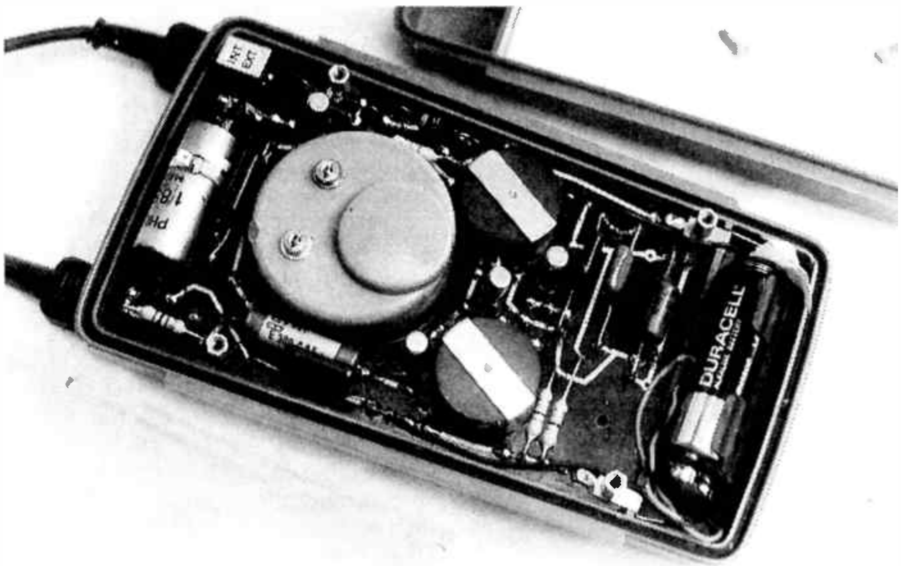


The circuit schematic for the Philips Geiger Counter, as re-drawn by the author. A simple ringing-choke converter and voltage doubler were used to produce the 500V supply for the Geiger-Muller tube (GM).

No doubt many devices from the period from 1900 to well after the second World War still lie in drawers and cupboards, quietly emitting their potentially dangerous and destructive radiation — and all the while quite unsuspected.

Historical background

The year 1896 was an extraordinary one for inventions and discoveries. In England, the youthful Marconi was in the process of having his system of radio communication patented and accepted by the British Government. In France, in that same year, an equally momentous discovery was made by the scientist Antoine Henri Becquerel.



Inside the Philips Counter. The internal Geiger-Muller tube is at far left. As you can see from the schematic, the instrument used early germanium transistors.

Representing the third generation in a family of distinguished physicists, Becquerel discovered *radioactivity* in one of the heavier elements, uranium, and was later awarded the Nobel Prize in physics for his work. This was awarded in 1903 and was shared with two other equally notable French scientists, Marie and Pierre Curie.

The Curies went on to deduce the atomic nature of the radioactive phenomenon and to discover the new element radium — which they refined from uranium. In carrying out the refinement of the uranium, which had been in the form of the naturally occurring substance *pitchblende*, they had also isolated the element polonium. Later Marie Curie went on to discover the further radioactive element thorium.

These startling new advances in the field of physics were soon to result in older theories concerning the structure of the atom being abandoned.

From the time of the seventeenth century English chemist, John Dalton, knowledge of the structure of matter had slowly developed. Initially the elements from which more complex molecules were composed were recognized and in the nineteenth century the Russian scientist Mendeleev proposed a chart of the elements called the periodic table. Since 1896 this has seen some significant additions.

Up until 1896, it had been assumed that the elements were composed of more fundamental particles which were called atoms. It had also been believed that the atoms were the basic constituents of matter and were indestructible by any known means. Within 50 years that assumption was shown to be totally wrong as, initially, a mushroom-shaped cloud erupted over New Mexico and then, more horribly, over Hiroshima and Nagasaki.

Atomic radiation

In the story of the unravelling of the mysteries of the atom and the discovery of the enormous forces waiting to be tapped with its disintegration, many names are encountered. Of these, however, there are none that are more distinguished than those of Rutherford, Einstein, Bohr and Fermi.

Ernest Rutherford was to reveal the structure of the atom and the inter-relation of its two major components — the central nucleus and the orbiting electrons. Later it was shown that the nucleus consisted of a group of protons, equal in number to the orbiting electrons, and a group of neutrons. In recent years this rather more complex picture of the atom has become even more complicated, with such new particles as quarks being discovered.

Neils Bohr specified the manner in which energy is absorbed and released at the atomic level as 'quanta', or packages of energy which occur in discrete steps.

Albert Einstein in setting out his 'Theory of Relativity' changed the whole face of physics. In this process and almost as a side product, he was to define the interchangeability of matter and energy in his now famous equation $E = M \times C^2$, where C is the velocity of light at 300,000,000 metres per second, M is mass and E is the equivalent energy. This particular theoretical concept received its most devastating confirmation at Alamogordo, New Mexico in 1945 with the detonation of the first atom bomb.

In 1934 the Italian scientist Enrico Fermi was able to break apart the nucleus of the atom. He later supervised the construction of the first successful atomic reactor at the University of Columbia. It was this work in 1940 which led directly to the successful development of the atom bomb.

Types of radiation

Radioactivity represents the spontaneous disintegration of the nuclei of unstable elements with high atomic weights, such as uranium and radium. It can also occur as a result of the irradiation of elements with lower atomic weights, and the creation of unstable artificial isotopes. In this process of disintegration, a number of sub-atomic particles are ejected from within the structure of the atom. The most common of these products are two streams of particles, generally referred to as alpha and beta radiation, and electromagnetic radiation known as gamma radiation.

Alpha particle emission: An alpha particle is the nucleus of the Helium-4 atom, i.e., it is simply a body consisting of two protons and two neutrons bound together. Consequently, if an alpha particle is emitted, the remaining nucleus must change to one that has a smaller charge and mass.

Alpha particle emission occurs mainly in radio-isotopes whose atomic number is greater than 82. With increasing atomic number, the occurrence of alpha particle decay increases rapidly and it is a characteristic of the very heavy elements. It is particularly in evidence in the main decay chains of the natural radioactive isotopes. It is represented by the Greek letter α.

Beta particle emission: The instability that is the cause of beta particle emission arises from the fact that the neutron to proton ratio in the nucleus is too high, i.e., there are too many neutrons in the nucleus. To achieve stability, a neutron in the nucleus can decay into a proton and an electron. The proton remains in the nucleus, so that the neutron to proton ratio is decreased and the electron is ejected. This ejected electron is known as a beta particle (β).

The negative sign is used with the β if there is any chance of ambiguity, because there also exists a similar particle which carries a positive charge and is denoted by $+\beta$. There are many beta particle emitters and the phenomenon of beta particle emission has found wide application in industrial devices. It is highly prevalent in decay chains associated with the decay of fission fragments. It is important to note that the term beta particle, to represent an electron, is used to convey its nuclear origin.

Gamma ray emission: Electromagnetic radiation in the form of gamma rays is emitted when a nucleus in an excited state transfers to a more stable state. The nucleus thus retains its original composition, the excess energy being radiated away. If the frequency of the radiation is ν and the nucleus changes from a state of energy E1 to a state of energy E2, then the two energies are related by the equation:

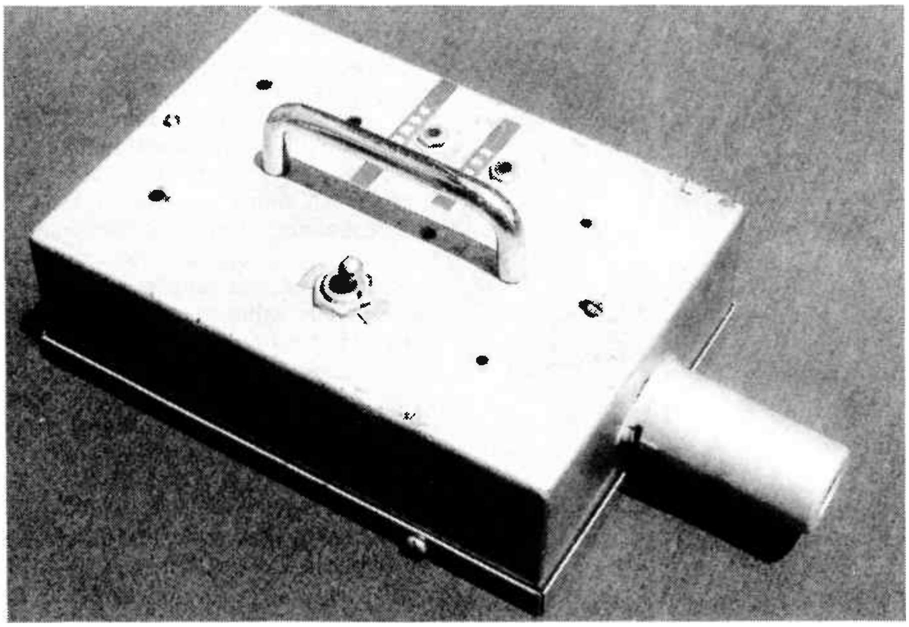
$$E1 - E2 = h.\nu$$

where h is Planck's constant, having a value of 6.624×10^{-27} ergs per second. The energy of the emitted gamma ray is thus $h.\nu$. In equations the gamma ray is represented by the Greek letter gamma (γ).

It is important to note that physically gamma rays are similar to X-rays. Their difference lies only in their source. Gamma rays originate from a nucleus transferring from one nuclear excited state to another, whereas X-rays originate from electrons transferring from a higher to a lower atomic energy state.

As atomic energy levels are in general spaced much closer, in terms of energy, than nuclear levels, it follows that the frequencies of X-rays are much less than those of gamma rays.

As far as industrial applications are concerned, the only difference between



The Geiger Counter described in this magazine (then R, TV & H) back in July 1962, as built by a reader now living in Cooma, NSW. In this case the Geiger-Muller tube was mounted outside the case, in a thin aluminium valve shield (lower right).

them is the penetrating power, which increases with frequency. The greater penetrating power of gamma rays is very useful for industrial applications, but of course radiation shielding problems are also increased.

The Geiger counter

The Geiger-Muller counter tube, usually abbreviated to the first name only, is really a very simple device, as indicated in the diagram. The main elements are the central anode wire and the surrounding partial vacuum contained in a jacket which forms the cathode connection. The voltage set up between the anode and the cathode is around a thousand volts or more.

As compared with other forms of radioactivity detecting device, the main advantage of the Geiger counter tube is the very large gas amplification factors that are possible. This means that such counters are very sensitive, and also that the output pulses may be several volts in magnitude. This, in turn, means that external amplification may not be required in order for a voltage pulse to be recorded.

The size of the voltage pulse is independent of the initial ionization produced and so the same effect is produced in the counter by different types of radiation. The dependence of counting rate of a Geiger counter on applied voltage is shown in the illustration.

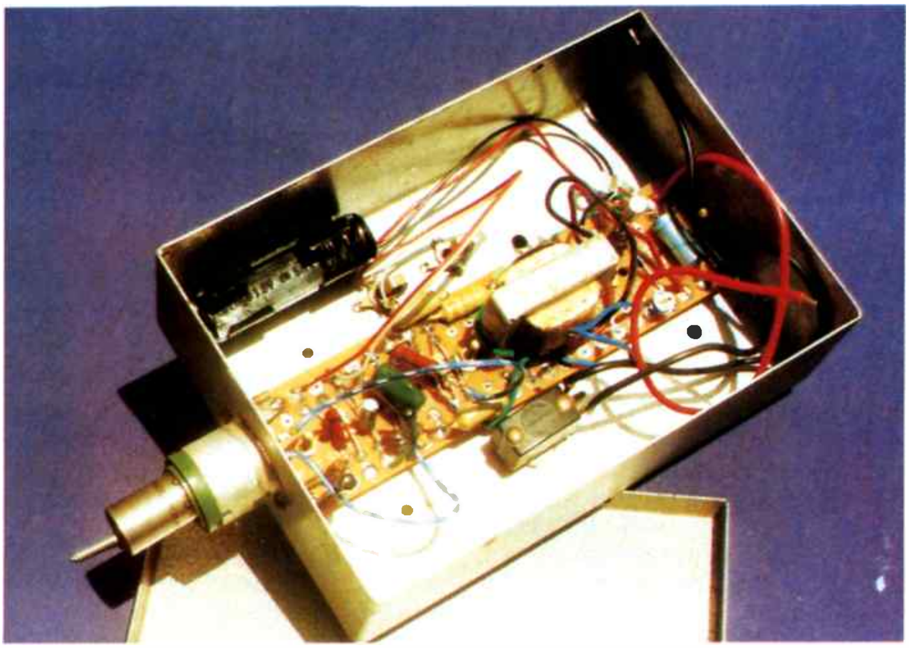
The diagram shows the main characteristics of the Geiger counter, which are the 'threshold' voltage, the 'plateau' and the 'plateau' voltage.

If it were possible, the ideal arrangement would be for the plateau to be horizontal. However, in practice, a slight slope of the plateau cannot be avoided. The counter should be operated at about the centre of the plateau, so that small variations in applied voltage do not affect the operation.

In counter specifications it is usual to quote the working voltage, the width of the plateau, and the slope of the plateau in terms of percentage rise per hundred volts. The action of the Geiger counter tube is as follows. The initial ionization produced by a particle entering into the detection region gives rise to an avalanche breakdown.

This discharge is propagated along the whole length of the wire. It is possible for this discharge to initiate a further series of discharges. Thus one discharge may give rise to a series of pulses at the output.

To obtain reliable measurements it is necessary to quench the spurious discharges. There are two ways of doing this. One is to use an external quenching circuit, which reduces the applied potential to a value below the threshold potential of the counter after each pulse, and then restores it in readiness to record the next primary pulse.



Inside the Cooma reader's version of the 1962 R, TV & H Geiger Counter. The few components used are here mounted on a length of utility PCB strip. The Geiger tube is visible at lower left, its shield having been removed for the shot.

This is not very convenient, however, and the most common means is to use an appropriate gas filling of the counter itself, so that the counter becomes self-quenching.

The quenching additive is most usually a polyatomic organic molecule such as ether, alcohol or acetone. The action of this additive is to suppress photoelectric emission from the cathode and prevent ionized molecules (which produce secondary emission) from reaching the cathode.

Most counter tubes used today are of the self-quenching type, a typical filling being argon with a very small proportion of ethyl alcohol as the quenching agent. After the primary discharge has been quenched, a positive space charge is left around the central wire anode.

This reduces the electric field to below the threshold value, and hence the counter is now insensitive to any further ionization pulses. The space charge sheath then diffuses towards the cathode and the field recovers.

The time taken for the recovery of the field to the threshold value is known as the 'dead time' of the counter, because in this time no counts will be recorded. Even after the field has regained the threshold value, it still has to recover its full value. The time taken to do this is known as the *recovery time*. Although pulses will be recorded after the dead time has elapsed, they will be of a smaller magnitude until after the recovery time.

These characteristics are illustrated in the accompanying diagram. For the normal type of Geiger counter tube, the dead time is of the order 100 microseconds. This means that the Geiger counter is limited to counting rates below about 10^4 counts per second. Even at counting rates far below this, some pulses will occur in the dead time, simply because of the random nature of the incident radiation. It is possible, and very necessary at high counting rates, to correct for the loss of counts due to the dead time.

The efficiency of a Geiger counter is defined as the ratio of the number of recorded counts to the number of incident particles traversing the detection region of the counter tube.

The efficiency for the detection of alpha particles, beta particles and electrons is very high, approaching 100%. The reason for this is that only one primary ionization electron is required to initiate the discharge.

The efficiency for the detection of gamma rays or X-rays is usually very much lower (only about 2%) and is dependent upon the probability of an electron released by an interaction in the wall material reaching the sensitive region of the counter. This probability

can be increased by the use of suitable wall materials and suitable geometry.

Geiger counters are used for a very wide range of measurements covering all types of radiations and particles. Among the many types available are counters with different types of wall material, including thin end windows for measurement of low energy beta rays and high efficiency gamma ray detectors and so on.

Types of detector

Ionization chambers (pulsed): Used widely for alpha particles, for which efficiency approaches 100%. Efficiences much lower for beta particles and gamma rays. Dead time less than 1us for fast counter.

Ionization chambers (continuous): Continuous currents of approximately 10^{-10}A, dependent upon type of radiation. Efficiencies are very dependent upon constructional details

Proportional counters: Gas amplification up to 10^4. Dead time less than 1us. Used for alpha and beta particle discrimination. Efficiencies approach 100% for alpha and beta particles, but very low (approx 1-2%) for gamma rays. Useful modifications include flow counters, and detectors for thermal neutrons. Up to 50% efficient for thermal neutrons.

Geiger counters: Counting rate restricted due to long dead time of 100-300us. Efficiency approaches 100% for alpha and beta particles, but only 1-2% for gamma rays. Output pulse height is independent of the type of incident radiation.

Semiconductor counters: Useful for high resolution measurements of alpha particles and protons. Can be used for gamma rays and modified for neutrons.

Scintillation counters: Characteristics depend largely upon the phosphor used. Dead times less than 3 x 10^{-8} seconds can be obtained. Efficiencies of 100% for alpha and beta particles, and gamma rays by use of appropriate phosphor. Radiation energy-pulse height relationship is often linear.

Two Geiger counters

As a part of the research undertaken for this article, access to a personal archive of *Electronics Australia* magazines was possible. It's perhaps an interesting reflection on the extent to which atomic radiation and radioactivity are taken for granted these days, but it was found that the last time that a Geiger counter had been described in *Radio Television and Hobbies*, as the magazine was then called, was way back in 1962. This was a design put together by our esteemed Editor, Jim Rowe, and bears a passing resemblance to the Philips device, internally at least.

While simplified by the omission of the metering circuitry, the system of high voltage generation is effectively identical and the method of amplification of the pulses developed at the anode connection is very similar.

Again early transistors were used and it is interesting to note the graphical convention adopted by the draughtsman for this device. In many ways it may have been a more logical representation of the actual construction of the germanium PNP transistor, but now made obsolete by international convention.

By coincidence, one of the members of the author's computer user group, the Australasian Microcomputer Users Society, is a radio amateur and has a son who was exposed to the electronic bug at quite an early age.

Some of the story contained in this article was conveyed to the Society at a recent meeting and the result was that the aforesaid amateur revealed that his son, when a teenager, had built the *Radio, Television and Hobbies* Geiger counter and it was still in his collection in Canberra.

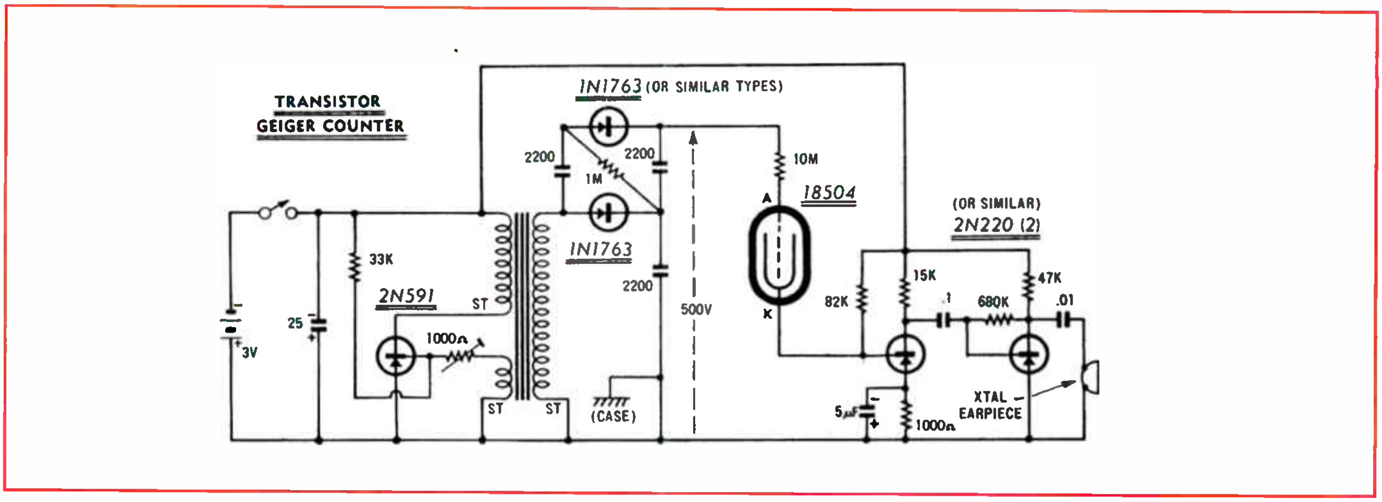
A couple of telephone calls the following day led to arrangments being made for the unit to come up to Sydney. However as it turned out this plan was overtaken by events.

The author was passing through Cooma on business, and was able to meet the owner of the Geiger counter in person and take the desired photographs. As can be seen, the results provide a nice comparison with the illustrations of the Philips device.

Now you may be inclined to sneer at the unsophisticated nature of the circuit and the method of wiring up the components, in both these early Geiger counters. However it is as well to remember the fragility of modern solid state integrated circuits under the influence of hard radiation.

At the same computer user group meeting previously referred to, one of the members related an experience involving the enforced premature demise of a digital watch, a terminal and other solid state electronic devices, before it was realized that a radioactive barium meal, taken for diagnostic purposes, was the culprit.

As he said, "All I did was lean over the terminal and it immediately went



And here, extracted from our files, is the schematic for the Geiger Counter described by EA's current editor, in the July 1962 issue of R, TV & H. Like the Philips design it uses a ringing-choke converter to produce the 500V DC needed for the Geiger-Muller tube (type 18504). To lower cost, a crystal earpiece was used as the output 'indicator'.

mad. It started printing out someone's Last Will and Testament on all the other screens in the network and the poor fellow concerned was acutely embarrassed".

The re-emergence of the venerable valve in part of the sensitive areas of some modern communications equipment is also a reflection of the vulnerability of solid state devices to the pulses of radiation which occur after a nuclear explosion, or in space when the Sun is involved in violent activity.

The apparently gargantuan size of the old Mullard series of transistors may be some small protection against radiation from the radioactive sources being measured. Certainly, after the best part of thirty years, they are operating quite happily in the Philips and *Radio, Television and Hobbies* Geiger counters.

In setting out to build a modern version of either of these two counters, the problem areas would be in finding a source of Geiger-Muller tubes and the two transformers.

Based on personal experience, while the capacitors are no longer common values, they are not totally inaccessible to the really determined constructor. In addition, *EA*'s Editor informs me that there is a project in the pipeline which may well provide the answer to all the problems of supply of components. This will involve some form of kit.

Exposure levels

Having now exposed you to some of the possible sources of radiation that may be lurking around your house all unsuspected, and having described the Geiger counter as a means to their detection, it is only reasonable to give a factual discussion of levels of radiation and limits that relevant authorities currently recommend as appropriate for anyone to receive on a short and long term basis.

The source of information for this advice is, firstly, the International Atomic Energy Agency and secondly its agency in Australia — the Australian Nuclear Science and Technology Organization (ANSTO), located at Menai in New South Wales.

The Information Office of this latter organization makes available two pamphlets and a single sheet of information from which the most significant points have been extracted.

However before going to the recommendations and the numerical limits suggested for acceptable levels of radiation, a direct quotation from the ANSTO broadsheet helps to put the whole question of radiation levels into some sort of perspective. As this publication says:

Radiation is all around us, all day, every day; it sustains our lives. We see because our eyes detect and analyse the radiation we call light. Infra-red radiation keeps us warm, whether from the sun or from a glowing fire. We often cook with microwaves. Radio waves allow us to communicate over huge distances by sound or picture. Ultra-violet radiation can be used for medical treatment or for acquiring a good suntan. All living things rely on some form of radiation for their existence. In the twentieth century we recognised another type of radiation: ionising radiation, the subject of this pamphlet. Ionising radiation is all around us, all day, and gives rise to our natural background radiation dose. It comes from many sources, including outer space, the sun, the rocks and soil beneath our feet, the buildings we live in, the air we breathe, the food and drink we ingest, even our own bodies.

Man has also enhanced his radiation dose by a variety of activities. Two are dominant. The first is living indoors. In surrounding ourselves with bricks and mortar we increase the concentration of a radioactive gas called Radon in the air we breathe. Radon arises naturally from the radioactive decay of uranium and thorium, normally present in rocks, soil, bricks, mortar, tiles and concrete. Reducing ventilation in order to conserve energy increases Radon concentration still further. Using bore water, especially in a hot shower, also increases one's Radon dose.

The second is medical use, X-rays in radiography and tomography and radioactivity in nuclear medicine. Some therapeutic uses of radiation give you a dose to certain organs many times higher than your annual background radiation dose.

Small extra doses of radiation arise in a number of ways. The higher one goes, the less shielding the atmosphere affords from cosmic rays: on a mountain top the air may be cleaner, but the radiation dose is higher. Air travel increases radiation dose; astronauts also receive higher doses. Fallout affects us mainly through our food and drink. Many industries release otherwise locked-in radioactivity into the environment. This is especially true of coal-burning plant and to a lesser extent the fertiliser, mining and building industries.

Other common sources of radiation are some older luminescent clocks and watches, gunsights, compasses, exit signs, certain paints and pigments, dental porcelain, fire alarms, smoke detectors, television sets, normal operations of the nuclear power industry and the use of radionucleides in industry, agriculture and the environment. Their contribution to our radiation exposure is very small.

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COOMBE, R.A., *An introduction to Radioactivity for Engineers*, Macmillan 1968.

ROWE, Jim, 'A Transistor-Converter Powered Geiger Counter', *Radio, Television and Hobbies*, July 1962.

The broadsheet goes on to talk about units of radiation and as the recommendation as to dose level will be given in units which are generally unfamiliar to most people, a further quotation is appropriate:

Ionising radiation is a form of energy travelling as electromagnetic waves (X-rays and Gamma rays) or as streams of particles (Alphas and Betas). They all transmit kinetic energy to materials they encounter. Faster rays deliver a harder punch. The measure of absorbed radiation dose is the Gray (Gy). The Gray replaces the old unit, the Rad. One Gray equals 100 Rads.

While the energy delivered by different particles may be the same, the effect on living cells can be quite different. Alpha particles and neutrons are approximately ten times as damaging as Beta particles and Gamma rays for the same amount of energy deposited. So the dose equivalent, the Sievert (Sv), is the important unit to assess the effects of ionising radiation on living cells, especially human beings. It does not measure the same thing as the Gray. The Sievert replaces the old unit, the REM, (the Roentgen Equivalent for Man). One Sievert equals 100 REM and so 1 millisieverts equals 100 millirem.

Note that the radiation dose you receive from radioacivity depends not only on the biological effectiveness of the radiation but also on the strength of the source, its distance from you, the effect of any shielding and your exposure time.

The strength of a radioactive source is determined by the number of disintegrations of its radioactivity per second. The unit is the Becquerel (Bq), one disintegration per second. This is a very low rate and it is common for radioactive sources to be quoted in kilobecquerels (KBq), megabecquerels (MBq) or gigabecquerels (GBq). The Becquerel replaces the Curie. There are 37 million Becquerels to the Curie.

Radioactivity dispersed in another material may be expressed as, say, megabecquerels per kilogram (MBq/kg) for natural radioactivity of some rocks, or as Becquerels per cubic metre (Bq/m^3) when describing the radioactive content of air. These units do not describe your radiation dose; they represent the strength of radioactivity at a given place.

With this preparatory information it is now possible to turn with rather more confidence to the specific recommendations and the numbers suggested as generally safe where exposure to radiation is likely to occur. Given that the background radiation to which everyone is exposed on an annual basis amounts to about 2 millisieverts (mSv) or 2000 microsieverts (uSv), then the annual doses suggested as an upper limit for workers in the Atomic Energy or Radiological area should not exceed 25 times background or 50,000 microsieverts (uSv) per annum.

By comparison with this, members of the public are suggested as having an an-

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THE SERVICEMAN

Venturing into the bowels of a computer, and trying to resurrect an elderly VCR

I have two stories for you this month, one of which comes from a contributor and concerns his successful efforts at repairing a second-hand computer with an elusive video fault. The other story is a tale from my own bench, about a VCR whose problems took me longer to track down than they should have...

Most of the stories we tell in these pages are 'hammer and nails' kind of yarns. They tell about finding faulty parts and replacing them with new ones. In other words, they deal with what those who work a lot with computers tend to call *hardware* problems.

The few computer servicing stories we have told in the past have also been of this type. Problems with power supplies and interconnections, etc. Which is not surprising, since mechanical parts are the ones that wear out, or are physically abused until they reach breaking point.

Yet computers are more than just a collection of parts. They will do nothing without software. So what happens if the software breaks down?

The story that follows is one about just such a software failure — that is, screwdrivers and soldering irons don't get much of a mention. It should make quite a change.

The story comes from P.H., of Raymond Terrace in NSW. P.H. doesn't say if he is a computer professional, but his familiarity with the software side would seem to indicate that he either works in this area, or is a real enthusiast. He certainly knows more about the subject than I do, and reading his story has taught me a lot about software problems. He tells the tale thus:

My first computer repair was on my recently purchased (but by no means new) HP150. It uses an 8088 processor, twin 3.5" 270KB floppies, a touch screen and the most beautiful green display I had ever seen.

The chap who had sold me the HP said he had recently paid $500 to have a board replaced due to some memory trouble. I hoped this was a 'one off' problem. Besides, after my old Microbee, the HP's resolution couldn't be resisted.

But inside two months the machine failed again. Occasionally dots or commas would appear in the first column, down the left hand side of the screen! At first I only noticed it if I dragged the cursor about with my finger and I hoped that this would be as far as it went. But it was just wishful thinking.

Other software eventually began to show the same symptoms. It had to be a hardware breakdown! I had the address of the company the previous owner had used for service, but after spending $800 on buying the machine, I couldn't lose face in front of my wife. Besides, I was determined to avoid repair bills, no matter how much it cost!

Step 1: Call Hewlett Packard about a service manual. "..I'm sorry, Sir. That machine is no longer supported..."

Step 2: Perhaps someone at HP would talk to the Test Equipment Officer of the company I work for? (That's me. I also wash the cars, but I didn't think telling them that would help) "... I'm sorry, Sir. That machine is no longer supported..."

A friend in a bigger, well known company came up with a name in Sydney. That got me past the first three phone blockers to an HP employee who seemed to want to help. "That machine is no longer supported, but maybe we can get something from the United States", he said.

Four weeks later a packet of about 200 top quality unbound pages arrived. Cost me $120, though. Then after about a week they realised I was only an ordinary citizen, with no special privileges. So another bill for $34 sales tax arrived in the mail.

By now I had decided that the fault was in the display card, as software ignored the presence of the ever-increasing number of random characters advancing across the screen. However, graphics remained unaffected.

After some preliminary checks of the power supply, my first thought was that the video text RAM was faulty. The HP uses six 2KB static chips for text: 6KB for three pages of text, and another 6KB for character attributes. If only I had a BASIC that would run on this machine, I could poke a value into the screen RAM and then peek at it later to see if it had changed.

It cost me another $150, but I soon had an HP GWBASIC complete with a nicely bound handbook. Poking a character into screen memory and later reading it seemed to put the text RAM into the clear, but there was still doubt due to the previous owner's 'memory problem'.

With a little deduction I was able to determine that the fault must be a permanent logic HI on the first text data line, as only odd characters would show in the faulty part of the display. I put a CRO on that line, but had an impossible job trig-

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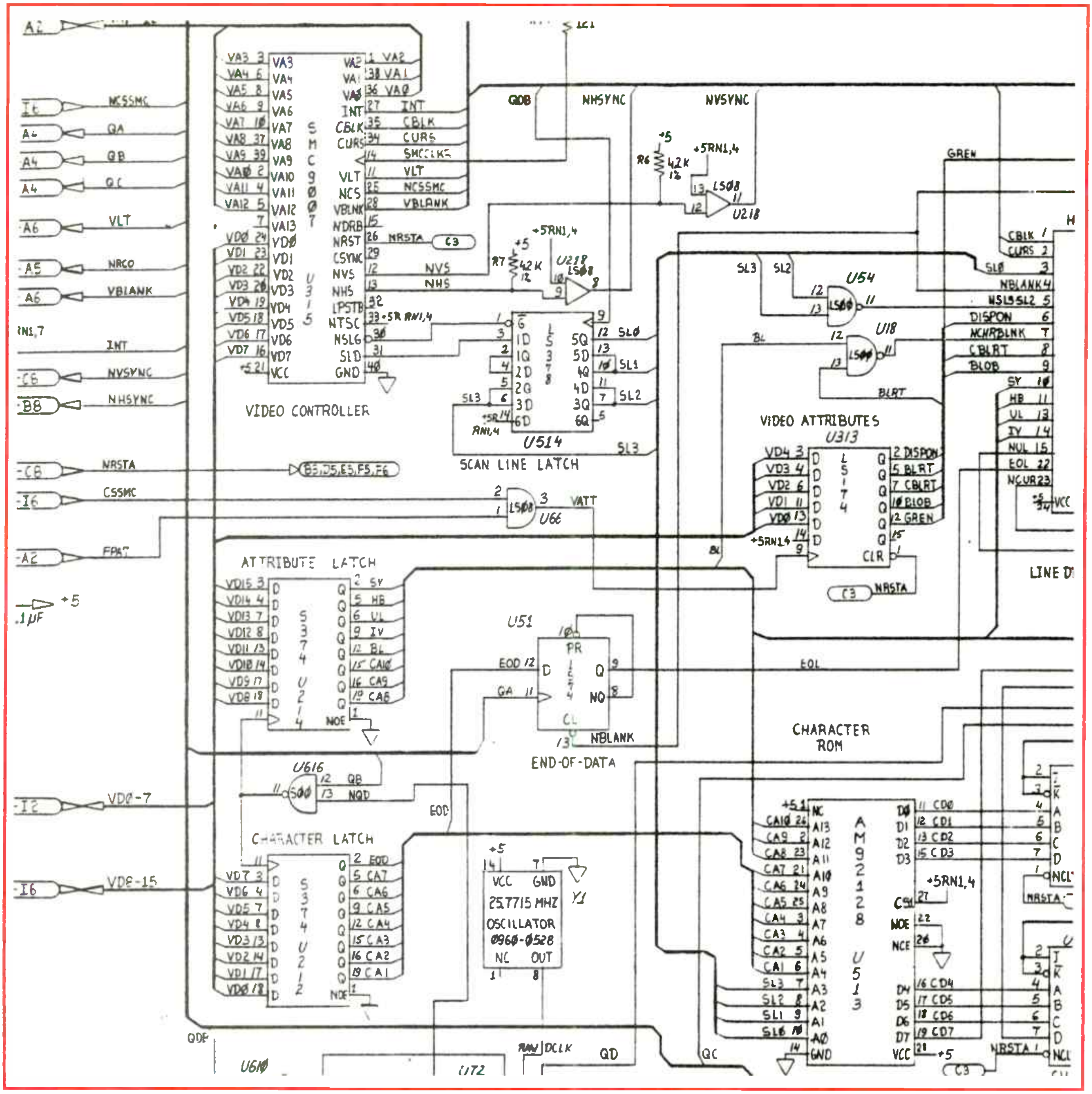


Part of the video display subsystem of a Hewlett Packard HP150 computer. The video controller chip is visible at upper left, while the character generator ROM is near the lower right. Contributor P.H. tracked the fault down to this area.

gering a ghost free trace. I was expecting the fault to show as a phantom positive pulse, and I certainly saw plenty of these — but I wasn't convinced.

I spent a day building a trigger delay box for my CRO. Triggering this from the computer's horizontal sync pulse and then increasing the delay before triggering the CRO allowed me to examine a line one character at a time. The ghost pulses were there alright, but it still wasn't conclusive. I finally gave up and put in three new 6116 memory chips. No change. I should have relied on my poking and peeking.

The data bus from the text RAM feeds two chips: an SMC9007 video controller (U315) and a 74LS374 latch (U212). There was not a real lot I could do about the LSI video controller — they may have been freely availiable in the USA seven years ago, but I doubted my chances now. The latch was cheap and readily available, so I removed it and socketed the board. The replacement brought no joy. Suspicion now fell on U513, a 128K-bit character ROM.

There was no way to 'peek' at its contents, but by removing the character latch chip again, I was able to insert seven wires into the latch socket 'Q' lines feeding the character ROM. Switching these from 0 to 1 allowed me to display a full screen of any character, perfectly. The ROM appeared to be good!

I was so despondent at this stage that I left the wires plugged into the character latch socket, the other ends dangling in space like seven little antennas! Does static electricity really destroy ICs?

I was never really convinced, but an electrical storm during the days it took to drum up the courage to have another go

has somewhat changed my mind. On reinstalling the video board I now had no text at all. I could not duplicate my earlier experiment of directly addressing the character ROM. It was now an ex-ROM!

Following a minor nervous breakdown I contacted HP. "...Yes, I know this machine is no longer supported, but there must be a ROM or a file somewhere. I'd even be glad to get a paper listing of the character data..." The return call never came. I knew I was on my own.

I had only one chance. I must acquire a second HP150 and copy its character ROM. By good fortune my brother had access to one, though if I damaged it, we would both be in hot water.

I also needed an EPROM burner. Starting with an old EA circuit, I threw out the monostables and added a second 4040 counter to allow a 24-bit address bus for those really big ROMs somewhere in the future. I controlled it with my old Microbee running BASIC.

Years before, a mate had given me an ultraviolet sun lamp. I could use this as an EPROM eraser, although its 60W output almost melted the chip. I stuck a 10W fluoro ballast in series with the UV tube and it worked perfectly.

I practised reading and writing to various old EPROMS and experienced no problems with my set up. I even found the character set in the Microbee memory map and burnt a 64K-bit EPROM with that data.

It struck me that there was no reason why I couldn't plug this into the HP. The 64K and 128K chips are pin compatible, and the HP would address the lower addresses by default. Once plugged in and reassembled, I booted the HP up. I was presented with near-perfect text. Even the original fault had gone!

It seems the HP character ROM had been OK at low speed, but couldn't respond to the higher rate of addressing 14 lines by 80 characters for each line of text. Multiply this by 27 lines to the page, 60 times per second, and a dicey ROM could be the answer.

The text was not quite right, though. It seems that the Microbee character sits at the bottom of its character cell, with blank scanning lines at the top, while those in the HP sit in the centre with blank lines to the top and bottom.

This had the effect of lopping off the lower parts of y's and g's, etc. But after a minor change of the character ROM reading software and a reburn of the EPROM, the displayed text was quite acceptable.

As I stared at the text in triumph, I realised that probably I was the only person to ever create a HP150/Microbee hybrid quite like this. It made me giddy just to think about it!

With my technique worked out, I was eventually able to copy the character ROM from the other HP machine, and now my HP150 works perfectly. It certainly was a confidence booster.

Now for my next trick, I will devote my life to illuminating the yukky LCD display on my new AMSTRAD PPC640...

Well, now, wasn't that something? I don't know about you, but I learned a lot about computers from that story. However, I should make one correction to my introductory remarks. It wasn't really a 'software' repair, but a 'firmware' ditto.

There is a distinction, clearly understood by expert computerists. Hardware is the machine itself, software is the program on paper or disk before its entered into the machine, or stored in normal 'random access' memory or RAM, and firmware is a fixed program inside the machine, usually in a read-only memory or ROM.

So P.H. was actually repairing the 'firmware'. Which is no mean feat since you cannot see, touch or measure faulty firmware. It was all done by deduction.

Thanks, P.H., I'm sure we all appreciated your story. Now, back to my own bench.

Another VCR

A few months ago, you may recall that I told the story of an AWA video with an obscure problem in its IF strip. I couldn't find the fault myself, but a colleague nailed it from the circuit diagram, without even seeing the offending machine.

I should have learned a lesson from that exercise, but I didn't. And last week I got caught by my own forgetfulness.

The story this time concerns a Fisher video recorder, a model FVH-P620. These VHS machines were produced by Sanyo, some eight to ten years ago when that company was still producing Beta recorders under their own name.

The Fisher was quite a robust model and a great many of them were sold. However with top loading, no remote control, and not many trick functions, they have now faded from the scene and very few remain in service. Indeed, this fact raises a point about the economics of repairing old machines — which I will raise later.

This one came to me some weeks ago, with a tale of woe about several trips to another serviceman, but without any satisfaction. It seems that the machine had been suffering from a bad picture, although the customer couldn't describe very accurately just what the problem looked like. His immediate complaint was that it would now not record anything that could be called a picture.

It would play back a pre-recorded tape quite well, but would not record off-air. Even more to the point, the owner could not watch SBS using the video as a tuner, as he had done in the past.

When I saw the machine working, I could appreciate his problem. The screen showed nothing but psychedelic patterns of light and colour. The colour could be removed by tuning off channel, and the sound could be changed from 'terrible' to nothing at all. Otherwise there was nothing remotely like a picture.

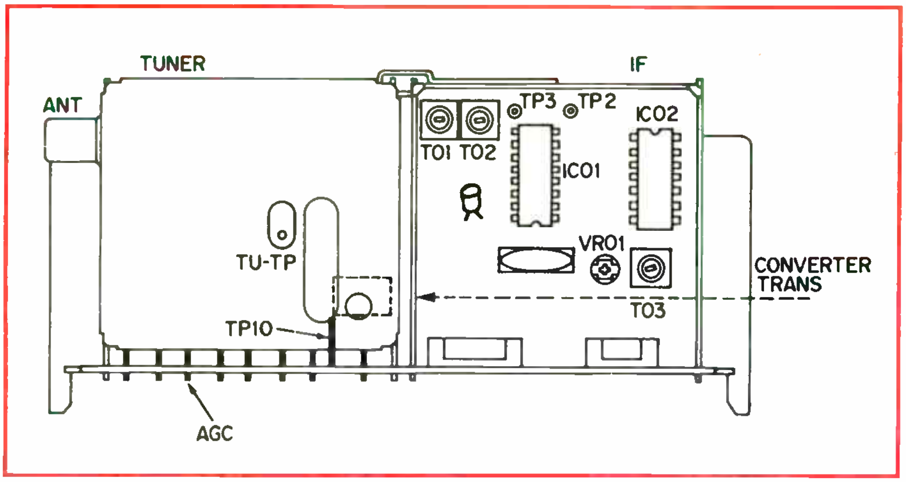
I guessed that we had a tuner problem and at first this looked like a good bet. Unfortunately, in this set the tuner and IF module are in one compact assembly, and are not conducive to easy testing. More to the point, the module was extremely difficult to get out of the machine. It was mounted on a metal plate that was held by two plastic runners moulded into the frame. These runners seemed to have distorted, and the plate was jammed solidly into the machine.

It took lots of brute force to eventually get the plate out of the frame, and over the next week or so many removals worked it looser. But right to the end it was not easy, and I was sorely tempted to break away one of the plastic runners and let the module hang loose in the chassis.

With the module now accessible, I found that the tuner was, in fact, faultless and was producing clean IF that could drive my test set perfectly. Similarly, IF from the tuner in my test set produced the same weird symptoms after being passed through the Fisher's IF strip.

That placed the trouble squarely in the IF strip, and gave me my first real contact with surface-mounted components. The IF module was contained in a small tinplate box, about 50mm square. Inside, on the top of the PCB, were very few components. There were two IC's, a couple of electro's, three miniature coils, something that looked like a ceramic filter, and a miniature trimpot. On the underside of the board however, it was a different story. This was heavily populated with surface-mounted resistors and diodes. If I was going to work among that lot I would have to be extremely careful.

At this point I got out the service manual for the model. This is a most impressive document, some 15mm thick, and containing a most useful fault finding tree. But would you believe it? There was not a skerrick of information about the tuner and IF module.



The tuner/IF module from a Fisher (Sanyo) FVH-P620 video recorder, which forms the subject of this month's second story. A replacement module would have cost $210 trade, so the Serviceman elected to try fixing the original unit.

Most manuals give at least a tuner and IF strip circuit diagram, even if the boards are modularised and not meant for repair. But not so the Fisher. There was nothing more than the adjustment diagram shown here. So I was on my own.

It was clear that Sanyo didn't want servicemen poking around inside their Fisher front ends, so presumably they had a repair or spare parts service. I faxed off a query asking about the price and availability of replacement parts, and the reply really shocked me.

Sanyo could supply a tuner/IF module, for $210 trade including tax, plus $8 post and packing. After I had added my margin, and then a charge for my time, the customer was going to be up for more than the old machine was worth.

Even before I asked him, I knew he would not be interested in going that way. If I could manage a repair in my shop, it might be economical. But the delicate nature of any work among the surface-mount components put the project very much into question. One slip of the iron and the machine may well have become a writeoff.

I rang the owner and put the tale of woe to him. He agreed that the machine was old, and although still capable of doing all he wanted of it, a new machine was probably justified. So I should go ahead and try to repair the old one. If I failed, I could have it for junk and he would understand that at least I had tried. (Wouldn't it be nice if all customers were that considerate?)

I guessed that the fault in this system was due to a failure in one of the active circuit components and in this case it could only be in one of the two integrated circuits.

These were a TA7607 and an LA1365. Knowing my luck, and the machinations of the detestable Murphy, if I guessed at which IC was faulty I would finish by replacing the wrong one. So I needed to know which chip did what in the circuit.

But as mentioned, the Fisher manual gave no clues to help me. It didn't even give the type numbers of the IC's in the parts list. Still, they were clearly visible on the chips themselves, so all that remained was for me to find a reference to those numbers somewhere else. I went through dozens of reference books and other manuals, without finding a trace of these two chips. Then I thought to look in the manual for a Sanyo Beta machine of about the same vintage as the Fisher. And there they were.

The LA1365 is an audio IF, detector and audio pre-amp chip, so that had no immediate interest for me. It was the TA7607 that did all the IF processing. It includes an IF amplifier and video, AGC and AFT detectors. Clearly, any fault in that lot could cause the symptoms that we were getting with this machine.

I spent some time carefully examining the copper side of the board, planning where I would have to be super-careful with the iron. As it turned out, 12 of the 16 pins were relatively easy to get at.

Sure, it needed a needle tip on my iron, and a strip of the thinnest solderwick I could find. But it didn't take long to get those 12 pins free. The really difficult part was freeing the other four pins, without disturbing any of the miniature components.

Each of these pins had a surface-mounted resistor attached to the same donut. The solderwick not only pulled the solder away from the IC pin, it also drew the solder out from around and under the resistor endcap. All I could hope for was that it would flow back under the resistor when I replaced the solder around the IC pin.

The TA7607 chip was readily available from my usual supplier, and at less than $8 was ridiculously cheap, compared to the cost of a new module. In no time at all I was ready to reassemble the module. The moment of truth came at the four pins mentioned above.

In fact, things went together slowly, but without any great fuss. I got a spool of the finest solder I have ever seen, and taking my time with the needle-point iron, I was able to restore everything to normal.

The solder very conveniently replaced itself around the miniscule resistors, and after I had cleaned off the surplus flux, the board looked almost as though it had never been touched.

I refitted the module into the chassis and switched on. I had my fingers and toes crossed because if it didn't work, I would only have a junked machine to show for all my work.

But Murphy, while perhaps not on holidays, was at least away for the weekend. The set fired up with good sound, and a 'reasonable' picture — the emphasis because the picture was not perfect. I have since learned that this was the prior fault mentioned earlier, and now I'm not surprised that the customer had difficulty in explaining the symptoms. I'm in the same boat.

The picture was sometimes perfectly normal and couldn't be faulted. Then intermittently, parts of the picture would pull to the left, just as though it was about to lose horizontal hold.

Sometimes the effect was obviously tied in with the video level, and moved with video on the screen. Yet at other times it was quite static, and moving video had no effect on the nature or degree of the pulling. If it was bad, then fine tuning could make it better. Or vice-versa. Sometimes even retuning the monitor would improve the image.

Fault of the Month

SONY KV1830AS Colour TV

SYMPTOM: Black screen, no sign of luminance or colour. Picture tube heater is glowing normally, and all voltage supplies are present and correct.

CURE: C816, a 4.7uF 250V electro on the E board, was open circuit. This capacitor is a bypass on the horizontal blanking circuit, and when it goes open it allows the blanking bias to go hard on, permanently.

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.

THE SERVICEMAN

I tried resetting the AGC, with no noticeable change in reliability. I tried adjusting the automatic fine tuning, but that did nothing to stabilise the picture either. Through all of this, the machine would chose its own time to play up, and would produce a perfect picture for sometimes an hour or more.

After setting up all the adjustments provided for in the manual, I had to admit that the set still contained a fault and that I didn't look like ever finding out what it was. With a circuit diagram, I might have had a chance. But without it I was just floundering in the dark.

The pity of all this was that the IF module circuit board was clearly marked with component numbers which must have, at some time, referred to those on a circuit diagram. But I had no information, and I couldn't find anyone who did.

So for the time being, that's where the matter rested.

A week or two later, I was talking with a colleague on matters video and happened to mention the Fisher with the wriggly picture. He said that he had never heard of an IF chip going funny in Fisher machines, then he asked me if I had "...changed the little yellow capacitor."

I couldn't see any connection between a dud chip and a yellow cap, until he explained that he had often found bad pix in the Fisher to be caused by a 0.47uF 50V electro in the IF module.

Then I remembered the AWA machine and its very similar symptoms. That fault had been a 0.47uF electro, but this time I had not noticed the item in the module.

As mentioned earlier, I may have found it if I'd had a circuit diagram. It probably served a similar bypass function on the AGC rail as the capacitor in the AWA set, and would have been easy enough to identify from the diagram.

The location of the offending capacitor is shown on the drawing printed here. It is a very tiny component and is easy enough to overlook. But its bright yellow colour will forever more remind me not to trust any low value electrolytic.

And before I leave this subject, I'd like to comment about the economics of repairing old machines like the Fisher, and particularly about the high cost of some parts for them.

As mentioned earlier, Sanyo wanted $210 for a replacement tuner/IF module. That price was just too high to justify, so I set about trying to repair the old one.

In a year or two from now there won't be any Fishers left, and Sanyo will have to junk all those expensive spare parts now on their shelves. Wouldn't it have been a better idea to sell out the old parts at a reasonable price? At $100 I wouldn't have considered repairing the old module, and Sanyo would have had one less item in stock.

I can see some justification for the high price of spare parts, particularly while the equipment is new and valuable. But old machines become fewer as time passes and the call for spares becomes less and less. So why not clear the shelves of 10 year old parts stock at a price the market can bear?

Some years ago I paid $20 for a quantity of spare parts for an old black and white video recorder, that had originally been listed at close to $1000. That manufacturer had the policy of clearing out old parts for what he could get, rather than holding them on the shelves at the book price.

I can appreciate that manufacturers would not like to see cheap parts being used to resurrect hundreds of old TV's or videos. But I'm not talking about hundreds — just ones and twos. I can't see that these 'vintage restorations' would be a threat to new sales.

Or am I just wishing thinkfully?

See you again next month. ❖

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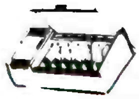

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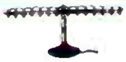

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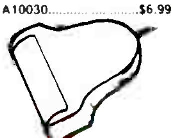

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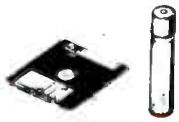

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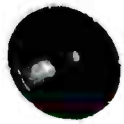

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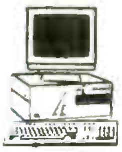

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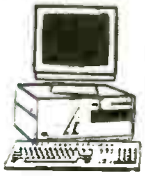

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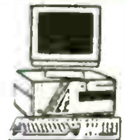

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126 MEG HARD DISK 12ms ACCESS TIME
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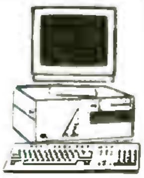

80486SX-20 CPU
1 MEG RAM EXP TO 32 MEG
75Mhz LANDMARK SPEED TEST
85 MEG HARD DISK
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101 EXTENDED "CLICK" KEYBOARD
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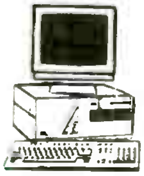

80486-33 CPU
256K ON BOARD CACHE. 1 MEG OF RAM
157Mhz LANDMARK SPEED TEST
85 MEG HARD DISK
1.2M JAPANESE BRAND F.D.D
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When I Think Back...

by Neville Williams

Vintage radio magazines: how they came and went, and transmitters BC (Before Crystals)

According to an estimate that I heard but failed to memorise, a startling number of technical radio periodicals have been launched in Australia over the years, only to pass into limbo. A reader brings to my attention the story of several radio amateur-related publications and, indirectly, unearths a few more facts about *EA*'s own history.

Fig.1: Originally 'Sea, Land and Air', 'RADIO in Australia & New Zealand' was acquired by Wireless Newspapers Ltd and finally absorbed into 'Wireless Weekly', our own source publication.

Many moons ago, I acquired a battered bound volume No.4 of the early Australian magazine *Sea, Land and Air*, containing the issues from April 1921 to March 1922. From time to time, I've quoted snippets from them, *inter alia* about Guglielmo Marconi, Ernest Fisk, AWA (Amalgamated Wireless A'asia), and the WIA (Wireless Institute of Australia).

In its day, *Sea, Land and Air* would have provided compelling reading for technically inclined subscribers. Thumbing through its pages reveals articles on land transport, on maritime pilots, ferries, tugs and shipping generally, and on the Australian aviation scene. Included is a profile of the Aircraft & Engineering Co at Mascot, Sydney, at the time an active aircraft assembler/manufacturer.

I noticed also a news item and picture of Lieutenant 'Hinckler' (sic) and his baby Avro, which had just made it from London to Turin in nine-and-a-half hours. This was followed by an article on Australia's experimental wireless stations and a picture of the new Hupmobile tourer, being imported in chassis form and fitted with a 'gracious' all-Australian body — provided by I. Phizackerley at 169-171 Elizabeth St, Sydney — opposite Hyde Park. It occurred to me that the body might have been so described because everything Phitz exackerley!

Launched in March 1918, *Sea, Land and Air* was published in Sydney by Wireless Press which specialised in (I quote) 'books and magazines written by experts for your benefit'.

Now but a distant memory, the magazine figured prominently in an article by Colin Mackinnon VK2DYN, in the January 1991 issue of *Amateur Radio* magazine entitled 'The History of the WIA Journal'. For a photostat of the article I am indebted to a reader from Jannali, NSW who suggested that it could shed a little more light on early Australian wireless literature and possibly on the roots of our own magazine *EA*.

Magazine for amateurs

Well, it certainly does put several largely forgotten publications into context, but it serves also to show that they had little to do with *Electronics Australia*'s own family tree. As it happens I also have on hand a supplementary letter from Colin Mackinnon, passed on to me recently by Jim Rowe.

In his article, Colin Mackinnon says that while wireless experimenters/amateurs, legal and otherwise, had been active in Australia since the late 1890's, no serious attempt had ever been made to circulate a regular national experimenter's publication until after the 1914-18 war. Until then, they had pursued their interest in virtual isolation or at most in regional groups.

The first postwar meeting of the one-time NSW Wireless Institute was convened in the classrooms of the Marconi School of Wireless in January 1919, by the prewar secretary, Malcolm Perry. An experimenter and enthusiast since 1905, Malcolm Perry was, in 1919, manager of the Experimental Sales Department of Australectric Ltd, a subsidiary of AWA based at 79 Clarence St, Sydney.

The meeting was chaired by Ernest Fisk (callsign 2EF), the managing director of AWA, who stressed the need for state-based experimenter groups to amalgamate into a single Australia-wide Institute. Only then, he said, could they

When I Think Back...

RADIO

expect meaningful recognition of the amateur movement by the Federal Government.

Elected in March 1919 as president of the Wireless Institute of NSW, Ernest Fisk suggested that his company's existing monthly magazine *Sea, Land and Air* should become the official organ of the NSW WIA, and this arrangement was implemented without delay.

Within the next few months, the major state bodies had re-grouped to become 'Divisions' of the Wireless Institute of Australia, with *Sea, Land and Air* as their official organ. A formal link was also forged with the Wireless Institute of New Zealand.

Indicative of this cosy arrangement, advertisements in my 1921 editions of *Sea, Land and Air* for both Wireless Press and the Marconi School share AWA's postal address at 97/99 Clarence St, Sydney. Matters to do with the Wireless Institute were to be referred to the NSW secretary, who could be reached c/- The Editor of *Sea, Land and Air* — all on AWA premises.

Winds of change

Colin MacKinnon says that in early 1922, an amateur operator S. Tatham (2ST) became editor of *Sea, Land and Air*. But in March/April 1923, the magazine was re-styled and re-issued as *Radio in Australia and New Zealand*. S.Tatham continued as editor with N.H. Thompson as associate editor.

As it happened, I have in my files a front cover from the latter title (May 27, 1925, Vol.3 No.54), made available to me back in 1969 by John Stokes of Auckland, NZ. It was endorsed 'Incorporating Sea, Land and Air' and indicated that the re-styled journal was being published fortnightly for sixpence (5c) a copy.

At the time, John Stokes was unsure whether 'The Wireless Press' of Sydney, Melbourne and Wellington (NZ) was an offshoot of the Marconi-owned 'The Wireless Press Ltd' (UK); this was later absorbed by the British Iliffe organisation, publishers of the highly respected *Wireless World* (which itself evolved from *The Marconigraph*, I seem to recall). But having in mind the close working relationship between AWA and the Marconi Co, some link between the two publishers can reasonably be assumed.

As it turned out, the new magazine's formal association with the WIA lasted only a few months (until October 1923). But the journal maintained an independent news coverage of the amateur scene, prepared by Charles Mclurcan, 2CM.

In early 1925, Tatham resigned as editor and his place was taken by Thompson. Then, in September of the same year, the magazine was sold to Wireless Newspapers Ltd, becoming a virtual stablemate of *Wireless Weekly* under the latter's then editor Arthur William Watt, 2WW. Watt was joined by C.W. Slade (2SX) as technical editor — which raises the question as whether he was the same Charles Slade who was later involved in the manufacture of Slade and Slade-Paton test equipment.

Fig.2: As pictured in Wireless Weekly for August 5, 1932, Mrs C.R. Mackenzie was better known in the early days as Miss F.V. (Vera) Wallace. Reputedly Australia's first female engineering graduate, a radio amateur and retailer, she was one of a small group which founded Wireless Weekly in 1922.

In the meantime, the size of the words 'in Australia & New Zealand' had been drastically reduced, and the magazine had come to be known simply as *RADIO*. It was re-launched as an 80-page monthly in April 1927, for one shilling (10c) per copy. Then Watt resigned in September 1928 and was replaced as joint editor by G.V. Blunden, with the well known amateur Don Knock (2NO) as technical editor. But in this form, *RADIO* lasted only until the December 1928 issue. Thereafter it was incorporated into *Wireless Weekly*, and effectively relegated to magazine limbo.

Succession of titles

Left without an official publication, the Victorian Division of the WIA toyed with the idea of a quarterly 'Proceedings' publication but, in collaboration with an outside publisher, ended up in December 1923 with a 32-page (approx) magazine entitled *Radio Experimenter*. Its editor was the well known Victorian WIA President Howard Kingsley Love (3UM), and its Technical Editor a state WIA councillor in the person of Ross Hull.

A few months later, on the occasion of the first Australian Wireless Convention (Melbourne Town Hall, May 1924) *Radio Experimenter* was seriously considered for the role of official journal of the WIA, but the proposal lapsed. Instead, the magazine reverted to the publisher, changed its name to *The Radio Experimenter and Broadcaster* and attempted to diversify into wireless retailing. In this form it lasted only until June 1925.

In the meantime (August 1924) the Victorian WIA launched the 50- page *Experimental Radio Broadcast News*, with Howard Love as editor and Ross Hull as assistant editor. In March 1925 the name was changed to *Radio Broadcast*, with the subsequent addition of 'incorporating the Radio Experimenter and Broadcaster'. By this time, Howard Love had assumed the role of managing director of the WIA (Vic) publishing offshoot, with Ross Hull as managing editor.

At the second federal convention of the WIA (Perth, August 1925), *Radio Broadcast* was adopted as the official national organ of the WIA but, after disruptive changes in personnel and location, the magazine also lapsed in January 1927.

The period 1927-29 saw the formation of the rival Amateur Radio Transmitters League and the appearance of state-based publications *CQ*, *QTC*, *Journal of the WIA NSW*, *Radio Journal of Australia* and the *WIA Bulletin* (WA).

The rivalry and argument continued through 1929, bringing us to the conclusion of Colin MacKinnon's January 1991 article. As I remarked earlier, it certainly puts a group of those early publications into perspective and explains my own puzzlement, from time to time, at references to titles which came and went while I was still at school studying the three R's!

It also adds another dimension to the pivotal role of Mr (later Sir) Ernest Fisk, as the managing director of AWA — along with the Marconi School, Australectric Ltd and a publishing arm with its own extended influence. (See 'When I Think Back' for June and July 1989).

And it likewise adds to the stature of Ross Hull, also featured in this series in February 1989. When Ross Hull knocked on the door of the ARRL headquarters in

West Hartford, Connecticut (USA) in 1926, he was not just a keen Australian amateur looking for a job. He was a keen amateur with demonstrable experience as a technical writer/editor, which was exactly what they were looking for at the time.

Years later, he was to bring those qualifications plus his work experience with the ARRL back to our source journal *Wireless Weekly*, providing one very tenuous link between our own past and the events in Colin MacKinnon's story.

The origins of *WW*

As many *EA* readers will be aware, *Wireless Weekly* (*WW*) dates back to 1922, when the Australian public were just awakening to the fact that public broadcasting was technically practical and needed only the stroke of the Federal Government's proverbial pen for it to become an everyday reality.

Aware that I would be taking a closer look at the origins of *WW*, and acting on a hunch, *EA*'s current managing editor Jim Rowe turned up the issue for August 5, 1932. Sure enough, *WW* had marked its tenth anniversary with a 1-page article by Mrs C.R. Mackenzie entitled 'The First Wireless Weekly'.

Old timers, especially Sydneysiders, will remember Mrs Mackenzie better by her maiden name: Miss F.V.(Vera) Wallace. Reputed to be Australia's first ever female engineering graduate, she had gained a Diploma in Electrical Engineering at the Sydney Technical College and set up a contracting business in which she assumed both an executive and a hands-on role.

Interested also in wireless, she opened a radio parts shop in 1921 in Sydney's Royal Arcade. In the 1930's, it was one of several such stores in the vicinity, to which impecunious wirers like myself made regular pilgrimages to window-shop!

Somewhere between establishment of the shop and 1932, when the abovementioned article was written, Vera Wallace had become Mrs C.R. Mackenzie (Fig.2), although the shop was always identified with her maiden name.

The only mention of Mr C.R. Mackenzie in the article is as the creator of a 'sea-shell' horn loudspeaker (Fig.4) — surely one of the most frequently used illustrations ever in stories about early Australian wireless.

In her article, Mrs Mackenzie claims that the idea behind *Wireless Weekly* originated in the Royal Arcade shop, where she had discussed the need for such a publication with Mr R.C. Marsden — the 'technical man' behind the counter, with expertise in circuit design.

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***Fig.3:** The simple card-style advertisement which Miss F.V. Wallace ran in 1923 editions of a rival magazine 'The Australasian Wireless Review'. Note the four figure phone number.*

In due course, the idea was put to Mr A. Mitchell, an acquaintance who worked on Sydney's *Evening News* daily. He in turn referred them to Mr W.M. MacLardy, a printer in Castlereagh St, who also happened to be a wireless enthusiast.

Through him they were introduced to Mr W.J. MacLardy, presumably a brother, who had his own pet ambition — namely to set up Australia's first public broadcast station. To the would-be entrepreneur, a magazine which might conceivably excite public interest in broadcasting and stir the Government into action would be a gift from the gods!

***Fig.4:** Contrived from a magnetic driver unit and a generously proportioned sea shell, this novel and frequently pictured horn loudspeaker was the creation of Mr C.R. Mackenzie.*

After further discussion, the decision was made to go ahead. The new magazine would publicise the work of existing amateur stations, emphasise the potential of public broadcasting, encourage experimenters and create a climate for action by the Federal Government. (Colin MacKinnon adds that *WW* was also to serve for a while as official organ of the Australasian Radio Relay League, a short-lived segment of the WIA devoted to amateur message handling.)

Dream takes shape

So the magazine was born, with a meeting each week in Mr MacLardy's reportedly 'dark and dusty basement' in Castlereagh Street, Sydney. Mrs Mackenzie would submit industry news, notes about components, a short story or maybe a wireless 'poem'. Mr Marsden would contribute technical articles and circuits. Mr Mitchell, in the role of editor, would sub-edit and arrange the material, fleshing it out with science jottings and relevant overseas news, culled from the resources of the *Evening News*.

Mrs Mackenzie relates that the first 12-page issue had a print run of a few hundred copies, and went on sale from her shop at 8am on August 4, 1922. It carried the imprint:

Published by W.J. MacLardy, "Truro", Powell St, Neutral Bay, at the offices of W.M. MacLardy, 249 Castlereagh Street, Sydney.

Subsequent issues grew progressively in size to around 60 pages and to a circulation measured in tens of thousands, spread all over Australia.

By the time the 10th anniversary article was written, the magazine had outgrown the resources of the original publisher and as Mrs Mackenzie relates, had 'passed into other hands' (a tinge of regret?). Certainly, a 1926 edition in my files indicates a different printer and a different publisher at a different address: Wireless Newspapers Ltd, not to be confused with AWA's Wireless Press.

I also know that, when I assumed the responsibility for *WW*'s technical offspring *Radio and Hobbies* in 1939, both *WW* and *R&H* were the property of Associated Newspapers, and *The Evening News* and Wireless Newspapers Ltd alike were but fleeting memories in the corridors of the *Sun* building near the corner of Elizabeth St and Martin Place.

A question of lineage

In his letter to Jim Rowe, Colin MacKinnon questions whether *Radio & Hobbies* can really be regarded as a linear descendant of *Wireless Weekly*, seeing the latter continued for a time, in its own right, as a magazine devoted to programs, station topics and fiction. If, says Colin, we're keen to emphasise our historical links, why not the one through *RADIO* and *Sea, Land and Air*, back to 1919? That would give us three extra years!

As I see it, the answer is simply that the first proposition is credible; the second is not.

From the outset, *Wireless Weekly* sought primarily to cater for the needs of a 1920's-style wireless family, with a mix of programmes, comment on stations and personalities — plus technicalities for the 'man of the house' who had to operate the equipment.

As the wireless/radio scene gradually changed through the 1930's, the publishers of *WW* decided that the interests of all concerned would be better served by splitting the contents into two separate magazines:

1. For general readers a re-styled weekly with expanded coverage of programmes, stations, features and personalities; and
2. For the technically inclined, a monthly with a broader technical content, plus popular science and hobbies.

The existing *WW* editorial staff was accordingly divided into two distinct groups, while retaining the existing administration and secretarial support. They kept working in the original offices, with the same advertising section and using the same production and distribution facilities.

Having assumed responsibility for *Radio & Hobbies* in that very environment, shortly after the changeover, it has never occurred to me to question the continuity of the overall operation. By contrast, I sensed no carry-over at all from the ill-fated *RADIO* — no staff, no tradition, no records, no files or back issues. It was as if *RADIO* had never existed.

So there it is: whereas the publications mentioned by Colin MacKinnon sought to establish interdependent links with the amateur/experimenter fraternity, *Wireless Weekly* was directed primarily to prospective listeners from the public at large, in the cause of public broadcasting.

It involved experimenters and amateurs mainly because, in its formative years, they dominated the technical fraternity.

Two matters to do with the founders of *Wireless Weekly* are worthy of further mention.

A licensed radio amateur with what our one-time correspondent Pierce Healy describes as an 'almost musical fist', Mrs Mackenzie organised a centre in Sydney during World War II to train service personnel — particularly WAAF's — as telegraphy operators. Highly regarded and remembered by many as 'the grand old lady of wireless', 'Mrs Mack' died in her nineties in mid-982.

For his part, W.J. MacLardy's 'Broadcasters Ltd' opened Australia's first public broadcast station 2SB, on November 23, 1923. Operating under Fisk's ill-fated sealed set plan (see *EA*, July 1989), the listener's annual subscription fee was set at ten shillings ($1.00). The callsign was subsequently changed to 2BL (Broadcasters Ltd) because, on air, 2SB sounded too much like 2FC (Farmer & Co) which opened at about the same time.

Fig.5: W.J. MacLardy, as pictured in 1934. He was the first publisher of Wireless Weekly in 1922, launched Australia's first public broadcast station in the following year, and in 1934 sought to promote the use of sound film as an editable medium for recording and distributing radio programs.

As indicated in 'Think Back' for January 1990, the man responsible for the initial installation of 2SB/2BL was the well known Ray Allsop. His subsequent involvement in sound film technology could well have been behind another story which Jim Rowe came across in *Wireless Weekly* for January 16, 1934, entitled 'No More Howlers with the Latest Sound Film Records'.

With 2BL having been designated as a class-A station and taken over by the Australian Broadcasting Commission (1932) W.J. MacLardy (Fig.5) was free to contemplate broader issues, one of which was the inability of broadcasters to edit programs before they went to air.

His answer was to form a company in collaboration with the Commonwealth Film Laboratories, to develop the idea of recording new programs on sound film, so that they could be edited at the time of production and distributed for broadcasting free of errors.

He reasoned that material costs could be reduced by recording a sound track on both edges of the film and simply inverting the film in the equipment, at the half-way point in the program. But in any case, he said, the costs would be less than the alternative of re-recording complete faulty episodes, as with disc technology.

The very same argument led to the universal adoption of magnetic tape a couple of decades later, the vital difference being that tape offered instant replay without the need for processing. But even if MacLardy's proposal didn't get very far in 1934, he certainly had the right idea.

Technical personnel

Unfortunately from an historical viewpoint, *Wireless Weekly* rarely published authors' names, with the result that there is little to indicate who wrote or designed what in the way of do-it-yourself projects during that first decade.

Indications were that old-timers Ray Allsop and Don Knock were both active contributors during the mid-1920's and we knew about Ross Hull, 'Braith Hull and John Moyle in later years, but that's all.

I was most interested, therefore, to receive a letter from Stan Tonkin (VK2SG and VK5SG), who is now in a rest home in North Adelaide, SA. Stan can look back to the early 1920's when as the 15-year old son of the lessee of the Royal Hotel in Bathurst, NSW, he used to receive race results and cricket scores from 2FC Sydney and 3LO Melbourne, when both were still on the long-wave band.

Having indicated his background, Stan goes on to say, and I quote:

I had a visit from Bill Hamilton, who wrote about 90% of the constructional articles for Wireless Weekly, under the name of 'Insulator'. He worked with E.R. Cullen of 96 Bathurst St, Sydney and later with Wiles Wonderful Wireless,

which was one of the larger radio component retailers at the time.

Also at Cullens was a mechanic named Viv Maidment, who lived at Marrickville, Sydney — where he had installed a massive T-type aerial. He used to take all Bill Hamilton's creations home for a test run.

I joined E.R. Cullens myself in 1926, as a counter jumper and messenger boy. Bill Hamilton had left by then, but he came to an arrangement with Watt, the editor of Wireless Weekly and continued to produce articles for the magazine.

Most of the articles in your reprint of Wireless Weekly for 1927 were Bill Hamilton jobs, and where it mentions 'tested at Marrickville', it would have been on Viv Maidment's aerial.

Thanks Stan, for that unexpected peep into a hitherto closed book. Where else could we have obtained the information, other than from someone who knew the anonymous feature writer?

Early AM transmitters

While Stan's letter is much too long to reprint here in full, a section about early broadcast transmitters contrasts with the modern requirement that Australia's 260-odd medium-wave broadcast stations operate on the precise frequency allocated to each one.

Apart from anything else, this minimises the risk of an audible heterodyne between the many stations which now have to share a common channel. It also ensures that high frequency heterodynes which may occur between stations on adjacent channels will fall exactly on 9kHz, which can then be eliminated in wide-band tuners by a sharply tuned 'trap' filter.

But things were not always like that, with each station doing its sometimes questionable best to keep its tunable master oscillator on frequency. Or should I say on wavelength?

As a lad, I can recall discussions between my father and other local wireless buffs about particular stations being 'out of position' at certain times. Listeners in those days invariably kept cards showing the exact dial settings of the available stations, and it became apparent to all and sundry if a particular station was out of position.

While the PMG's Department was nominally responsible for checking station frequencies, indications are that it couldn't always cope. For this apparent reason, the Authorities announced at one stage that frequency measurements made by Charles Maclurcan, 2CM, arguably Australia's best known radio amateur, would be officially recognised by the Department.

Again, an article in *Wireless Weekly* for August 13, 1926, by engineer E.G. Beard sought to assure readers that the station he was installing for the Theosophical Society (2GB, Sydney) would not cause interference with 2BL or 4QG. Its wavelength would be carefully positioned between the two by the PMG's Dept, and the transmitter would be crystal-locked to the allocated wavelength, as soon as the exact figure could be commmunicated to the crystal supplier.

Fig.6: Arthur William Watt, who was editor of Wireless Weekly in early 1925 when RADIO was acquired by Wireless Newspapers Ltd, and both magazines were produced for a time under his editorship, from the same offices. He resigned in September 1928, and three months later RADIO was merged into Wireless Weekly.

I recall a separate news item, published about the same time, which made much of 2GB's initiative in adopting crystal technology. As evidence of a problem this is all anecdotal, but Stan Tonkin experienced it at first hand in quantitative terms.

Country station

After working for some years in the city, Stan took a job as a wireless mechanic with J.C. Rice at Albury on the NSW/Vic border. He continues:

About 1930, J.C. Rice was granted a B-class broadcasting licence for a local station to be identified as 2AY. He accordingly rented an AWA transmitter — 50 or 100W, I forget which.

At the time, there were only three country stations of any consequence: 2XN Lismore, 2MO Gunnedah and 2AY Albury. It was before the days of crystal control and 2MO (227m, 1320kHz) was pretty close to 2AY (229m, 1310kHz). We used to talk in metres in those days and I couldn't swear to the exact figures.

The modulated oscillators on the last-named transmitters used to drift closer together, such that a merry old beat note would become audible to a lot of listeners around 9.00pm on most evenings.

Eventually, the PMG's Dept decided to shift 2AY to around 203m or 1480kHz; I certainly remember the occasion. The PMG read our frequency in Sydney and talked to me in Albury by phone, while I fiddled the dial of the master oscillator on the transmitter.

Unfortunately, the dial movement was a bit jerky and the closest I could get to the specified channel was 600 cycles (Hertz) off, which the PMG said was near enough. Nowadays it has to be spot on!

Perhaps I should add that, at the time, I held only an AOCP licence (Amateur Operator's Certificate of Proficiency) and my position with 2AY could only be recognised as 'temporary'. I subsequently moved back to Sydney to qualify for my full Broadcast Ticket.

In the light of the above, I was interested to come across a reference to frequency control in a paper 'Broadcasting in Australia' presented to the IRE 1938 World Radio Convention by (Sir) Harry P.Brown, the distinguished Director-General of Posts and Telegraphs in Australia. He pointed out that, at an international conference in Madrid in 1932, it was agreed that the frequency drift of AM broadcasting stations must not henceforth exceed 50Hz. If memory serves me correctly, the tolerance was subsequently reduced to 5Hz.

Back in the 'big smoke'

Broadcast Ticket in hand, Stan Tonkin was appointed as a shift engineer to the Sydney commercial station 2UW, reporting to chief engineer Alec Marshall. This would have been around 1933, he says, when 2UW was gearing up to become Australia's first 24-hour broadcaster. My *Macquarie Book of Events* records that they actually did so on February 22, 1935. Looking back, Stan recalls:

The main transmitter at 2UW was (what seemed to me at the time) a huge

AWA series-modulated job with an output of 1kW. The standby transmitter was less pretentious, having been cobbled together from bits and pieces. These two transmitters and the associated studios were all located on the top floor of the State Theatre building in Market Street, City, the signal being radiated from a tapered lattice tower erected above the building.

In those days, much of Sydney's central business district had 240V DC power mains and the entire equipment at 2UW was powered from DC/AC rotary converters.

Looking back, I recall a lot of discussion about 2UW's initiative in 24-hour programming from the central city. From George Street, one could glimpse the tower — just — rising above a conglomeration of stores and office buildings. How efficient a transmitting aerial would be in such a situation was certainly open to question.

There was speculation as to whether 2UW's intention was to saturate with signal an area which had a notoriously high noise level, arising from the arc-prone DC supply system, the ancient wiring and the absence of noise suppression devices. Some saw it as a ploy to outmanoeuvre 2CH, which was surmounted by a handsome tower atop the new AWA building in York Street — a tower that was always more emblematic than functional. Then again, 2UW's move could also have been an economy measure, to minimise manning levels through an endless succession of 24-hour days? So went the argument:

Did they stand to lose more in the suburbs than they could hope to gain in the city? And anyway, how many people would be listening to the radio in the small hours of the morning?

There were stories also about interference from the transmitter into nearby electrical equipment, and RF voltages being developed along lift cables as they passed through a resonant length. Even in those days, let alone at this remote point in time, it was difficult to say what actually happened or what critics expected to happen.

To verify the above, I cross-checked it with retired engineer Winston Muscio, author of *Australian Radio, the Technical Story, 1923-83*. Having, about that time, moved into the transmitting section of STC, he remembers not only the debate about 2UW's initiative in the central city, but the sequel when they subsequently relocated their transmitter in the 'swamp' — the lowlands around Homebush Bay in the Parramatta river.

Nowadays, its all water under the bridge, anyway. Sydney's ever-expanding suburbia demands broadcast transmitters with blanket overall coverage and resonant vertical antennas with an unambiguous ground-plane/earth. As well, 24-hour programming is now routine, even if it is highly mechanised in many cases during the wee small hours.

Back to the country

After his stint in the central city, Stan Tonkin headed back to the country, joining the staff at 2LM in Lismore NSW in 1936. 2LM had taken over the 2XN licence and was in the process of installing new AWA equipment. The installation was being handled, Stan says, by Tom McNeil, and Stan's first assignment was to help finish the job.

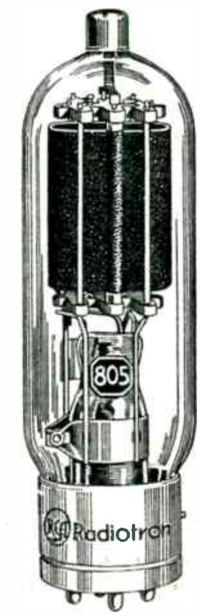

Fig.7: The RCA 805, a 125 watt transmitting triode which forced the PMG Department to re-think their guidelines on transmitter efficiency.

Unless I'm much mistaken, and despite the spelling discrepancy, my guess is that Tom McNeil is the same T.A.E. (Tom) McNeill I remember as the chief engineer of 2UW in the late 1930's and listed as an IRE member at the World Radio Convention in 1938.

Winston Muscio knew T.A.E. McNeill well, and says that Tom was dismayed by what he found at 2UW's inner city installation — the end product of an administrative decision. The base of the tower and everything bolted to it was apparently way above earth in terms of RF, and it was anybody's guess what the radiation pattern might have been.

Tom McNeill had first to convince management to reverse the decision, and then commission the new installation when he won the argument. Winston recalls that Tom faced a major problem with intermodulation involving other Sydney broadcasters and, for good measure, a problem with salt-laden moisture eating away the copper risers which connected the buried counterpoise to the base of the vertical mast.

But that aside, and getting back to 2LM, Lismore, Stan Tonkin's letter provides yet further evidence that the PMG authorities, along with the transmitting fraternity, was also clambering up their own learning curve. I quote from his letter:

The transmitter at 2LM was a brand new type using four 805 valves in the final. It was actually one of the first to use a class-B modulator and high-level (anode) modulation.

In those days, PMG regulations covering transmitter installations stated that, if suitable measuring equipment was not available, one could assume the final RF output to be 60% of the DC power input to the final stage.

As it happened, measuring equipment was available at 2LM and it showed that the final stage was operating at about 75% efficiency. This the Department refused to believe, and despatched a team of experts to Lismore to discover the reason for the anomaly.

Unfortunately for their peace of mind, their equipment showed that the efficiency was indeed 75%. Caught between their instruments and their regulations, they finally decided that the latter had to be sacrificed, which they effected by scrubbing out the 60%".

Out of curiosity, I looked up RCA's ratings for the 805 in their contemporary manual TT3: 'Air-Cooled Transmitting Tubes'. In plate modulated class-C telephony service, the typical maximum DC input per tube was shown as 1250V and 160mA, or 200W. For this, the rated RF power output was 140W, representing an efficiency of 70%.

Commenting on this, Winston Muscio — who, prior to retirement, headed up STC's transmitter Division — said that the ultimate efficiency of a class-C stage depends on the finer points of its design. 75% would have been entirely achievable and, in fact, in special cases he had seen figures approaching 90%. This startled me, I must confess, but my own experience with transmitters has been limited to the much less pretentious communications type equipment.

The technology of electronics never stands still! ❖

FORUM

Conducted by Jim Rowe

Persuading switch-mode supplies to generate fewer harmonics — and other topics

This month we have some more comments from readers about the challenge of suppressing the harmonics generated by switch-mode power supplies in things like compact fluorescent lamps and personal computers. There's also a further comment about the use of 'moisture inhibitor' sprays to rejuvenate printer ribbons, and a mildly critical follow-up letter on the subject of FM stereo demodulation by switching.

I guess the main topic this month has to be the one about techniques to reduce the harmonics in the mains current drawn by switch-mode supplies, judging from the number of letters that have turned up in response to our discussions in the September 1991 and January 1992 columns. So we'll devote most of our space to that one, but before doing so and to break things up a little, I'd like to present a couple of letters which talk briefly about other things.

First of all, you might recall that in the December column I presented excerpts from a number of letters sent in by people offering helpful explanations about the operation of switching-type FM stereo demodulators. One of those letters came from Mr Bill Metzenthen, of Ormond in Victoria, who had gone to quite a lot of trouble not only to provide a written explanation of the demodulation process, but also to provide a series of spectrum plots produced with the aid of a computer CAD program.

As it happened, I elected not to use a great deal of Mr Metzenthen's text, but I *did* reproduce a couple of his spectrum plots. The only trouble is that I also took a small liberty with one of them, using it to illustrate not what Mr Metzenthen had intended, but something different — which to my mind it also did rather well. But the astute Mr Metzenthen has caught me out, and in a follow-up letter seeks not only to chastise me for taking such a liberty, but also to offer some further helpful comments. Here's what he has to say:

Having just read the Forum column of the December 1991 issue, I would like to offer a few comments further to my letter of 26th June.

In my letter I stated: "I believe that unfortunately only a hand-waving version of the frequency domain picture can be grasped without invoking at least basic Fourier transform theory."

Indeed, the utility of Fourier transform theory for an electronics engineer should not be under-estimated. Many seemingly difficult results become almost trivial if one applies this theory. In particular, the factor of π/2 which arises in the FM multiplex demodulation process can be seen to be a simple consequence of the fact that the ratio of the DC component to the fundamental frequency component(s) of a square wave pulse train is π/2.

It appears that under the pressures of publication you have given an incorrect interpretation of my original figure 9. Figure 9 of my letter does not show the spectrum of the modulation process, but rather it shows part of the demodulation process. It is the spectrum corresponding to figure 7 of my letter, which is the result of switching the complete FM multiplex signal at a 38kHz rate. It is the form of signal which would be seen if one looked at the collector current of any of the transistors Q39-Q42 of Fig.3 of the June Forum.

The purpose of my figure 9 (which should be compared with figure 8) was to demonstrate that the signal contains both the L and R components, although the relative magnitude of one component (in this case the L component) is decreased (by about 13dB).

Your speculation about the possibility of directly demodulating the multiplex signal by sampling means is correct; if I may be permitted to quote once again from my earlier letter: "If you have your wits about you, you will have noticed that simply filtering the signal in figure 7 will not recover just the L signal. However if the signal is SAMPLED (at the mid-point of the 'on' period of the switching) and then filtered, then just the L signal will be recovered".

I apologise if I did not sufficiently develop the points which I made in my original letter, but as you will be aware it is often difficult to judge the depth of information which will neither bamboozle nor bore your audience.

Thanks for those comments, Mr Metzenthen. It looks as if I too must apologise, for having taken such liberties with your spectrum plots. No doubt it was particularly irksome to you, when at the same time I had used relatively little of your own text. However I can't claim 'pressures of publication' as my excuse, in this instance.

Deliberate sin

The decision to use your plot number 9 to illustrate the broad nature of an FM multiplex signal's spectrum was quite a conscious one, I'm afraid. I did realise that you'd produced the plot to illustrate the output of the switching *demodulator* before filtering, but it seemed to me at the time that it also served to show rather well (in a general sense, if not in specific detail) the spectrum for the output of a switching *modulator* — again before filtering. I'm still inclined to think so, to be honest.

I guess your further comments about Fourier transform theory are intended to answer my parting comments in the December column — about not quite understanding the reason for the π/2 factor in the demodulation process. Fair enough, too — I admit that my recollection of Fourier transform theory is now pretty flakey, partly because I never did really understand it in the true sense. Like most of my fellow students, I suspect, I grasped enough of it to pass the exams, but that was about all.

Mind you, I still believe that it really isn't enough, when you're trying to explain something, merely to quote a slab of the relevant maths — whether the maths concerned comes from Mr Fourier, Mr Maxwell, Mr Einstein or whoever. It's a pretty common approach, I know (especially among university and college lecturers), but to my mind it is rarely enough to provide a full understanding.

In my own case, I never feel that I have really grasped a concept unless I understand the physical side of it, as well as the maths. And if I only have the opportunity (or the capability) of understanding one or the other, I'd rather have the physical side any time. But I guess that's largely a matter of personality — and perhaps a function of my own rather limited skills in maths!

Finally, Mr Metzenthen, I note your reminder that you did in fact refer to the option of using sampling-type demodulation, in your original letter. I'm happy to acknowledge this (better late than never, I hope), and I had actually noticed it when I read your letter. But again there was a reason for not specifically mentioning it in the December column — rightly or wrongly, I thought it more significant to note that Carl Eilers and his Zenith colleagues had envisaged this method of demodulation, right back in 1961 when they were developing the FM stereo system.

Overall, I agree that it does look as if I was ignoring many of the valid and helpful comments you made in your original letter. This certainly wasn't my intention, though, and I'm sorry that you got this impression. I was and still am very grateful for your generous contribution.

Ribbon rejuvenation

And now let's pass to the next letter, which comes from a frequent contributor to this column: Mr Keith Walters, of Lane Cove in NSW. This time it has nothing to do with his pet topic of TV broadcasting standards, though; instead it's about the technique of using moisture-inhibiting and lubricating sprays to rejuvenate printer ribbons.

You may recall that in the 'Information Centre' column of the October 1991 issue, Peter Phillips ran a suggestion from one 'K.W.' of Lane Cove, regarding the use of CRC-226 and CRC 5-56 sprays for this purpose — but not advising the use of WD-40. Following that, we received a letter from Mr Garry Ridge, the MD of the WD-40 Company in Epping, NSW, claiming not only that WD-40 was very suitable for this purpose, but that this use for the sprays had originally been discovered by a WD-40 user. We published Mr Ridge's letter in the December issue, on page 5.

Well, as you've no doubt twigged by now, K.W. was in fact Keith Walters. And it seems that here too Mr Walters is keen to have the last word:

In response to Mr Ridge's letter about 're-inking' ribbons with CRC and WD-40, in the December issue, my original information now claims that the original newsletter's correspondent DID in fact specify WD-40 as the one to use, and that it was CRC that would gum up the works.

Now I know bloody well that that WASN'T what he said originally, and I'm sure he does too. He actually WATCHED me using CRC on a number of occasions without commenting on the fact.

But anyway, as was made quite clear in my letter, I was merely reporting what I had been told, and the results I obtained using this information. I happened to have some CRC on hand and it worked fine; I didn't see any reason to experiment with anything else.

I have nothing against WD-40, although I tend to prefer CRC, for no other reason than that I've always used it. Actually, I'm quite pleased that WD-40 is

[illegible]

also suitable, because you can buy that just about anywhere, while nobody seems to sell CRC any more.

But before Mr Ridge gets too comfortable, upon further investigation I've found no real difference in performance, for this application, between CRC, WD-40 and some real el-cheapo stuff I bought in one of those 'five and ten cent' stores down in the city. So Mr Ridge is quite right — WD-40 is perfectly suitable for this application, but so apparently is just about any other water-displacing aerosol lubricant!

The ribbon I'm printing this letter with has been treated with CRC for the third time, and as you can see there's heaps of life in it yet. The technique definitely works, and I think the information will be of great benefit to your readers.

One wonders why, if Mr Ridge knows so much about the subject, HE didn't take the time and the 43 cents to write in, 'many years' ago.

Fair comment from Mr Walters, I think, and that seems to clear up the subject fairly well. It certainly looks as if this kind of spray can be used to extend the life of cloth-type printer ribbons very significantly, even though WD-40 users (and distributors?) seem to have been keeping it a bit to themselves. Perhaps they didn't want to upset the printer ribbon makers — who no doubt haven't been all that keen for dot-matrix printer owners to hear about it.

Taming harmonics

With that topic out of the way too, let's return to the matter of switch-mode power supplies and their habit of generating harmonics on the mains, as a result of drawing current in short pulses. (Yes, I know that virtually all conventional linear supplies with a capacitor-input rectifier circuit tend to have the same problem, but in switch-mode supplies the problem tends to be worse due to their lack of a buffering transformer.)

As noted earlier, I've received a number of letters and faxes about this one, offering comments and helpful further information.

Actually one of the readers concerned is again Keith Walters, who offers his comments in a further letter, sent mainly to have another go at me about HDTV. But in his comments on fluoro lamps and harmonics, he begins by noting that another drawback of fluoro's is their peaky, non-white light output — which makes them generally unsuitable for film and TV production. He then continues:

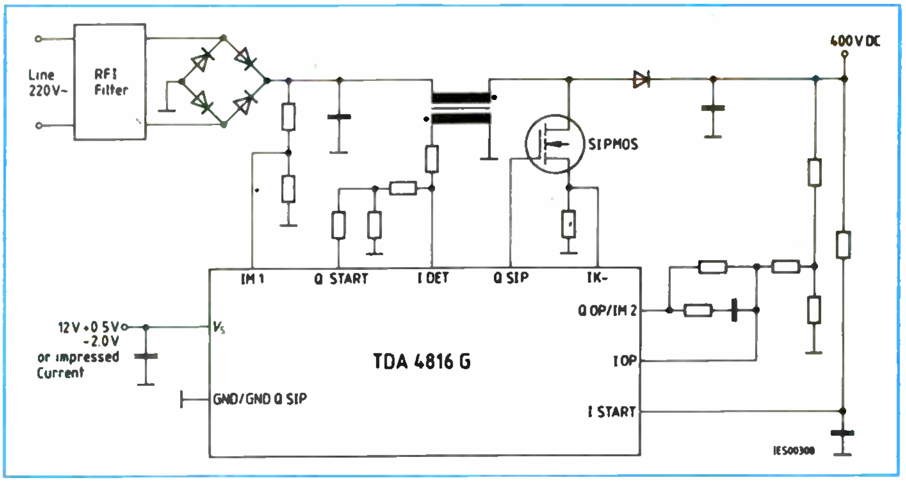

Fig.1: A basic switch-mode supply using the Siemens TDA 4816G chip, taken from that company's data. It converts the incoming AC into regulated 400V DC, with high efficiency and while also drawing a sinusoidal mains current...

For this reason, incandescent lighting is still the method of choice for the film and TV industries. However where really powerful lighting is required, they usually have to resort to mercury-discharge 'HMI' lights. These produce a visible spectrum reasonably similar to daylight, with much better efficiency than incandescent lamps.

Apart from their much higher power ratings, an induction-ballast HMI's circuitry is not all that different from that of a domestic fluorescent light — consisting of a gigantic iron-cored choke, a huge bank of power-factor correction capacitors, and a Tesla-coil ignitor arrangement. Their biggest drawback is that, being a gas-discharge lamp, their light is modulated at a 100Hz rate which causes strobing effects on film and TV cameras.

More recently there have appeared 'flicker free' HMI ballasts. These first convert the mains input to around 330V DC, then pass it through a switchmode constant-current supply to the lamp.

Until recently, flicker-free ballasts up to four kilowatts have used a simple bridge rectifier/large electrolytic type of power supply input. As you can imagine, this takes enormous 100Hz 'gulps' from the mains, causing problems with generators in particular.

For the new 12kW lights, such a power supply would simply not be a practical proposition, so a new type of power supply has been developed. In these, the mains input is rectified but not filtered. A high frequency flyback converter generates a 340V DC supply rail from the unfiltered input, the filter electrolytics being connected to the OUTPUT of the converter.

By means of a complex control circuit, the flyback converter is made to draw current from all parts of the rectified AC waveform, simulating the action of a purely resistive load.

At first glance this might not sound all that difficult, until you consider that with most switchmode power supplies, as the input voltage goes up the current drawn tends to go down — which is just the opposite of what is required. In the new lamp ballasts, not only does the power supply have to draw current in direct proportion to the input voltage waveform, it also has to figure out how to do it in such a way that it maintains a constant output voltage!

It would seem to me that if they continue to proliferate, all electronic mains power supplies will eventually have to incorporate circuitry similar to this. In the case of fluorescent light ballasts, I can't see that it would add all that much to the cost — basically requiring the IC, a high-voltage MOSFET, a high speed diode and another ferrite core.

Thanks for your comments, Keith. I hadn't realised that the harmonic problem existed with 'HMI' type lamps as well, nor had I heard of the new type of ballast scheme you describe. I tend to agree with you, that this type of circuitry will probably have to be incorporated into most electronic power supplies before long.

Chip data

Incidentally, Mr Walters also sent in data on a series of chips from the US maker Unitrode, which are apparently used in the HMI lamp ballasts to which he refers. Carrying the type numbers UC1854, UC2854 and UC3854, they are described as 'high power factor preregulators'. As Keith Walters suggests, they require relatively few external components (mainly a boost inductor, a high voltage power FET and a high-speed

[illegible]

diode), and according to the data they can achieve a power factor as high as 0.99, with less than 5% distortion of the line current waveform.

Another chip

Two other readers very kindly drew my attention to the existence of some chips produced by Siemens for the same purpose: the TDA4814/4816/4817, which are each described as an 'IC for Sinusoidal Line-Current Consumption'. From the Siemens data book, they seem to have been available in Europe at least since about the middle of 1990.

One of the readers who drew my attention to the Siemens chip was David Chambers, of Waterford in WA. The other was my former colleague Rex Callaghan, Technical Services Manager at Dick Smith Electronics, who very kindly also sent technical data on the TDA4814/4816/4817.

OK then, how do these chips work? As Keith Walters has pointed out, it's not a bad trick simultaneously to draw a sinusoidal current from the mains, while delivering a steady DC voltage to a load on the other side.

From the data sent in by Keith Walters and Rex Callaghan, it looks as if both the Unitrode and Siemens chips work in roughly the same fashion. The trouble is that neither of the sets of data sent to me seem to be particularly helpful in explaining exactly how they work.

Fig.1 shows a basic 'application circuit' for the TDA4816, taken from the Siemens data book. It's labelled as showing a configuration with a 'detector, free-running frequency and triangular-shaped choke current'. Fig.2 shows a second and somewhat more complex circuit from the same book, for an electronic ballast for fluorescent lamps. I reproduce it here not because it's easy to follow, but mainly because it reveals something of the fairly complex circuitry inside the TDA4814 chip itself.

Searching through the accompanying text, I can only find a few general clues about how the chips operate. The basic idea seems to be described as:

...a bridge rectifier followed by an up-converter. Through a controller action, it is possible to draw a virtually sinusoidal current from the single-phase line and produce a regulated DC voltage at the output.

In another section, we get somewhat more detail:

The operational amplifier can be wired as a control amplifier. It will then compare the divided output voltage Vq to a reference voltage Vref that is stable with temperature. The output voltage of the op amp that is produced in this way is multiplied by a sine-magnitude voltage in the multiplier (M). At the output of the latter a sine-magnitude voltage then appears, that is variable in amplitude. This nominal voltage is applied to the plus input of the comparator. The nominal voltage at the multiplier output can then be compared via the comparator to a voltage derived from the actual line current. The output of the comparator feeds the reference signal via a logic circuit to the driver that switches the SIPMOS transistor. No current gaps must appear in the choke, otherwise the line current would no longer be sinusoidal. To achieve that, the detector input I DET senses when the choke current has fallen to zero after the turn-off of the SIPMOS transistor. This ensures that the SIPMOS transistor does not turn on too early and that no current gaps occur.

Hmmm... Perhaps I'm getting even denser in my advancing age, but I find that little lot pretty confusing, I must confess. How about you?

Frankly I get the impression that either something's been lost in the translation from an original description in German, or else the Siemens engineers weren't too keen to explain exactly how their chips do work.

I guess the general impression I get is that the circuit seems to be working as a switch-mode stepup converter, in which the power FET is turned on and off at a

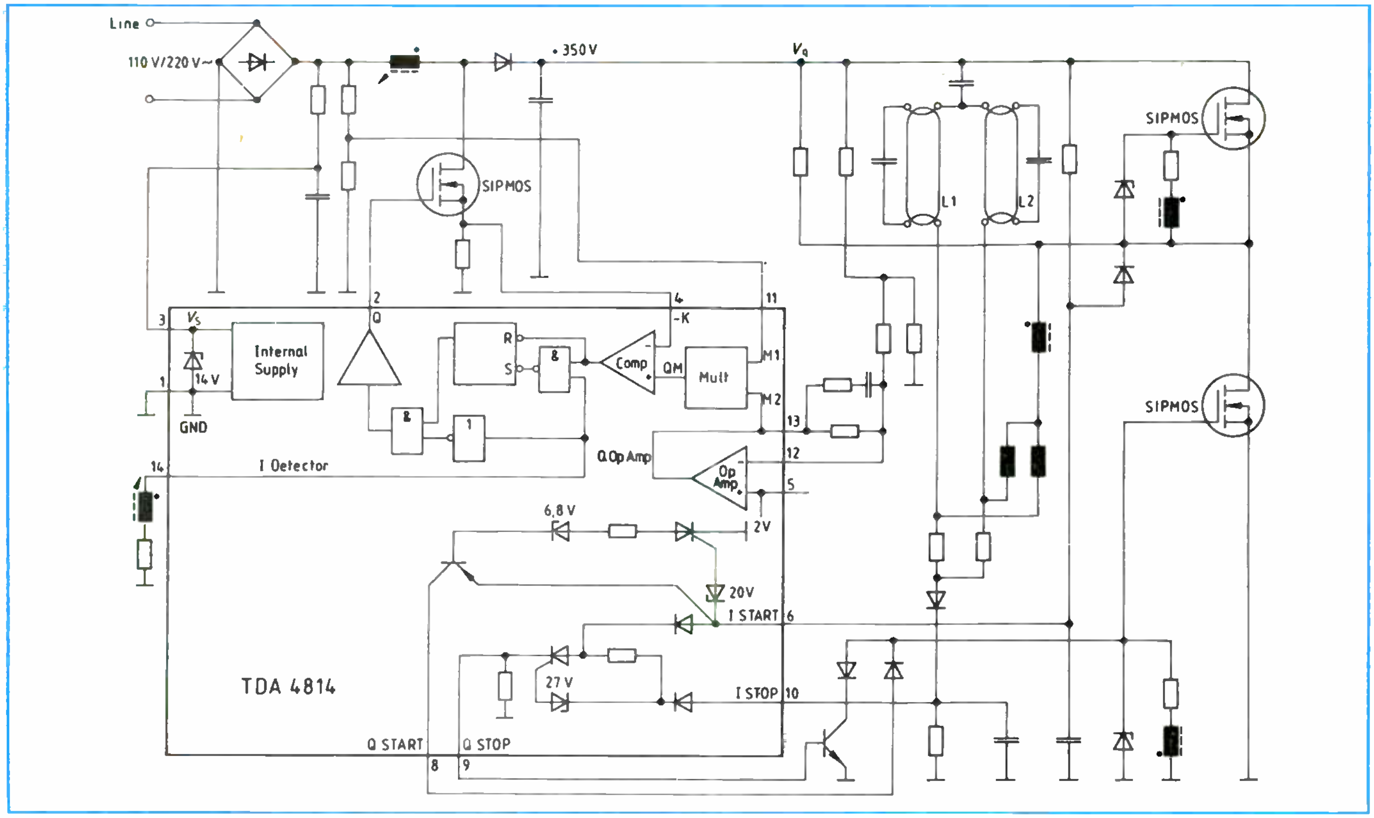

Fig.2: Another application circuit from the Siemens data, showing more of the circuitry inside the TDA 4814 chip. This is actually the circuit for an electronic ballast for fluorescent lamps, achieving a very high power factor.

[illegible]

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[illegible]

relatively high frequency, and with its conduction duty cycle controlled by the chip. The back-EMF in the series inductor is thereby manipulated, so that the series diode after the power FET feeds current pulses into the load to maintain a steady DC output voltage. But at the same time, the regulating action of the chip seems to be deliberately modulated by a 100Hz half-sinewave signal, derived from the output of the bridge rectifier at the input — so the actual current drawn by the converter varies up and down in synchronism with the unfiltered input.

It all sounds a bit too good to be true, somehow, although I don't doubt that the chips work. I just find it very difficult to visualise the exact operation of a switch-mode converter, whose input voltage and current are both heavily modulated at 100Hz in a half-sinewave fashion — while still delivering a steady DC output voltage.

Analysing the operation of this kind of circuit in detail sounds like something that would keep SPICE occupied for quite a while, even on a 486 running at 50MHz. I'd particularly like to see a plot of the varying waveform across that series inductor, during a complete cycle of the 100Hz half-sinewave — it must be quite interesting. Perhaps someone like Mr Metzenthen would like to run it through one of their fancy maths plotting packages, to show us what it actually looks like...

Anyway, even though the exact details of how they work are still a bit vague (at least to me), it's clear that chips capable of tackling the SMPS harmonic generation problem have been around for something like three years, from firms like Siemens and Unitrode. I'm grateful to Keith Walters and Rex Callaghan for drawing our attention to them.

Harmonic levels allowed

Incidentally both Rex Callaghan and David Chambers drew my attention to a table shown in the Siemens data book, showing the maximum percentage content of each of the significant line current harmonics allowable in Germany — as specified by Verband Deutscher Elektrotechnika, the German electrical standards association. I gather from Rex Callaghan that the VDE is one of the more active of the European standards bodies, whose standards are generally very carefully determined. Often the international IEC standards are closely modelled on those of the VDE, and of

Harmonics	Permissible harmonic content in %
3rd harmonic	$25 \times \frac{\lambda}{0.9}$
5th harmonic	7
7th harmonic	4
9th harmonic	3
11th harmonic	2
13th harmonic and higher	1

λ is the power factor

Fig.3: Taken from the Siemens book again, this table shows the permissible levels of AC line harmonics, relative to the 50Hz fundamental, allowed by Germany's Verband Deutcher Elektrotechnika in its standard VDE 0712. The Siemens chips apparently achieve these figures.

course Australia's standards are in turn generally aligned quite closely to those of the IEC.

I've reproduced the 'VDE 0712' table of harmonics here for your interest, as Fig.3. Note that Siemens claims its TDA4814/4816 achieves these specified levels of harmonic control.

More on resonance

I think we just have room for one more of the letters. This one is a further comment from Mr Frank Choate, of Amalgen Control Systems in Mortdale, NSW.

You may recall that I reproduced some of Mr Choate's comments in the January column, but expressed some confusion about his references to resonance problems arising from power factor correction. I was also intrigued by his reference to 'the dreaded seventh harmonic', and wondered why this particular harmonic seemed to have some special significance. Well, Mr Choate has responded by clearing up both points:

Resonant circuits can be a considerable problem in power factor correction, but parallel resonance at 50Hz is NOT the problem. A circuit power factor corrected to unity will be capacitive at any frequency above 50Hz, and this capacitance can resonate with transformer leakage inductances, stray wiring inductances or even deliberately included ripple blocking inductances — to form series tuned circuits at frequencies higher than 50Hz.

This is of no consequence if the voltages and currents present have only a 50Hz component. If harmonics are present, however, these harmonics may find a low impedance path through a series tuned circuit that includes the power factor correcting capacitor. This capacitor may already be carrying its full rated current at 50Hz, and the harmonic current could easily result in an overload of 100% or more.

There is nothing mystical about the seventh harmonic, except that it is frequently expected to be present and often seems to be over-represented in many power harmonic spectrums. A six-pole nonlinear load (full wave three-phase bridge, for example) is expected to have harmonic components of fifth, seventh, 11th, 13th, 17th and 19th and higher harmonics (given by NQ±1, where N = integer and Q = number of poles).

Harmonics need to be seen in perspective, in as much as we expect the amount of harmonic to diminish as the harmonic number increases (probably inversely proportional to the harmonic number). If the seventh is the same size as the fifth, say, we would see the seventh as the more difficult problem.

The reactance of any capacitor attached to the line is obviously smaller at higher frequencies, and hence the potential for overloading the capacitor is higher as the harmonic number increases — even if no resonance condition exists. If series resonance exists at or near to the frequency of a troublesome harmonic, serious overloading almost certainly will occur.

Even harmonics usually don't occur, and if they do it implies that the current profile drawn on the positive half-cycle does not match that drawn on the negative half-cycle. Even harmonics don't cause any particular problems for power factor correction, but can cause considerable problems for the driving transformers.

The cause of all this pain is the modern proliferation of semiconductor devices in the mains environment, and there are a number of solutions offered to clean up the 'mains pollution problem' in the tens of watts region. I know of no suggested 'cleanup at source' proposals for hundreds of kilowatts, although the same principles could apply.

Thanks for that further explanation, Mr Choate. I see now that I misunderstood your original point about resonance problems — I hadn't grasped that you meant resonance at or near harmonic frequencies. It all makes much more sense now, and you've made clear another reason why the authorities are concerned about harmonic generation.

And that's about all we have space for, this month. My thanks as usual to everyone who contributes to our understanding of these topics. ❖

your computer

[illegible]

[illegible]

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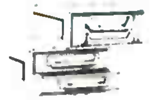

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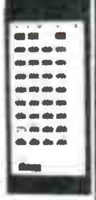

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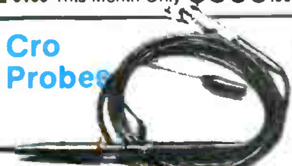
Cro Probes



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M 7112	6+6
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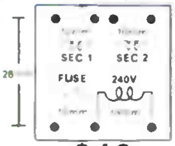
M 7130	15+15



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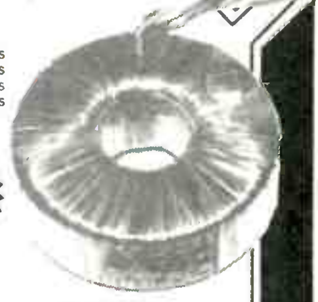

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Model	SEC. V
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M 3060	25+25
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M 3080	45+45

300VA

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Model	SEC. V
M 3085	12+12
M 3086	18+18
M 3088	25+25
M 3090	30+30
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M 3100	40+40
M 3105	45+45

500VA

Normally All $129.00

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Model	SEC. V
M 3120	30+30
M 3125	35+35
M 3130	40+40
M 3135	45+45
M 3140	50+50
M 3145	55+55
M 3150	60+60
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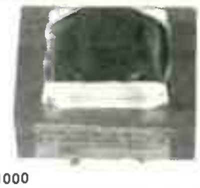
Impedance: 600 Ohm line/600 Ohm equipment **Turns Ratio:** 1:1



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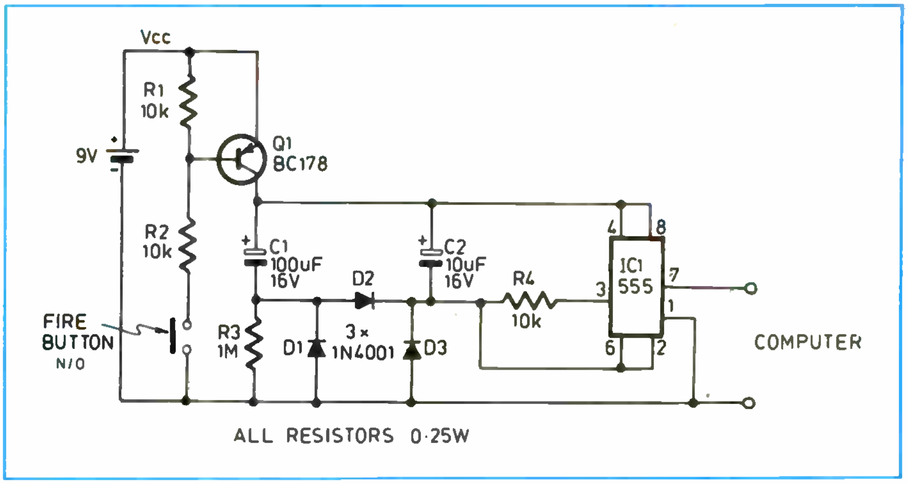
Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible for feasibility, the circuits have not been built and tested by us. We therefore cannot accept responsibility, enter into correspondence or provide further information.

Joystick fire button



If you add this circuit to your computer joystick, it produces an immediate one-shot when the fire button is pressed, followed by rapid fire if the button is kept depressed for more than one second.

The design is suitable for computers using a common negative in their joystick, e.g., Commodores etc. The circuit may be powered from the joystick port (see owner's manual) or from a 9V battery (no battery switch is needed as the fire button is normally open). Therefore, the unit is simply wired between the joystick and computer.

When the fire button is depressed, transistor Q1 switches on, which 'resets' IC1 (the 555). At this point, pins 2 and 6 of IC1 immediately go high. Pin 7 is connected to earth via an internal transistor in IC1, so this is equivalent to pressing the fire button on the actual joystick, and holding it down.

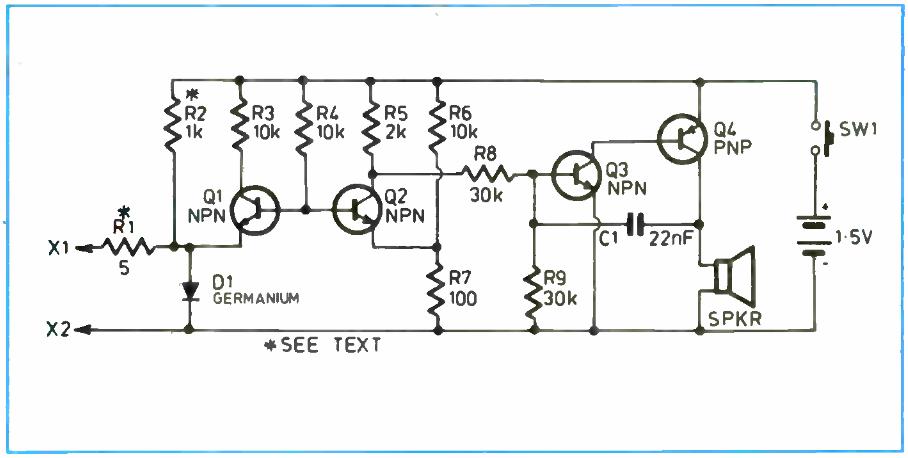
The two capacitors C1 and C2, acting in parallel as a single capacitor, now begin to charge through pin 3, which is low, and R4. As the capacitors charge, the voltage at pin 6 begins to drop, until it reaches less than 1/3V CC. Then the 555 is 'set', and the voltages at pins 3 and 7 are reversed — the computer thinks the 'fire-button' has been released.

Capacitor C2 now starts to discharge. (Diode D2 isolated C1, so its discharge path is only via the large 1M R3.) The discharge continues until the voltage at pin 6 reaches 2/3V cc, when IC1 is again 'reset'. The 555 now acts in astable mode, producing a series of 'fires'. So C1 and C2 determine the time between the initial one shot and the commencement of rapid fire.

Because C1 is much larger than C2, its value is effectively responsible for this period. C2 determines the rate of rapid fire. When you release the button, and Q2 turns off, diodes D1 and D3 discharge C1 and C2. Rapid fire ceases.

Phillip Foote,
Alexander Heights, WA. **$40**

Short/open detector



This simple short/open circuit detector enables you to detect a short circuit with resistance less than 10 ohms (and open circuit with resistance more than 10 ohms), in cables and printed circuit boards with and without mounted components.

The probe voltage of about 200mV is small enough to prevent any silicon diodes, transistors or ICs turning on, and interfering with the work of the detector. Also modern electronic circuits rarely contain resistors of less than 10 ohms.

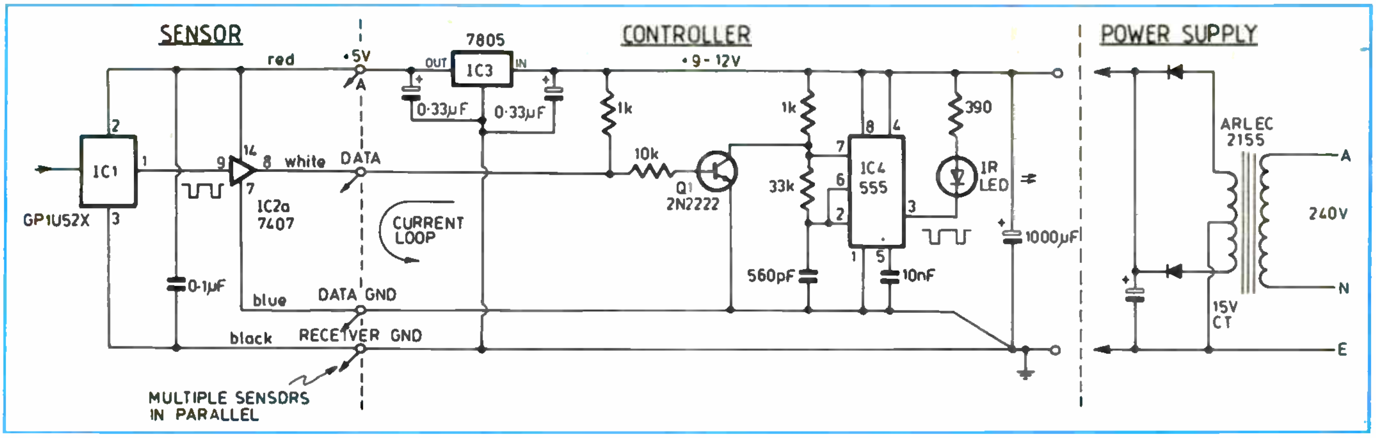
Transistors Q1 and Q2 form the common-base balancing stage of the circuit. The resistance between terminals X1 and X2, and resistors R1, R2, R6 and R7 make up a resistive bridge.

When the circuit resistance is high (more than 10 ohms), Q1's emitter potential is higher than the Q2's. So Q2 will conduct, and Q1 will not. The collector voltage of Q2 will go low, and this will turn off Q3. However, when the resistance between X1 and X2 goes low, Q1 will turn on and Q2 off. Then Q3 will turn on. Transistors Q3 and Q4, with the feedback from C1, form an oscillator, which drives an 8-100 ohm speaker at about 1000Hz. Changing the value of the capacitor will alter this frequency.

You can change the resistance threshold by changing R1 within the 0-20 ohm range, or increase or decrease the switching resistance threshold by varying R2.

The standby current for the circuit is about 2mA, and its supply voltage should be in the 1.25-3V range. But the detector will keep working even if the voltage drops below 1V. Any small-signal low-frequency transistors can be used, while D1 is a small-signal germanium diode. C1 should be a ceramic capacitor.

Dr Alex Belousov,
Sumgait, Azerbaijan, USSR. **$40**



Remote control extender

This system was designed to allow the remote control unit for a VCR to be used in a number of rooms — wherever there is a TV set. Thus the VCR could be used and controlled by the kids in the family room, or the adults in the bedroom, without affecting normal TV viewing in the lounge.

The aim was to keep the sensor units (of which there could be a large number) as simple as possible, even if this meant extra complexity at the VCR controller (where only one unit is required).

By using IC1 (Sharp GP1U52X), available with data sheet from Tandy for $7 (catalog number 276-137), the whole system has been kept very simple and gives excellent performance.

The chip is an infra-red receiver module which contains a photo diode, amplifier, limiter, band pass filter, demodulator, integrator and a TTL-compatible Schmitt-trigger output. The filter's pass band is centred on 40kHz, but is broad enough to respond from 35-45kHz.

2-pair telephone cable is used to connect up all the sensors, which are simply wired in parallel at point A.

The red/black pair carries 5V power to the sensors and the white/blue pair is a current loop which carries the data. The use of two separate ground wires is recommended, even if not strictly necessary — it keeps the data out of the receiver's power supply.

The output of the IC1 sensor goes low when the 40kHz carrier is detected, and this signal is fed to IC2a, an open-collector buffer. I used 7407s rather than build a circuit from discrete components, even though only one of the six buffers on each chip is needed. IC2a pulls the data line low. Of course, the IC2a buffer in any of the sensor units can pull the line low.

At the VCR end we have IC4, a 555 oscillator, which is normally disabled by Q1 which is conducting. When the current loop is completed by any of the sensors, Q1 is cut off. The oscillator regenerates the carrier and drives an IR LED which is coupled to the VCR's own sensor. I used a LED from Tandy, catalog number 276-143. The values shown will give a frequency close to 40kHz, which seems to be typical. If this frequency needs to be altered to suit your VCR, trim the 33k resistor between pins 6 and 7 of IC4.

Power could be supplied by a 9V DC plugpack, since IC3 (7805) produces the required 5V supply. But plugpacks tend to be inefficient and run quite warm, even with no load. Since this circuit will be operating continuously, this would represent a significant waste of energy. A simple alternative power supply is shown.

The use of a current loop to transmit the data also lends itself to computer control of the VCR for audio/visual presentations, with extra IR LEDs inserted in series to control other equipment such as a cassette deck or a compact disc player.

Graham Leadbeater,
Ringwood, Vic. **$50**

Audible logic probe

This circuit gives an audible indication of the logic state of a signal being tested, as well as providing visible readout via green and red LEDs.

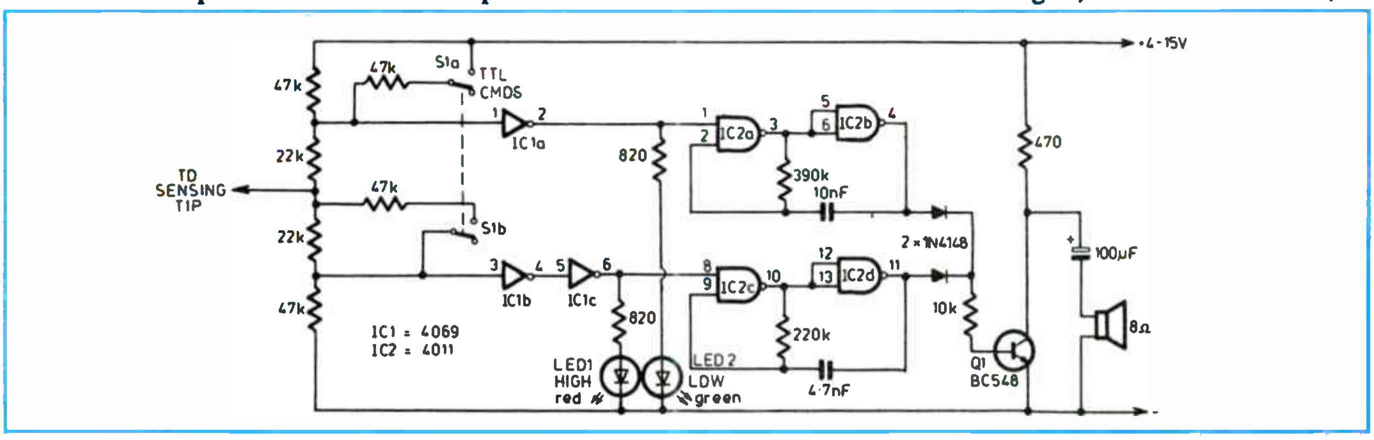
IC1 (4069) provides the level detection circuitry, while IC2 (4011) produces two different audio frequencies. Switch S1 allows the unit to work for both CMOS and TTL. A low signal on the sensing tip will change the state on IC1a. When the output goes high it enables the low frequency multivibrator built around IC2a and IC2b.

The output of the oscillator, via the diode OR gate, then switches transistor Q1 on and off and hence drives the speaker.

If a high signal is sensed, the normally low input to IC1b goes high, and its output is further inverted by IC1c to enable the high frequency multivibrator based on IC2c and IC2d.

No input, or a bad signal level, causes no sound.

Alister Huf,
Tarrington, Vic. **$35**



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Construction project:

Low cost 30+30W stereo amplifier

If you need a hifi amplifier with first class performance, but *don't* want to pay for loads of power that you'll never really use, this project should be ideal. It offers excellent noise and distortion figures, a power output of around 30W per channel, and a generous range of features.

by ROB EVANS

Regular readers of *Electronics Australia* may notice that the schematic diagram of this 'new' amplifier looks remarkably familiar. That's indeed the case, since the circuit first appeared in the August 1988 issue of the magazine, when we presented the then-new Playmaster 30-30 amplifier.

All in all, its low cost and impressive performance made this a popular construction project amongst *EA* readers, with a large number of units being built over the years.

To put it bluntly though, the case was a bit of a pest. In the interests of keeping the parts cost down at that time, we elected to use an off-the-shelf 'Horwood' brand instrument box which was small, neat and reasonably cheap. Unfortunately, there was quite a deal of work involved in bringing the case up to an (aesthetically) acceptable form, and it didn't lend itself to being pre-punched and silk screened by the kit manufacturers.

Consequently, kits for the Playmaster 30-30 were rather scarce, with only Dick Smith Electronics selling a 'short form' version — which included all of the essential parts and left the case details up to the constructor.

As it turned out, DSE sold a substantial number of these kits, and also handled a steady stream of queries regarding a suitable box.

Recognising the interest in a modestly-powered, yet high-quality hifi amplifier, the kit department at DSE has taken considerable effort to produce a complete new kit for the 30-30, which now includes a very nicely prepared rack-mount style box.

The case itself has an attractive black anodised finish with all holes pre-punched, has a silk screened front panel, and even staked-in threaded bushes for the case mounting screws — no nasty cross-threaded self-tapping screws here. In short, it's a very neat job.

The other aspects of the kit haven't been neglected of course — it also comes with every part you'll need to complete the amplifier, right down to the last nut, screw and washer. DSE have even sourced a neat set of black toggle switches with flat 'paddle' type actuators, to help give the amp a more attractive appearance.

So if it suits your needs, pop down to the nearest DSE store and check out the *new* Playmaster 30-30.

The full kit is available for $249, which surely represents excellent value for an amplifier of this calibre.

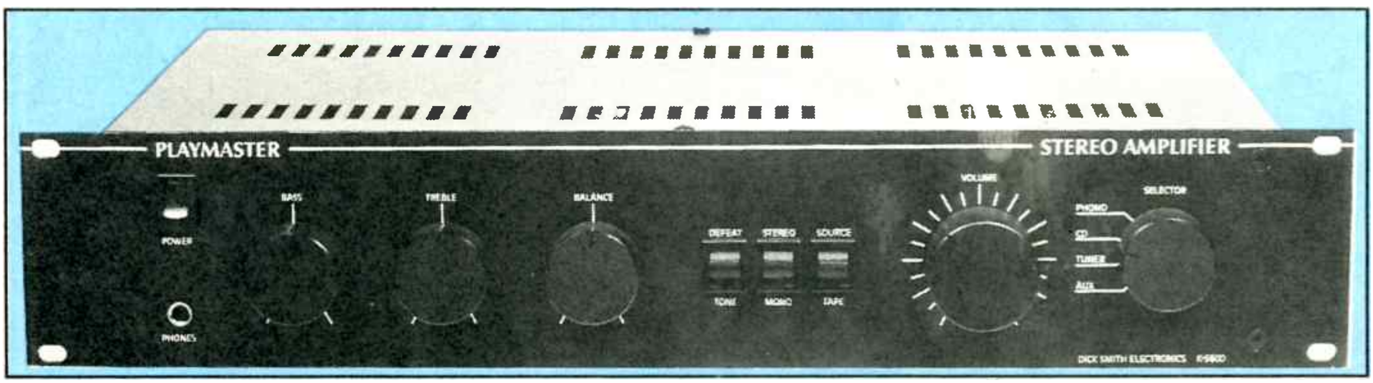
The circuit

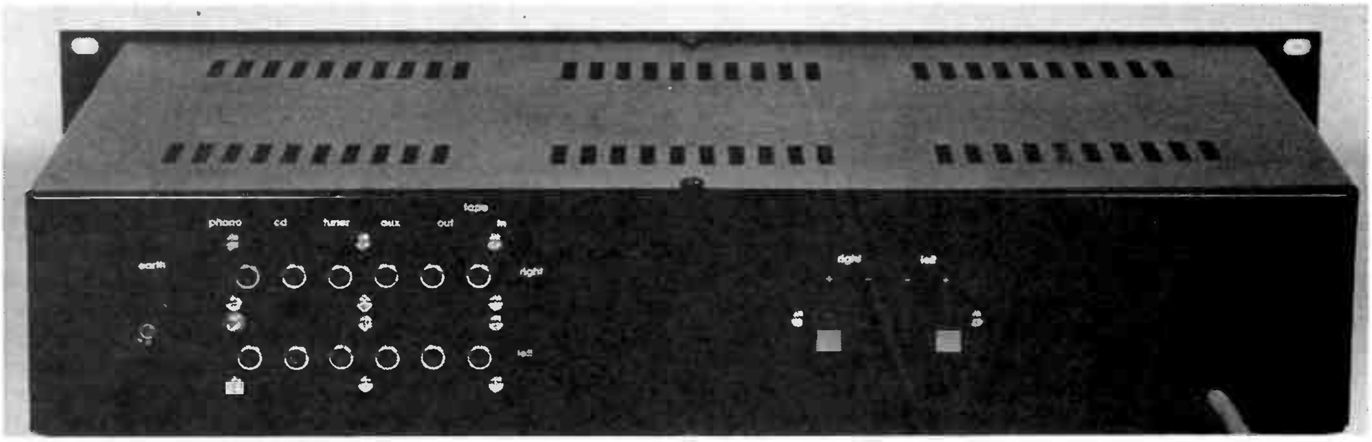
The performance of the 30-30 is really based on the capabilities of a very effective integrated power amplifier chip from Philips — the TDA1514A. This remarkable little beast offers a maximum power output of around 40W RMS, a 10V/us slew rate, very low noise and distortion levels, and built-in protection and muting circuits.

The chip's protection circuit will shut off the audio path if the chip exceeds its rated operating temperature, if the output stage is attempting to work outside its safe operating area (SOAR) curve, or if power has just been applied to the circuit (in other words, it has a power-on 'de-thump' feature).

Thanks to the capabilities of the TDA1514A, the overall circuit for the Playmaster 30-30 is quite simple — it's effectively based around just four ICs: three for the preamp (ICs 1,2 and 3), and one for the power amp stage (IC4).

Since a very detailed explanation of the circuit's operation was included in the original August 1988 article, we'll just stick with a general description here. For those who really want to know the nitty gritty of how each stage works, we suggest that you refer back to that previous issue of *EA*.



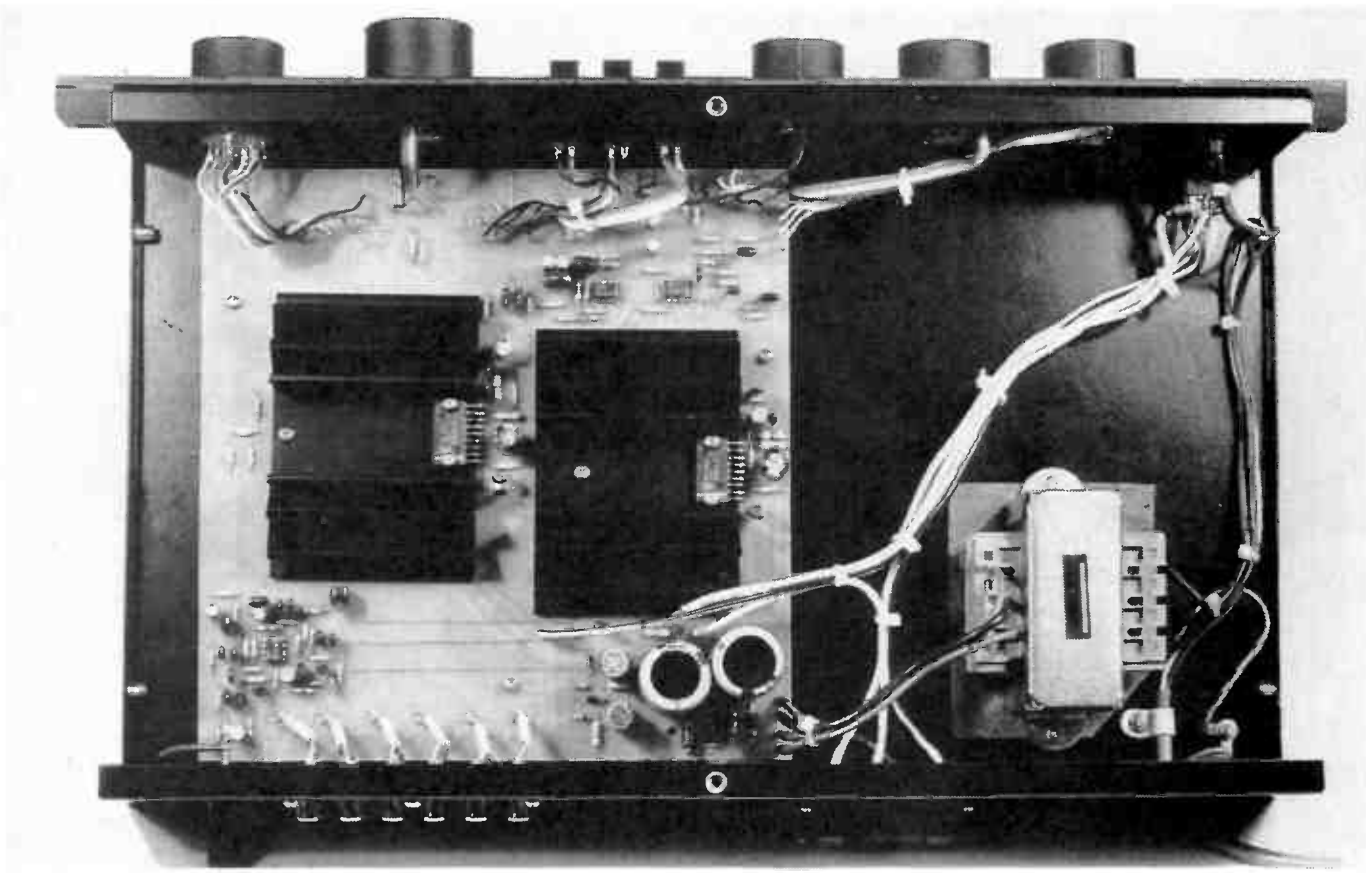


The rear panel sports the usual range of inputs, sockets and a set of speaker terminals. All chassis holes in the DSE kit are pre-punched to fit the various parts.

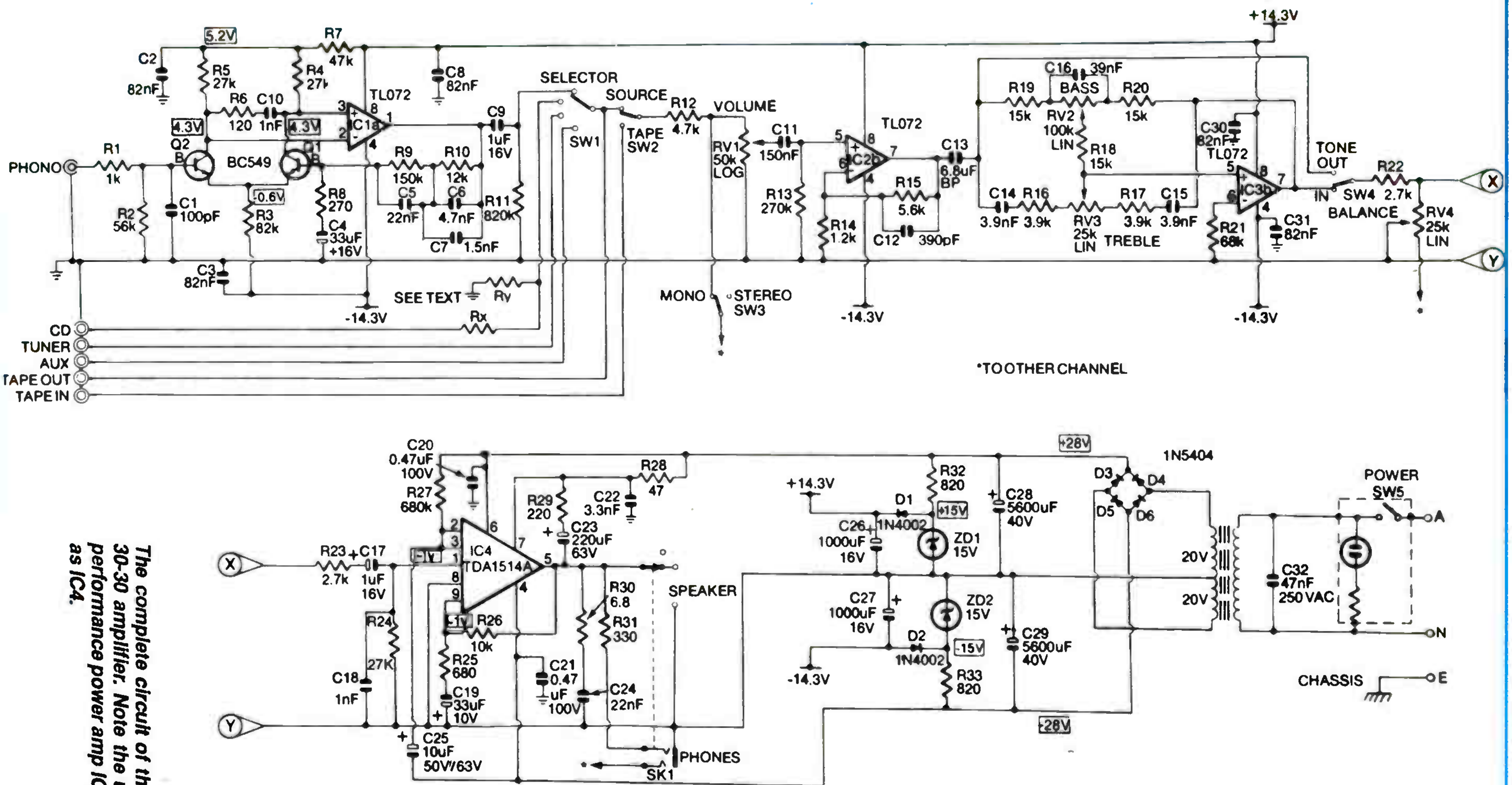
As mentioned, the power amplifier stage is based around the TDA1514A high performance power amp chip, which is shown as IC4 in the circuit diagram.

Its associated components set the closed- loop gain to around 16, provide the timing for the signal muting action, filter the input signal, provide output boot-strapping, and generally ensure the IC's high frequency stability. Its output signal is applied either directly to the speaker terminals or to the headphone socket, depending upon the switching action of SK1. The power supply section is quite conventional, where a bridge rectifier (D3 to D6) feeds the main filter capacitors (C28 and C29), which in turn supply the +/-14.3V preamp supply formed around zener diodes ZD1 and ZD2.

The phono preamp stage is based around two transistors arranged as a high-gain differential pair (Q1 and Q2), which are directly coupled to the summing amplifier IC1a. The combined open loop gain is controlled by the overall feedback network formed by R8 to R10 and C5 to C7, which results in a transfer function complying to the standard RIAA equalisation curve. All of the main signal sources, including the phono preamp's output, are then applied to the selector switch SW1, which passes the desired signal to the volume control RV1. The tape/source switch (SW2) disconnects the selector switch and applies the tape playback signal directly to the volume control, while the mono switch (SW3) simply bridges the amp's left and right channels.



A bird's eye view of the 30-30's internals. Note how the heatsinks for the power amp ICs occupy a large section of the PCB real estate.



The complete circuit of the Playmaster 30-30 amplifier. Note the use of a high performance power amp IC, shown here as IC4.

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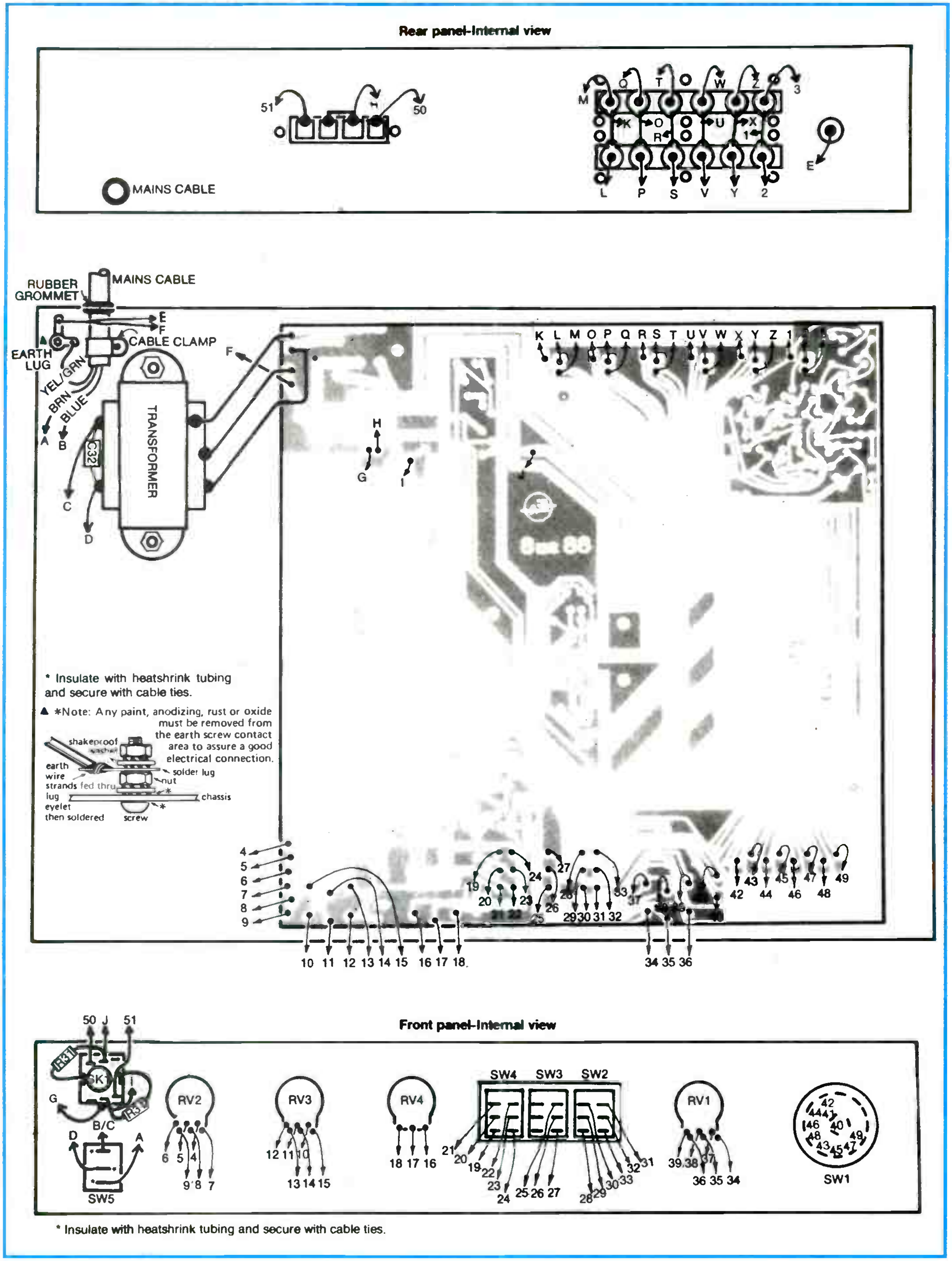
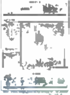


The amplifier's main wiring diagram. Carefully follow this arrangement when completing all of the amp's internal wiring.



30+30W amplifier

The signal from the volume control is then fed to opamp IC2a, which is set to a gain of around 6 by its feedback components. This stage offers a high loading impedance to RV1, yet a low output (source) resistance for driving the following circuitry.

When the tone in/out switch (SW4) is in the 'out' position, the power amp is driven directly from the output of IC2b via the balance control circuit (R22 and RV4). On the other hand if the switch is at the 'in' position, the tone control stage based around IC3b will then feed the power amp, allowing the bass and treble controls to determine the final sound.

The tone control circuitry is formed by a standard 'Baxandall' feedback network, which controls the gain and frequency response of IC3b — RV2 (bass) and RV3 (treble) alter the balance of this network for the required tonal effect.

Construction

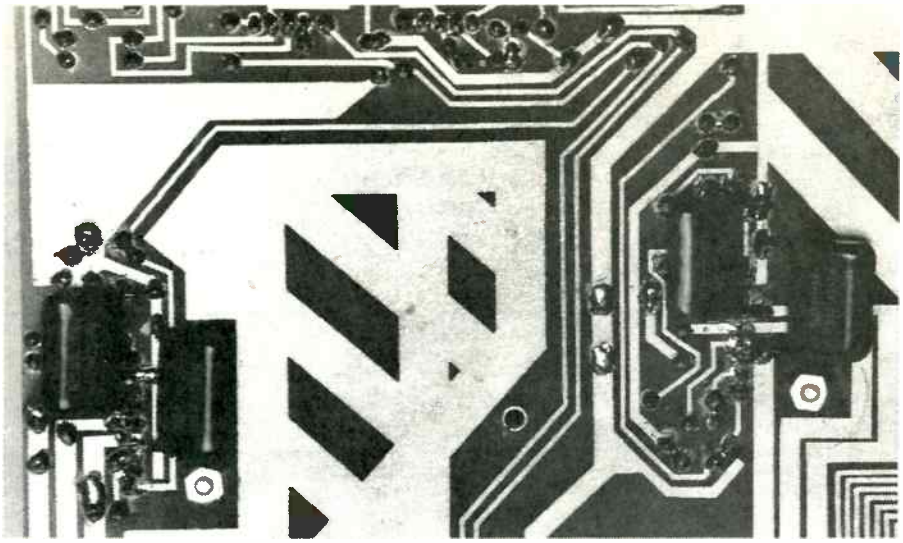
As you can see from the pictures of the amp's internals, most of the parts (including the heatsinks) mount on one large printed circuit board (code 88sa8), which has connection points around its perimeter for the various external components.

This arrangement helps to make the construction process quite straightforward. The only fiddly job is wiring up the front panel controls and input sockets, which connect to the PCB via short lengths of 'rainbow' wire and shielded cable, respectively.

Begin the construction by installing the PCB components as shown in the component overlay diagram. Start with the lower profile parts such as the resistors and wire links, and work your way through to the larger items — while taking particular care with the orientation of any polarised components (semiconductors and electrolytic capacitors).

Note that there are 13 links on the PCB, including three long connections between the power supply and the phono stage — these should be physically taut or constructed from insulated wire, so as to prevent contact with nearby parts. Also, this is an appropriate time to fit the PCB pins to each of the board's external connection pads, as shown on the overlay and wiring diagrams.

Before fitting the three opamps (IC1 to IC3), check that they are in fact the TL072-type, rather than the nominally equivalent LF353. According to the technical people at DSE, if LF353 opamps are installed the amplifier tends to produce an annoying thump through the speakers, when power is first applied. Presumably, these opamps have not yet stabilised by the time the TDA1514A's turn-on muting has 'timed out'.



An underside view of the PCB, showing how the power amp IC supply bypass capacitors are installed. Ideally, they should have very short leads and be mounted as close to the IC pads as possible.

On with the construction...

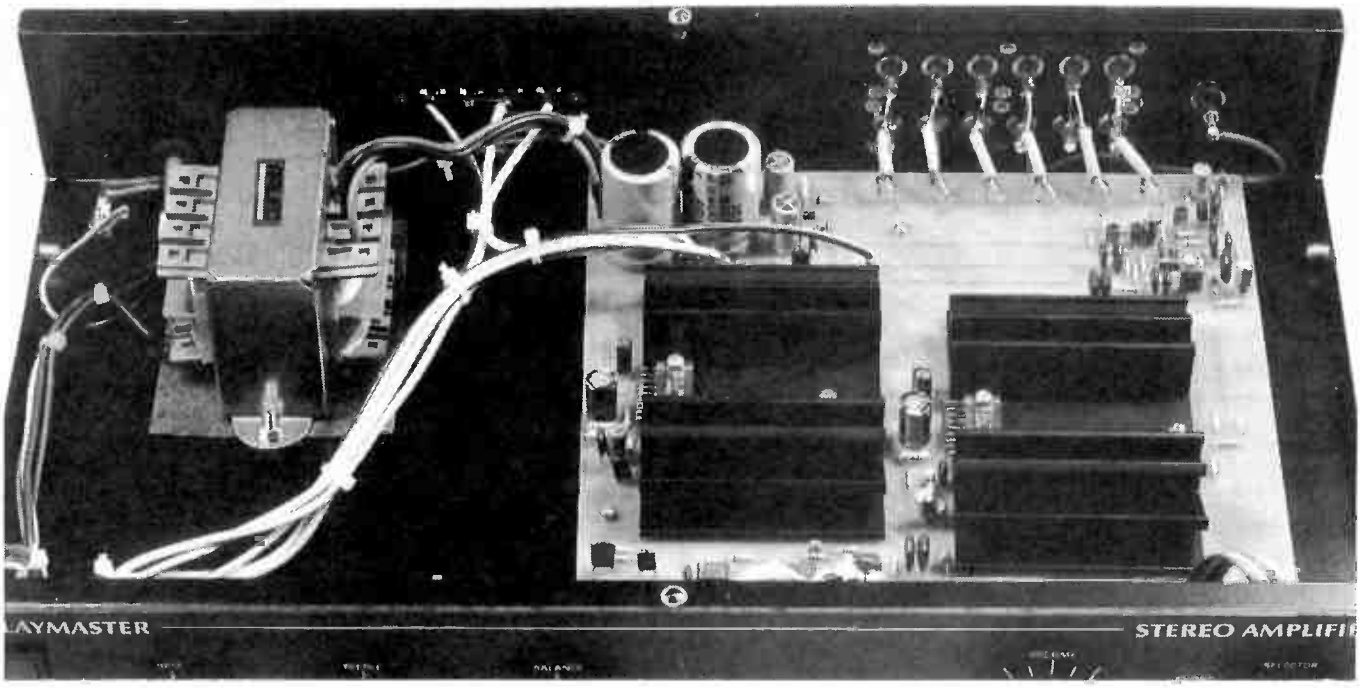
All resistors can be mounted flush with the PCB, except those with a higher power rating such as R28 to R33 — which should be positioned slightly above the circuit board surface so as to assist air flow and promote cooling. Conversely, the large power supply filter capacitors should be pushed fully down onto the PCB surface, which will provide a firm and stable mounting base.

By the way, the resistors marked as Rx and Ry in the diagrams act as an attenuator for the CD signal, and reduce that input's nominal sensitivity to around 2V when the supplied values are installed (47k and 6.8k respectively).

SPECIFICATIONS

Performance of prototype

	One channel	Both channels
Power output		
4 ohms	42W	32W
8 ohms	28W	26W
Dynamic power (IHF-A-202)		
4 ohms	56W	48W
8 ohms	38W	38W
Harmonic distortion		
8 ohms	0.025% at 25W	
4 ohms	0.065% at 25W (Typically less than 0.015% at normal listening levels)	
Frequency response		
Phono input	RIAA/IEC equalisation within +/-0.5dB (30Hz to 20kHz)	
Line inputs	+0/-1dB from 20Hz to 20kHz	
Hum and noise		
Phone input	-76dB unweighted (ref: 10mV/1kHz, terminated in typical MM cartridge)	
Line inputs	-91dB unweighted (ref: 250mV/1kHz)	
Damping factor	Approximately 80 (8 ohm load)	
Channel Separation (ref: 28W output)		
100Hz	-83dB	
1kHz	-72dB	
10kHz	-54dB	
Input sensitivity (ref: 28W output)		
Phono input	4mV (overload at 1kHz: 150mV)	
Line inputs	250mV	
CD input	2V (as set by optional pad resistors)	
Tone controls		
Bass	+/-12dB at 60Hz	
Treble	+/-12dB at 16kHz	



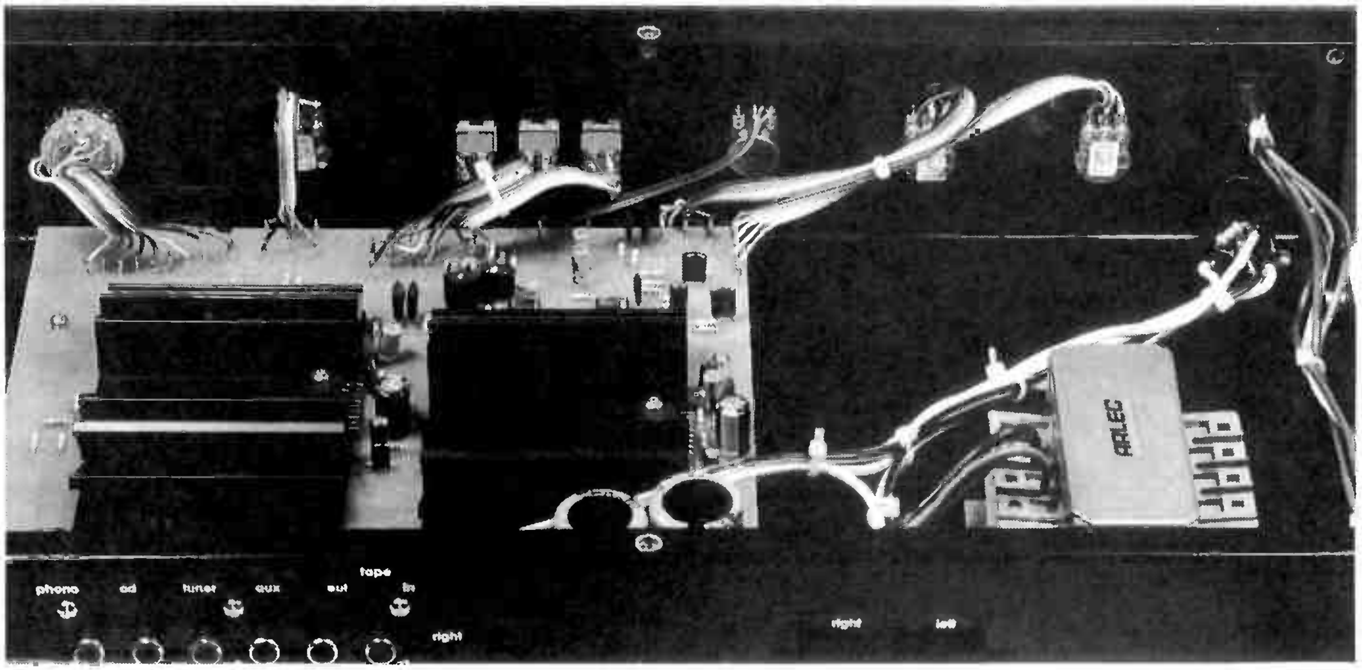
Note the square section of heavy duty paper insulator mounted under the power transformer. This insulates the 240V primary connections from the chassis, and prevents the panel from buzzing against the transformer's body.

Note that the PCB has a narrow track between the pads of Rx — this must be cut when Rx is fitted. Otherwise, if you're using a CD player with an unusually low output level, these resistors can be omitted and the section of track left intact.

Next, carefully install all of the semiconductors, finishing with the TDA1514A power amplifier chips (IC4) and their matching heatsinks. The best method for fitting the power amp ICs is to first bend the legs at right angles (at about 5mm from the chip's body), then smear both the heatsink and IC with thermal grease at their contact points, and *loosely* bolt both units to the PCB.

Finally, move the heatsink around until it is well clear of IC4's legs and any nearby components or PCB pins, then tighten the mounting bolts and solder the IC's legs in place. Note that the metal mounting face of the TDA1514A chip is internally connected to its negative supply rail (pin 4), which allows the heatsink to adopt the same potential when the two are bolted together. This in turn means that the heatsink *must not* come into contact with any other components or wires — keep this in mind also when you're testing the completed amplifier.

The final step in completing the PCB assembly is to fit the four 0.47uF power supply bypassing capacitors (C20 and C21 on each power amp IC), which are installed underneath on the *copper* side of



All of the front panel controls are connected to the PCB via lengths of 'rainbow wire', which makes for a neater job.

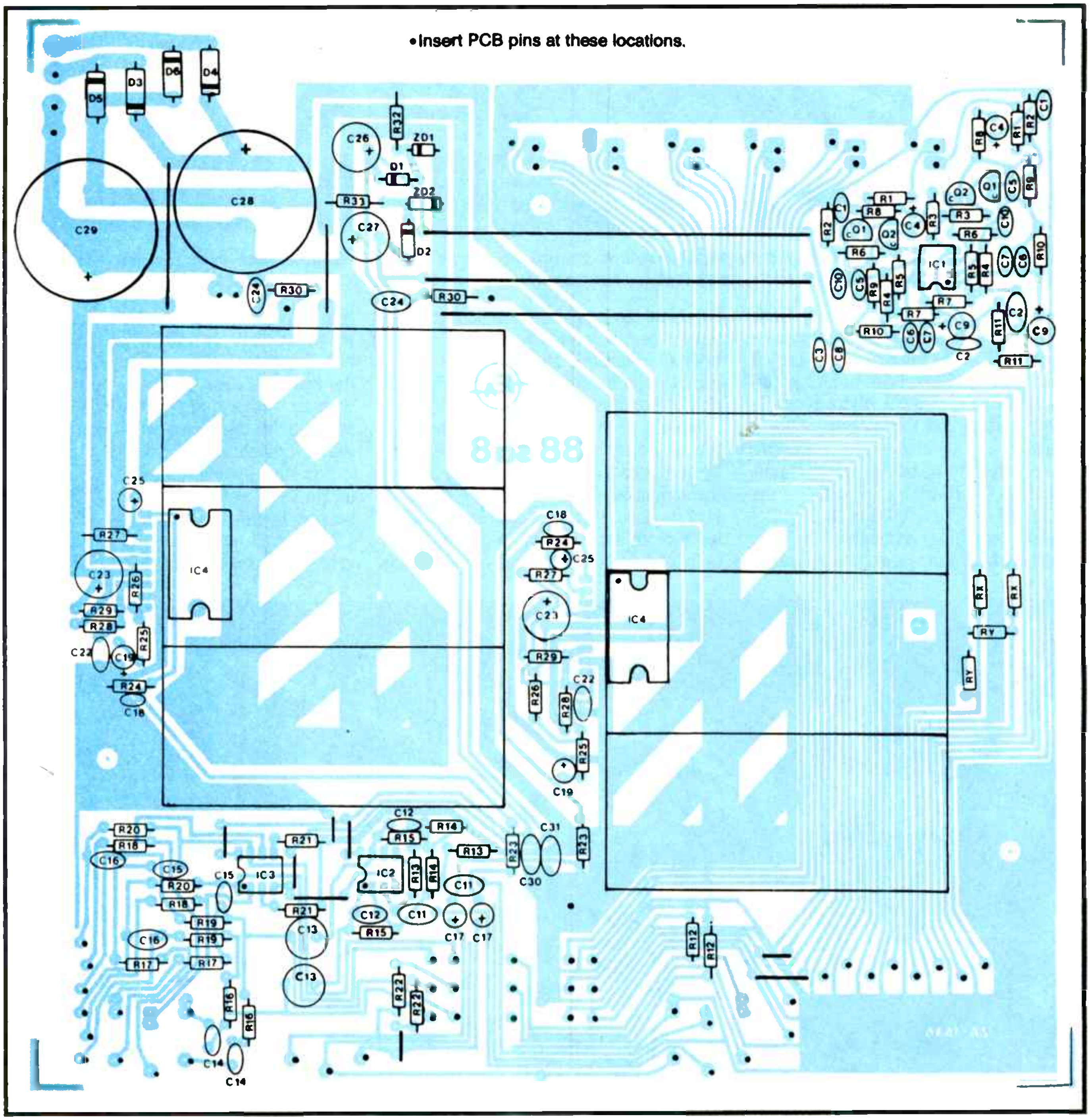


the board. They connect to IC4's PCB pads, and must be mounted as close to the chip as possible, as shown in the associated photo of the underside of the completed board assembly. Don't forget to fit these capacitors, since the high bandwidth and slew rate of the TDA1514A chips may induce some instability if they are omitted.

Once you are happy with the construction of the PCB assembly, it can be installed in the case in preparation for the amp's final wiring. Check that the heatsink screws don't protrude further than the length of the supplied spacers (if this was so, the ends of the screws would come into contact with the bottom of the case), then install the spacers and the board assembly.

Now all of the amp's remaining parts can be fitted to the case, and connected as shown in the various wiring diagrams.

Before fitting the transformer, fit C32 and two lengths of mains-rated wire (C and D) to its primary winding terminals, as shown in the wiring diagram. The capacitor can be mounted on top of the transformer's lower insulating cheek, with its leads passing through the two vacant inner holes. Insulate the exposed connections with heatshrink tubing, and bolt the transformer in place with the supplied piece of 'elephant hide' fibre sheet acting as an insulator. Use serrated washers on the mounting bolts for a reliable electrical contact, and position the insulating sheet as shown in the shot of



When installing components in the PCB, accurately follow this component overlay — take particular note of the orientation of the polarised components.

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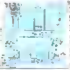

PARTS LIST

Resistor (All 1/4 unless specified)

R1.R1	1K (brn-blk-red)	☐
R2.R2	56K (grn-blu-org)	☐
R3.R3	82K (gry-red-org)	☐
R4.R4	27K (red-vio-org)	☐
R5.R5	27K (red-vio-org)	☐
R6.R6	120 (brn-red brn)	☐
R7.R7	47K (yel-vio-org)	☐
R8.R8	270 (red-vio-brn)	☐
R9.R9	150K (brn-grn-yel)	☐
R10.R10	12K (brn-red-org)	☐
R11.R11	820K (gry-red-yel)	☐
R12.R12	4.7K (yel-vio-red)	☐
R13.R13	270K (red-vio-yel)	☐
R14.R14	1.2K (brn-red-red)	☐
R15.R15	5.6K (grn-blu-red)	☐
R16.R16	3.9K (org-wht-red)	☐
R17.R17	3.9K (org-wht-red)	☐
R18.R18	15K (brn-grn-org)	☐
R19.R19	15K (brn-grn-org)	☐
R20.R20	15K (brn-grn-org)	☐
R21.R21	68K (blu-gry-org)	☐
R22.R22	2.7K (red-vio-red)	☐
R23.R23	2.7K (red-vio-red)	☐
R24.R24	27K (red-vio-org)	☐
R25.R25	680 (blu-gry-brn)	☐
R26.R26	10K (brn-blk-org)	☐
R27.R27	680K (blu-gry-yel)	☐
R28.R28	47 1/2W (yel-vio-blk)	☐
R29.R29	220 1/2W (red-red-brn)	☐
R30.R30	6.8 1/2W (blu-gry-gld)	☐
R31.R31	330 1/2W (org-org-brn)	☐
R32	820 1/2W (gry-red-brn)	☐
R33	820 1/2W (gry-red-brn)	☐
Rx.Rx	47K (yel-vio-org)	☐
Ry.Ry	6.8K (blu-gry-red)	☐

Capacitors

C1.C1	Ceramic 100pF/101K	☐
C2.C2	Greencap .082uF/82nF/823K	☐
C3	Greencap .082uF/82nF/823K	☐
C4.C4	Electro 33uF/16/25/35V	☐
C5.C5	Greencap .022uF/22nF/223K	☐
C6.C6	Greencap .0047uF/4.7nF/472K	☐
C7.C7	Greencap .0015uF/1.5nF/152K	☐
C8	Greencap .082uF/82nF/823K	☐
C9.C9	Electro 1uF/16/50V	☐
C10.C10	Greencap .001uF/1nF/102K	☐
C11.C11	Greencap .15uF/150nF/154K	☐
C12.C12	Ceramic 390pF/391K	☐
C13.C13	Electro B/P 6.8uF/50V	☐
C14.C14	Greencap .0039uF/3.9nF/392K	☐
C15.C15	Greencap .0039uF/3.9nF/392K	☐
C16.C16	Greencap .039uF/39nF/393K	☐
C17.C17	Electro 1uF/16/50V	☐
C18.C18	Greencap .001uF/1nF/102K	☐
C19.C19	Electro 33uF/16/25/35V	☐
C20.C20	Greencap .47uF/470nF/474K	☐
C21.C21	Greencap .47uF/470nF/474K	☐
C22.C22	Greencap .0033uF/3.3nF/332K	☐
C23.C23	Electro 220uF/63V	☐
C24.C24	Greencap .022uF/22nF/223K	☐
C25.C25	Electro 10uF/63V	☐
C26	Electro 1000uF/16V	☐
C27	Electro 1000uF/16V	☐
C28	Electro 5600uF/40V	☐
C29	Electro 5600uF/40V	☐
C30	Greencap .082uF/82nF/823K	☐
C31	Greencap .082uF/82nF/823K	☐
C32	Mains cap .047uF/250 VAC	☐

Semiconductors

D1	1N4002/1N4004	☐
D2	1N4002/1N4004	☐
D3	1N5404	☐
D4	1N5404	☐
D5	1N5404	☐
D6	1N5404	☐
Q1.Q1	BC549	☐
Q2.Q2	BC549	☐
ZD1	1N4744 15V 1W	☐
ZD2	1N4744 15V 1W	☐
IC1	TL072/LF353	☐
IC2	TL072/LF353	☐
IC3	TL072/LF353	☐
IC4.IC4	TDA 1514A	☐

Hardware

RV1	50K DG Log pot	☐
RV2	100K DG/Lin pot	☐
RV3	25K DG/Lin pot	☐
RV4	25K SG/Lin pot	☐
SW1	SW rotary 3 pol 4 pos	☐
SW2	DPDT lever action switch	☐
SW3	DPDT lever action switch	☐
SW4	DPDT lever action switch	☐
SW5	Rocker SW SPDT illuminated 240V 6 amp	☐
SK1	SKT 6.5mm stereo DPST	☐

Miscellaneous

1 x PCB ZA-1646, 1 x transformer 20-0-20V 2.5 amp, 1 x pre-punched metal case and cover, 1 x pre-punched and silk screened front panel, 1 x rear panel label, 2 x heatsinks, 1 x mains cable and plug, 1 x 4 way speaker terminals, 2 x RCA 6 way panel mount sockets, 1 x banana socket, 4 x 33mm black knobs, 1 x 40mm black knob, 72 x PCB pins, rubber feet, cord clamp, cable ties, silicon grease, spaghetti tubing, insulating paper,spacers, solder lugs, rubber grommets, solder, tin/cu wire, rainbow cable, hookup wire, SC2/A shielded cable, screws, nuts and washers.

the amp's internals. Take similar care when fitting the main earthing lug. It should be installed with the correct number of nuts and washers as shown in the wiring diagram, and have a secure electrical connection to the mains earth lead (yellow/green).

When fitting the mains lead, note that you will need to remove at least 200mm of its outer insulation cover, since the active (brown/A) and neutral (blue/B) wires connect directly to the front panel mains switch, while the earth lead is terminated near the cable entry point (as detailed above).

When it comes to fitting and wiring up all of the parts which are installed in the front panel, you may find it easier to complete the preliminary connections while the panel is separated from the main chassis — that is, not bolted in place with its flush-mounting Allan key screws.

This will allow better access to the various pots and switches, so that suitable lengths of rainbow cable can be prepared and attached to each of the components, as shown in the wiring diagram. When the front panel is finally attached, position the wires and connect the free ends to the appropriate PCB pins.

The mains switch should be connected to wires A, B/C and D *exactly* as indicated in the wiring diagram. A mistake here could be disastrous, since both the active *and* neutral wires are connected to the switch. Also, each of the switch terminals must be thoroughly insulated by suitable lengths of heatshrink tubing.

Note that the supplied mains switch is really a single-pole single-throw unit, where the third terminal (labeled B/C) merely acts as a connector for the neutral side of the built-in neon indicator lamp. If you have a close look at the switch, you should see the lamp connection leads where they exit the body and attach to terminals B/C and D.

If in doubt, though, check with a multimeter that switch lugs A and D connect together in one position of the rocker.

As it turns out, the neatest way to install the headphone socket is use a strong quick-drying adhesive such as Superglue, and position the socket so that it just protrudes through the front panel.

First, connect the various speaker wires and resistors (2 x R31), then glue the socket in place during the final assembly stage when the front panel is in place.

The rear panel wiring is quite straightforward, with short lengths of shielded cable used to connect the RCA sockets to the PCB pins, and the speaker terminals connected with heavy-duty hookup wire. Make sure that both the speaker terminal lugs and the shield connections of the RCA sockets are not contacting the case metalwork.

When you are satisfied that the mains wiring is quite safe and all of the other wiring is completed, fit the front panel and double check your work against the overlay and wiring diagrams. You're now ready to fire up the amplifier, and perform a few checks.

The test flight

Before applying power to the unit, arm yourself with a multimeter, turn the volume control to minimum, centre the tone and balance controls, and select the 'normal' switch modes (all toggle switches 'up').

Switch on, and quickly check the main DC power supply rails, then the preamp supply for their correct voltage levels as shown on the circuit diagram. If your tests show a significant voltage error, switch the amp off immediately and recheck the circuit.

Providing all is well, check the other voltages shown around the power amp chip (IC4) and the phono preamp stage (Q1, Q2 and IC1). When checking voltages around the circuit, don't forget that the heatsinks may be at the negative supply rail potential (as previously mentioned), and must not be shorted to either ground or nearby components by a stray multimeter probe.

Also, be especially careful if you need to test voltages on the pins of the power amp chip, since the probe tip can easily slip and cause a short between adjacent pins — this could destroy the TDA1514A's internal circuitry.

That's about it for the electrical checks of the amplifier; there is no quiescent current to be set, no DC offsets to adjust, nor thermal tracking to be checked. However, the TDA1514A chips will normally run at quite a warm temperature, so the unit should be monitored over a reasonable length of time to check that the heatsinks are operating efficiently.

As a final test, connect a suitable input source to the RCA sockets and check the controls and switches for their correct operation. After that, you are ready to experience the high performance of your new Playmaster 30-30 amplifier. ◆

APRIL BARGAINS FROM JAYCAR

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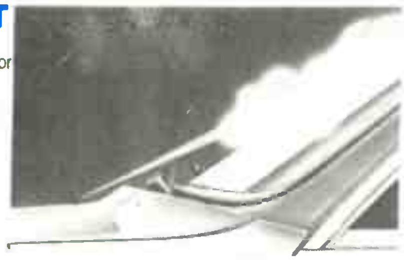

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23 Element Suitable for good to medium signal reception areas, or where ghosting is a problem. Specifications • Elements - 23 • Gain - 11dB • Channels - 21-69 • Bands - 4 and 5 • Frequency - 470-862MHz • Boom Width - 20mm sq • Overall Length - 680mm
Cat LT-3178 **$34.95**

43 Element Suitable for medium signal reception areas. Specifications • Elements - 43 • Gain - 13dB • Channels - 21-69 • Bands - 4 and 5 • Frequency - 470-862MHz • Boom Width - 20mm sq • Overall Length - 1234mm
Cat LT-3181 **$49.50**

91 Element Huge antenna suitable for deep fringe signal reception
Specifications • Elements - 91 • Gain - 15-19dB • Channels - 21-69 • Bands - 4 and 5 • Frequency - 470-862MHz • Boom Width - 20mm sq • Overall Length - 2214mm
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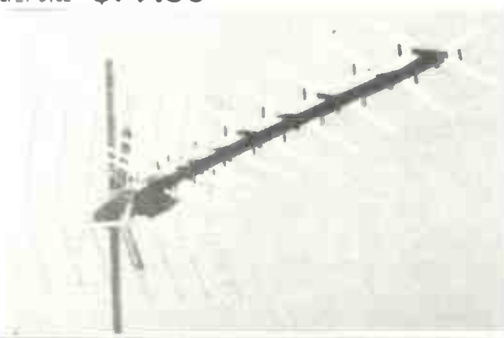

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Cat AX-3516	for 5" speakers	$8.50
Cat AX-3518	for 6-6 1/2" speakers	$11.95
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Cat AX-3522	for 10" speakers	$14.95
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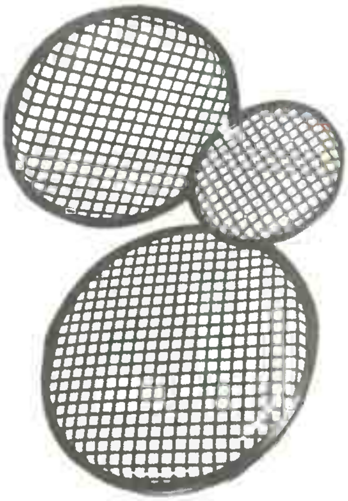

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TV Transmitter for VHF VCRs

Ref Silicon Chip March 1992

How many times have you wanted to watch something from your VCR on another TV set located in another room of your house? Up until now you had to run along cables through the walls or through the ceiling. Want to fix that? Our new transmitter does away with all those cable and simply connects into your VCR, and transmits a signal to your second TV set. THe Jaycar kit is supplied with Jiffy box, front panel labels and the VHF modulator, plus all specified components except the antenna assembly and connecting VCR cables.

Cat KC-5114

$99.50

BABY MONITOR/FM BUG KIT

Ref Silicon Chip Jan 92

The Baby Room Monitor kit allows you to listen to your baby from a remote location using a conventional FM receiver. It operates from a single 1.5V AA battery and includes muting facility so that it only transmits sounds above a certain level. The operating range is about 30 metres. Not only is it ideal for baby monitoring, but anywhere where you want to listen from another location. The kist includes PC board, case, microphone and all specified components.

Cat KC-5105

$24.95

8002 8 CHANNEL AUDIO MIXER KIT

LAST CHANCE!

That's it! The kit deparment has put together the last 15 of this ever popular kit. Main features include: balanced (600Ω) mic/line inputs, input attenuators, cannon connectors, bass, mid and high EQ on each input, 'effects' capability, etc. See our 1991 catalogue for full details.

Rack kit

Cat KJ-6504

Was $595

Less 15%

Now $505.75

Desk Console

Consists of console, chassis, power supply.

Cat KJ-6505

Was $119 Less 15%

Now $101.15

Unit pictured with optional desk control

40 Watt 12/230V Inverter Kit Sellout

Ref EA Aug 85

Improved design enables you to run small 240V appliances from a 12V car battery with modest current drain. When not in use it can also be used as a battery charger. As the 50Hz mains frequency is crystal generated the inverter is ideal for friving synchronous motor turntables with great speed accuracy. The Jaycar kit is complete and original to the project article as as is usual with your kits. An attractive silkscreen and drilled front panel provided. **Was $99.95**

Now $75 save $24.95

Metal Cabinet Handle

Quality plated steel cabinet handle. Recessed handle with black rubber grip and spring return. Cutout size 128 x 74mm. Cat HS-8015 **$12.95**

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SOLAR BATTERY CHARGER KIT

(High Power) Ref Silicon Chip Nov 91

EXCLUSIVE KIT TO JAYCAR

This new kit will handle currents of up to 2 amps or so, making it suitable for use with solar panels up to around 25 watts. Panels above 25 watts can be used but the charger will only allow 2A maximum charge to the batteries. This kit will stepdown the voltage to the batteries when the solar panels output is above 15 volts and stepup the voltage when there is less than 12 V available.

Kit includes: PCB, potcores, heatsink and all specified components.

Cat KC-5102

$34.95

THERMOSTATIC SWITCH FOR CAR RADIATOR FANS

Ref Silicon Chip March 92 Has the thermostat failed on your electric radiator fan? Our electronic thermostat can replace it and be adjusted to switch on at a temperature to suit your particular vehicle. The switch will ensure that your fan cuts in and out only as required so that your engine operates at the correct temperature for peak efficiency. The Jaycar kit is supplied with diecast aluminum box, PCB and all specified components except for the sender unit (which is available from K-Mart). Cat KC-5115 **$37.95**

Subwoofer Crossover

Add a subwoofer to your stereo! If you don't have enough bass and want to add a subwoofer you will need a crossover. This one is designed for adding a subwoofer to an existing speaker system. The cable to the original box should be routed through this crossover then on to the speaker box.

- Power handling 150 watts RMS
- Crossover frequency 100Hz
- Impedance 8 ohms
- Attenuation 12db/octave

Cat. CX-2630 **$55 ea**

Black Dome Midrange

What a midrange! This will brighten up any sound system. They are black in colour with a black grille over the huge dome (2" - 50mm). They are 6 1/2" 170mm in diameter and have a huge magnet. These are very similiar to the amazing Foster D050M12 dome midrange.

Power handling	80W rms
	System power 200W rms
Frequency response	800Hz - 10kHz
Resonant Frequency	800Hz
Sensitivity	93dB 1W/1m
Dimensions	A 168, B 155, C 125mm

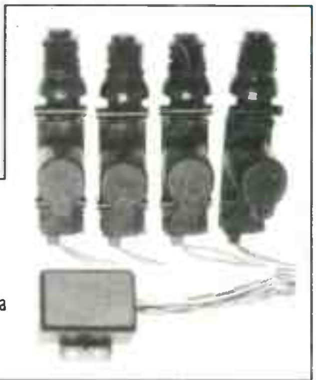
Cat. CM-2092

$49.95

4 DOOR CENTRAL LOCKING

A new addition to our range of central door locking products. You could say that this in an economy set because it cannot be wireless controlled and there is only one master control which is for the drivers door. The front seat passenger door is a slave is the rear door units. Supplied with relay, wiring harness and all hardware.

Cat LR-8850 **$119.50**



CELLULAR TELEPHONE HOLDER

If you own a portable cellular telephone or a car phone that isn't hands free, then you need one of these. The phone holder is like a hand and holds the phone, it has a suction disc which allows the phone to be mounted on the drivers side window. It has a cigarette lighter plug which allows the phone to be mounted from the cigarette lighter, and it even has another socket that clips on the hand for smokers so you can still light cigarettes. It has a bracket which can be mounted on the door to hgold the phone. The phone holder fits any brand telephone and car, and there is virutally no installation. It is a quality, well made product that will compliment any cellular phone.

Cat YT-6200 **$39.95**










60 Watt 12 - 240V InverterKit

Ref: Silicon Chip February 1992

This inverter is ideal for use anywhere where 240V AC power is not available. The Jaycar kit includes an improved and larger version of the transformer specified for the 40W version, which gives an extra 20 watts to around 60 watts. Ideal for fax machines, electric toothbrushes, battery chargers for mobile telephones, incandescent lamps, etc., etc. The Jaycar kit includes PCB, box, punched and screened front panel and all specified components including the larger transformer.

Cat. KC-5108 **$99**

TV Colour Pattern Generator Kit

Ref: Silicon Chip November/December 1991

A colour TV pattern generator is an essential service tool for the TV serviceman since it provides known and standard patterns. On a well adjusted set, each pattern will be close to perfect, while on a poor set the patterns will be far from satisfactory. This new kit produces seven separate patterns: checkerboard, crosshatch, dot, greyscale, white raster, red raster and colour bars. It will enable you to set your TV's convergence and purity for the best possible pictures. The kit includes PC board, box, punched and screened front panel, high quality video modulator and all specified components. 12V AC plugpack is an optional extra Cat. MP-3020 $16.95.

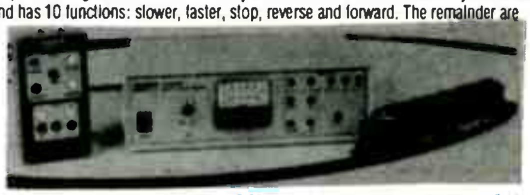
Cat. KC-5103 **$110**

Infra Red Remote Control Kit for the Train Controller KC-5028

This remote control unit is used in conjunction with our Train Controller kit and duplicates all the functions of the walkabout throttle. The receiver/controller box has LED acknowledgement and speed setting indication. It has an adjustable inertia run control and adjustable stop inertia. The remote control has a range of 10 metres, and has 10 functions: slower, faster, stop, reverse and forward. The remainder are auxiliary switches to switch lights or points. The kit is supplied complete with remote control and receiver cases, plus all specified components to turn the KC-5028 controller into wireless remote control.

Cat. KC-5029 **$139.95**

(Cat. KC-5028 **$89**)



240V Power Relay Kit

Ref: EA January 1992

This kit will monitor the power drawn from a "master" power point socket, and automatically switch on a slave socket. It's very versatile because it can monitor one or several appliances plugged into the "master" and switch one or several devices plugged into the "slave". An ideal use for this project would be to switch on your Hi Fi system. With a four outlet board plugged into the slave socket, turning on your amplifier (in master) will switch on your tuner, tape deck, CD player and turntable etc. The kit includes PC board, box, 240 volt sockets, lead and plug and all specified components.

Cat. KA-1740 **$49.50**

Light Beam Relay Kit

Ideal Shop Door Monitor

Ref: Silicon Chip December 1991

If you are running a business you will know that it's important to keep an eye on the door at all times. A properly installed door monitor will let you know that someone has entered the shop if you're working out the back. This kit 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. The kit includes PC board, box panel, buzzer and all specified semiconductors. Optional extras are 12V DC 300mA plugpack Cat. MP-3006 $15.95, Relay Cat. SY-4052 $9.95

Cat.KC-5106

$32.50

Low Voltage Cutout Kit for Cars and Boats

Ref: EA January 1992

Build this simple kit and avoid getting caught out with a flat battery. It simply connects into a 12 volt accessories power line and shuts off the flow if the batteries voltage drops to a dangerously low level, where it won't start the vehicle. The shut off voltage is adjustable over a nominal range of 10.9V to 11.9V and the unit will restore power to the load automatically when the battery voltage has returned to around 12.6V. An extremely useful and practical kit. The kit includes PC board, box, relay and all specified components.

Cal. KA-1739 **$22.95**

Karaoke Box Kit (Vocal Canceller)

Ref: EA November 1991

Karaoke is a lot of fun. With this kit you can remove the lead vocal from almost any recording, and replace it with your own via a standard microphone. It's a great way to liven up a party. Complete kit includes PC board, box, front panel and all components. Requires 2 x 9V 216 type batteries Cat. SB-2370 $2.85 each.

Cat. KA-1738 **$27.95**

Dolby Surround Sound Decoder Kit

Ref: EA January 1992. Experience cinema sound in your own lounge room. The Dolby "Surround Sound" process increases the sensation of "being there" by producing an effects channel to create surround sounds which a conventionals stereo system can't produce. Hook this simple kit in conjunction with your Hi Fi VCR or stereo TV and take full advantage of movies recorded with Dolby encoding. Short form kit - includes PCB, and all on board components.

Cat. KA-1741 **$39.95**

ADJUSTABLE 0 - 45 VOLT 8 AMP POWER SUPPLY KIT

Ref: Silicon Chip Jan/Feb 1992

This switchmode power supply has an adjustable output from 0 - 45 volt DC and it can deliver currents up to 8 amps. The kit is complete with case, punched and silkscreened front and rear panels, meters, toroidal transformer and all specified components. **Specifications of prototype: Output voltage** 0 - 45V • **Output current** 8A below 35V, 6A at 40V • **Load regulation** 1% • **Ripple and noise** 5mVp-p at 6A 13V, 10mVp-p at 8A 18V, 40mVp-p at 8A 35V • **Current limit** 800mA to 8.6A • **Overcurrent limit** 9A • **Foldback current** <2A

Cat. KC-5109 **$399**

LOW COST SINE/SQUARE WAVE OSCILLATOR KIT

Refer EA March 92

This project is an addition to our range of low cost bench gear and is relatively straightforward to construct. The kit covers the frequency range of around 6Hz to 70KHz in four ranges with very low distortion (typically 0.07%). It is based on a Wien bridge circuit, due to its low cost, high performance characteristics. The Jaycar kit comes complete with instrument case, front panel label, plus the PCB and all specified components. Our kit is also supplied with 1% resistors and the ultra-low noise 5534 op amp.

Cat KA-1742

$59.95

Telephone Call Timer Kit

Ref Silicon Chip March 92

This timer can save you or your business big money. It keeps track of time for you - for up to 19 minutes - and gives four warning beeps 12 seconds before the end of every minute. It then lights up one or more LEDs to indicate the elapsed time since the start of the phone call. The Jaycar kit comes with the box, front panel, PCB and all specified components. 9V battery not included Cat SB-2370 $2.85

Cat KC-5111 **$29.95**










Mini Breadboards

New for 1992. these are ideal if you don't need the full length boards.

Distribution Strip

Two strips supplied giving a total number of 100 holes.
Size 13(W) x 87(L)mm.
Cat PB-8830 **$5.95**

Terminal Strip

One terminal strip supplied which gives 30 holes x 10 - Total 300 holes.
Size 39(W) x 87(L)mm
Cat PB-8832 **$6.50**

Breadboard Jumper Kit

This kit consists of 70 pcs of single core sturdy wire which has been stripped on each end and bent at right angles. They are specifically made for breadboards. Supplied in a plastic box for easy storage. There is 5 pcs each of 14 different lengths.
Cat PB-8850 **$7.95**

The Best Passive Infra-Red Detector We've Ever Seen

We have made yet another scoop purchase of an extremely high quality 'National' (Panasonic) Japanese PIR. Quite frankly we have never seen a PIR built as well. To give you an example, the first amplifier stage from the Pyroelectric element is actually built right behind the element and housed in a shielded box. This maximises the signal to noise ratio and helps reduce false triggering.

Three lens configurations are offered:

1) Ceiling mount, 360° coverage. This is the only unit that we know that can do this.
Cat LA-5028 **$149.50**

2) Wall/ceiling mount long range. Will detect intruders up to 30 meters away, with a narrow beam angle. Ideal for hallways, looking down rows of shelving, etc.
Cat LA-5030 **$99**

3) Wall/ceiling mount, wide angle (80°) up to 16 metre range. Ideal corner mount unit, covers an enormous area.
Cat LA-5032 **$99**

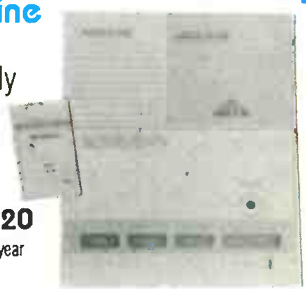
Each unit comes with comprehensive instructions, NC Tamper Circuit, N.O./N.C. alarm output. Power requirement 6-18V DC or AC. Range sensitivity is adjustable which is in keeping with the professionalism of the unit. These units were used by professional installers for major building securities. They are not cheap 'toy' PIR's.

AUDIOLINE ANSWERING MACHINE SELLOUT

Low cost answering machine

Cat YT-7020
Normally $99.95
Now **$79.95**
Save $20

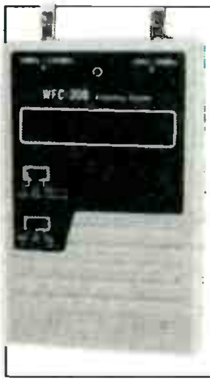
Remote Control Answering Machine



Cat YT-7025
Normally $139
Now **$119**
Save $20

Both have 1 year warranty

1.2GHZ DIGITAL FREQUENCY COUNTER



This amazing 1.2GHz digital frequency counter is small enough to be held comfortably in your hand. It measures only 82(W) x 34(D) x 131(H)mm. It includes internal rechargeable batteries which will give 5 hours operation on a full charge. It can be operated from the DC power socket with an adaptor (12V DC 500mA Cat MP-3012 $22.50) which will simultaneously charge the batteries. It has dual BNC input sockets, one for the low frequencies 8Hz - 25MHz, the other for the high frequencies 20MHz - 1.2GHz.

SPECIFICATIONS:

Input - Frequency range: A range (8Hz - 25MHz), B range (20MHz - 1200MHz), Sensitivity: A range 10Hz - 20MHz, B range 20MHz - 1200MHz, Impedance: A range 10Hz - 20MHz, B range 20MHz - 1200MHz 50Ω, Max input voltage: 100Vp-p for A range, 5Vp-p for B range, Coupling system: AC coupling.

Display - Accuracy: 1 count + timebase accuracy, Counting capacity: 8 digit LED display, Gate time: 2s, 0.2s, 0.002s switch selectable, 2.56s, 0.25s, 0.002s, Readout: KHz or 0.1MHz, Power source: 8V rechargeable batteries or DC 12V/500mA adaptor.

Cat QT-2330 **$299**

PASSIVE INFRA RED DETECTORS AT LOWER PRICES

See new catalogue for full specifications

Economy model
Cat LA-5017 **$49.95** Save $10

Terminator Pulse Count
Cat LA-5018 **$79** Save $10

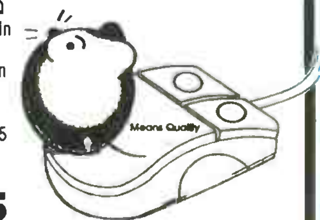
Terminator Deluxe Intelligent Pulse Count
Cat LA-5022 **$99** Save $20

Hi Quality Q Mouse

The Q Mouse™ is a serial opto-mechanical mouse cursor positioning device with a resolution from 50 to 8000dpi (dots per inch). Requires IBM PCs, PS/2 and compatibles with standard RS-232C Port or PS/2 Auxiliary Port.

Compatibility: Fully compatible with Microsoft Mouse™, Mouse Systems Mouse™ and PS/2™ Mouse.

Package contents: Q Mouse with DB-9 pin socket, Manual, Driver, Test program and Enhanced Productivity Software, 9 pin to 25 pin adaptor.



Cat XM-5100
$39.95

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New low cost Geiger Counter

Measure radiation with this simple, inexpensive and very portable Geiger counter. It's powered by two AA cells, and gives an excellent audible and visual display of any radiation encountered by the tube.

by PETER PHILLIPS

This device comes from Oatley Electronics and is another of their interesting, unusual and inexpensive projects. Much of the development of the project was done by Conrad Marder, in conjunction with Branco Justic.

In these days of environmental awareness, the terms cosmic radiation, nuclear physics and 'meltdown' are all well known. Mention 'nuclear' at a Green Peace gathering and you can bet the discussion will be heated.

In fact it's difficult to find a more emotive and divisive issue, and as one who lives about 1km from Australia's only nuclear research establishment, I guess you can say I've heard most of the arguments. But whether you agree or not with harnessing nuclear energy, paying for nuclear research or banning the bomb, the fact remains that nuclear radiation is all around us, and has been since time began.

There are two classes of radiation: non-ionising and ionising. Non-ionising radiations include the electromagnetic waves of ultraviolet light, visible and infrared light as well as microwaves and radio waves. Ionising radiation includes gamma rays, X-rays and cosmic rays.

Cosmic rays reach the earth from the depths of space and are generally regarded as more harmful than the non-ionising variety. Of course non-ionising radiation is not exactly harmless, as the various warnings about ultraviolet light continually remind us.

Studies of cosmic radiation began around the turn of the century and it is generally considered that cosmic rays come from sources distributed throughout space, perhaps within our galaxy or maybe outside it.

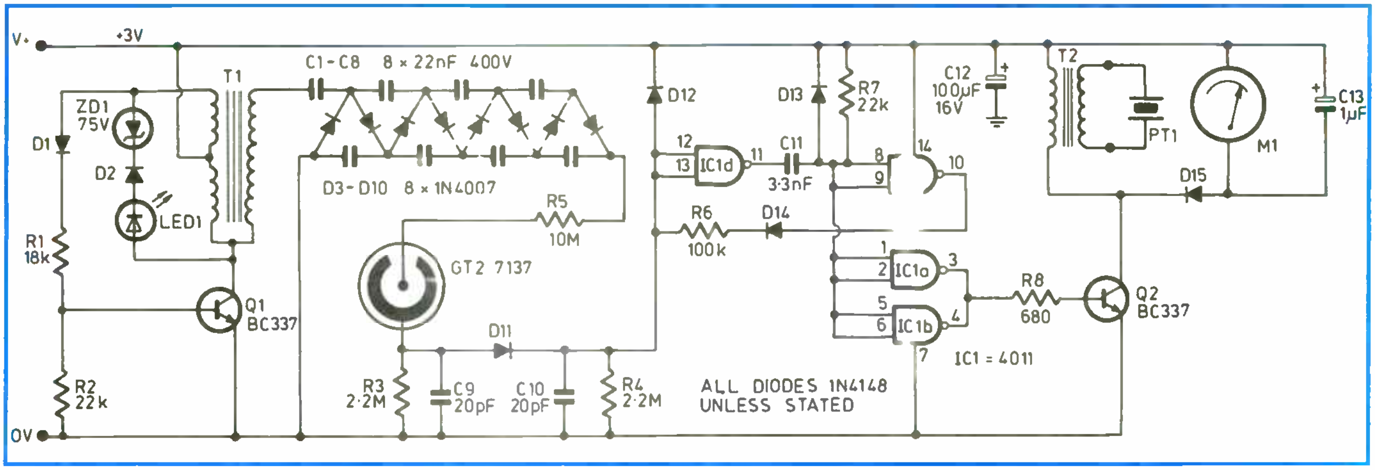
As well, it has been found that the sun is capable of producing cosmic rays, a conclusion reached by noting that an increase in cosmic radiation occurs during large flares on the sun's surface. Other forms of nuclear radiation are also present in our environment and come from the earth itself, from the atmosphere and even from food.

For example, it is estimated that over 100,000 cosmic rays penetrate each of us every hour. Couple this with 200,000 million gamma rays from soil and building materials, 30,000 atoms disintegrating in our lungs (producing alpha and beta particles) and millions of potassium-40 atoms disintegrating in our digestive systems every hour, and you can see that we are all fairly well radiated.

The study of radiation was given a considerable boost with the invention of a means of detecting it. These methods now include photographic plates (X-rays), solid-state PN junctions, scintillation counters and, of course, the Geiger counter tube.

The invention of the Geiger-Mueller tube goes back to around 1930 and their construction has not changed much over the years, except now they are available in miniaturised form.

There are various types of tubes available, depending on the type of atomic radiation you want to detect, but they all operate on much the same principle.



The high voltage for the Geiger tube is produced by the ringing choke oscillator around Q1, driving a four-stage voltage multiplier. The pulse output of the tube is stretched by the monostable of IC1d and IC1c and applied to the driver transistor Q2 via the buffer gates IC1a and b.

The Geiger tube

A Geiger tube seems simple enough and consists of an evacuated tube containing a quantity of gas and two electrodes, referred to as the anode and cathode. A high voltage is applied across the electrodes, and detection of an atomic particle relies on the particle releasing energy caused by collision with the gas molecules.

The energy is released in the form of electrons and positively charged ions, which then move quickly towards the electrodes. As they move, more collisions occur between the ions and the gas in an *avalanche effect*.

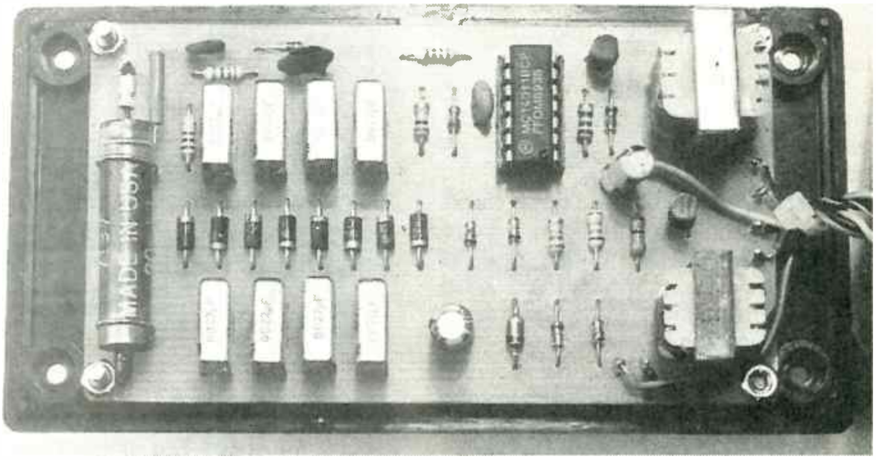
The flow of the electric charges therefore results in a small pulse of electric current that lasts for a short time. By connecting a Geiger tube as shown in Fig.1, the current pulse is converted to a voltage across resistor R1.

This short duration pulse can then be further processed and amplified to produce the characteristic clicking sound. The choice of gas in the tube is critical and includes a 'quenching agent', to make the tube revert quickly to its neutral state after a discharge event.

Because the process occurs quickly, a Geiger tube can effectively 'count' atomic particles, in which each click represents a particle. The graph in Fig.1 shows the effective operating range of a Geiger tube and that a plateau is reached once the number of atomic particles intercepted by the tube exceeds a certain value.

The obvious disadvantage of the Geiger tube is the need for a high voltage, usually around 500V DC. Semiconductor PN junction detectors are available that operate from a few volts, but they are not very sensitive to gamma rays — which are of most interest to those looking at changes in background radiation in the environment.

As the graph shows, the operation of the tube is somewhat dependent on the applied voltage. Ideally, this voltage should cause the tube to operate in the centre of the plateau region and not be



This is the printed circuit board. The Geiger tube is held to the PCB with two wire straps. The tube anode is the centre terminal, and connects to a short length of tinned copper wire soldered to the PCB.

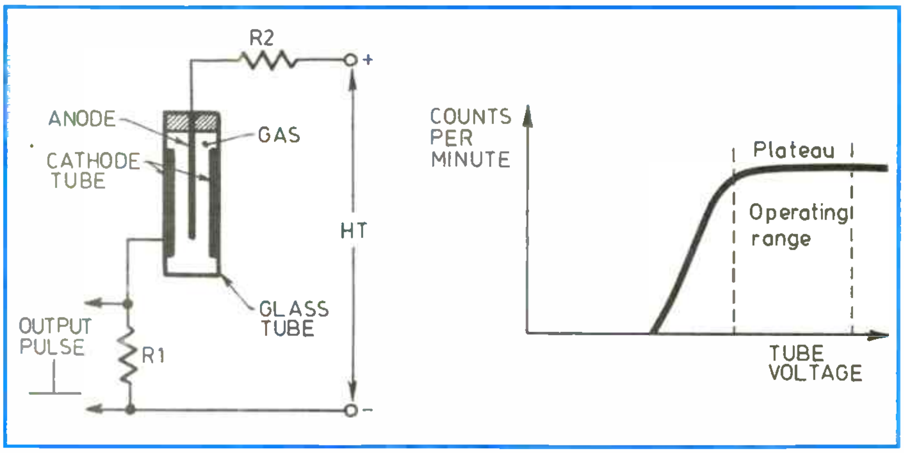


Fig.1: The basic electrical requirements of a Geiger tube are shown here, along with its operating characteristic. The ideal operating point is in the centre of the plateau.

high enough to destroy the tube. If the voltage is too high, the tube will conduct without the presence of radiation and will be damaged.

Therefore, the voltage needs to be reasonably well regulated, although this is not quite so critical for an instrument used to detect rather than actually *measure* radiation levels.

A Geiger counter

The essential elements of a portable Geiger counter are shown in Fig.2, and include a DC to DC converter to produce the high voltage and circuitry to amplify and process the output pulses. Part of this process is some form of pulse stretching so the pulses can be made more audible. As well, it is usual to provide some sort of visual indication such as a meter or a LED.

All kinds of variations are possible, and some Geiger counters use headphones as the audio output device. Our version uses a piezo device.

Another popular constructional variation is to fit the Geiger tube to a probe. While this is possible in this project, in the prototype, the tube was fitted to the PCB. As the photos show, the tube is quite small and has a total length (tube tip to end of terminals) of 50mm, with a tube diameter of 8mm.

The tube used in the prototype is a type 90-13, and needs a supply voltage of around 500V with an anode resistance of 10M. This value affects the recovery time of the tube and is therefore relatively important.

How it works

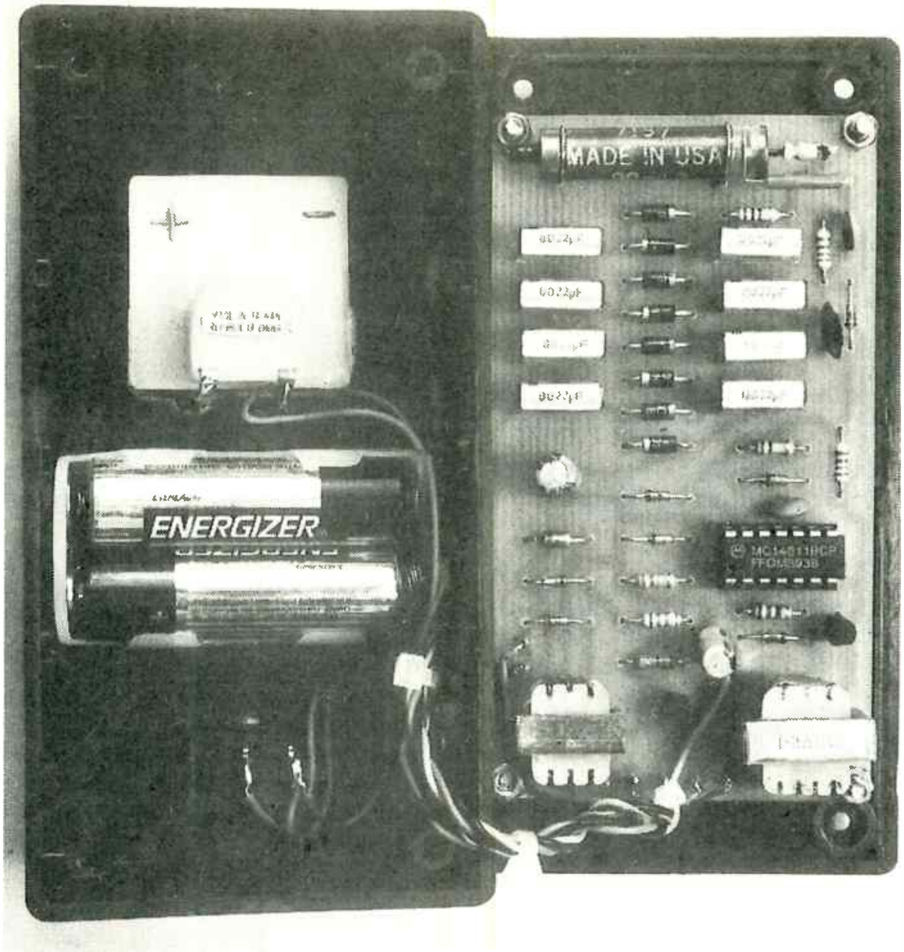
The high voltage for the Geiger tube is produced by the ringing choke oscillator around Q1. When power is first applied, current flows through the primary of T1, as Q1 is biased on by R1 and R2 via D1 and the centre tap of the primary winding of T1.

When current saturation is reached, the magnetic flux built up in T1 will start to collapse, causing a negative voltage at the anodes of D1 and ZD1. Because D1 is now reverse biased, Q1 will turn off and the current through T1 drops to zero.

The energy contained in the magnetic field causes the induced voltage to increase until ZD1, D2 and LED1 conduct. This dissipates the stored energy and when the magnetic field has collapsed, Q1 turns on and the cycle recommences. The operating frequency is around 200Hz and the waveform produced at the collector of Q1 is a series of short duration negative-going spikes.

This waveform is stepped up by the turns ratio of T1 and applied to the four-stage voltage multiplier circuit of C1-C8 and D3-D10. The approximate output voltage is 500V DC, which connects to the Geiger tube's load resistor R5.

As already mentioned, the value of this resistor is important as it affects the time taken for the tube to revert to normal after detection of an atomic particle.



Although rather hard to photograph, this shot shows how everything mounts inside the case. The battery holder, meter movement, LED and the piezo transducer are held in position with glue. The on/off switch clips into place.

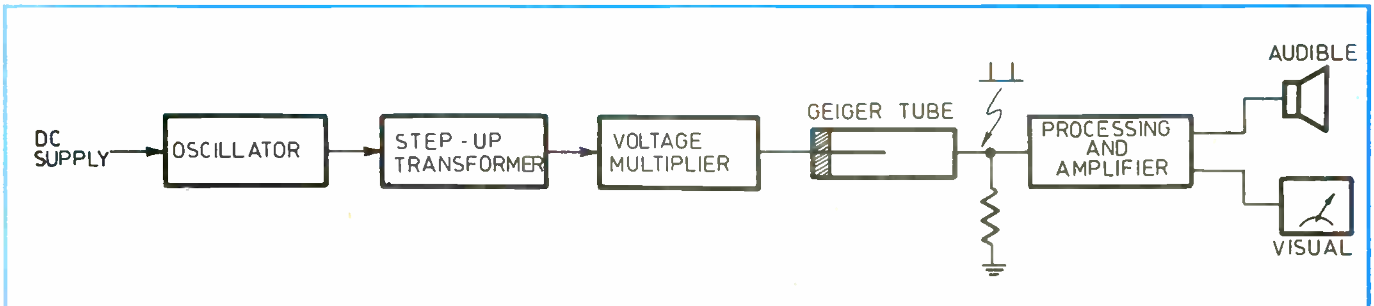
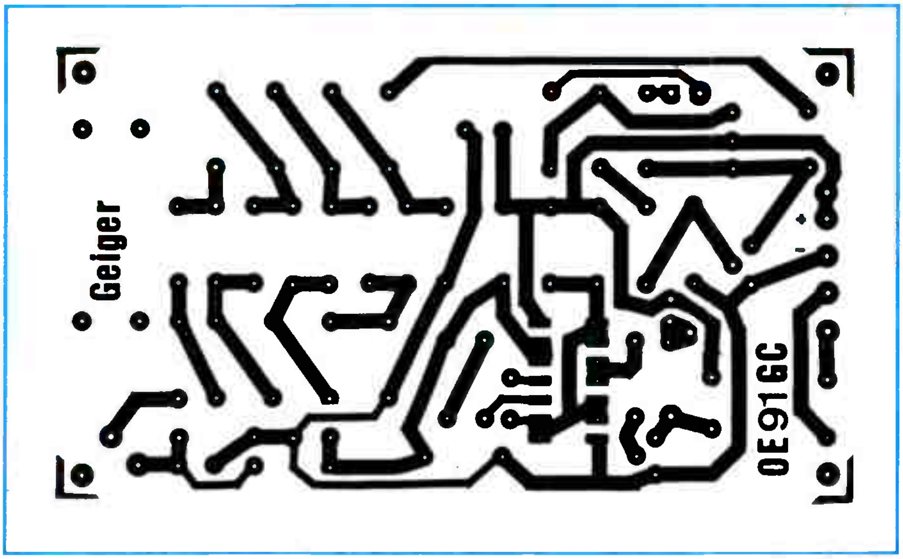


Fig.2: Most Geiger counters have a block diagram similar to this one. The output of the tube is a short voltage pulse for each detection event, and usually requires further processing to drive the visual or audio indicating devices.



Here is the PCB artwork if you want to make your own. However, the artwork is copyright to Oatley Electronics, and will not be available from other firms.

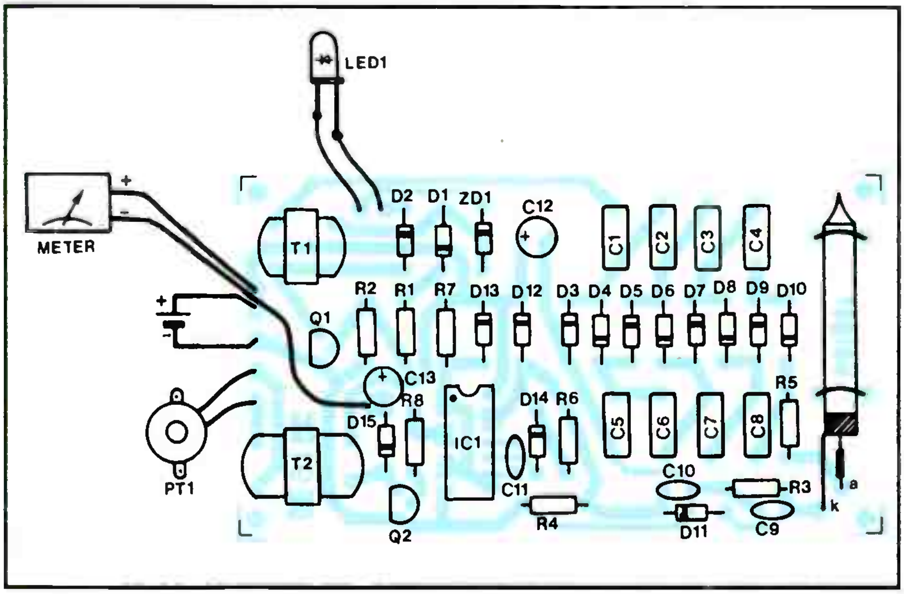
When the tube conducts, its current pulse passes through cathode resistor R3, producing a positive voltage pulse at the anode of D11. As Ohm's law shows, a current of around 1uA will produce a voltage pulse of 2V or more, sufficient to forward bias D11. The pulse is then passed to the inputs of IC1d, a CMOS NAND gate.

This gate and IC1c form a monostable, timed by C11 and R6. As a result, the short duration pulse applied to IC1d is lengthened (or stretched). Diodes D12 and D13 prevent the gate inputs exceeding the supply voltage.

The output of the monostable is taken from the inputs to IC1c and applied to the buffers formed by IC1a and IC1b. These gates restore the polarity of the pulse and drive transistor Q2. When a pulse is received, Q2 is turned on, allowing current to flow in the primary of T2 as well as the meter movement.

Because the pulse is only a few hundred microseconds long, C13 and D15 are required to allow the meter pointer to respond long enough to see. The pulse is also stepped up by T2 and applied to the piezo transducer PT1, which produces the well known 'click' for each detection event.

The circuit is powered by a 3V battery and filtering is provided with C12. Because LED1 lights when the oscillator is running, it indicates both that power is on and that the oscillator is functioning.



The layout for the PCB. The off/on switch connects in series with the positive lead from the battery. Make sure the polarity of all the diodes is correct, as there are quite a few in the circuit.

PARTS LIST

Resistors

All 1/4W, 5% unless otherwise stated:

R1 18k
R2,7 22k
R3,4 2.2M
R5 10M
R6 100k
R8 680 ohm

Capacitors

C1-8 22nF 400V polyester
C9,10 20pF ceramic
C11 3.3nF ceramic
C12 100uF 16V electrolytic
C13 1uF 16V electrolytic

Semiconductors

D1,2 1N4148 signal diode
D3-10 1N4007 diode
D11-15 1N4148 signal diode
ZD1 75V zener diode
LED1 3mm red LED
IC1 4011 CMOS NAND gate
Q1,2 BC337 NPN transistor

Miscellaneous

Inverter transformer (blue);
output transformer (red);
PCB coded OE91GC, 105mm x 60mm;
14-pin IC socket;
Geiger tube;
plastic case 67 x 130 x 40mm (W x L x H);
piezo transducer;
single pole on-off switch;
2 x AA battery holder;
meter movement (DSE Q2100 or similar);
hook up wire.

Kits of parts for this project are available from:
Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985
Postal address (mail orders):
PO Box 89, Oatley West NSW 2223.

Complete kit (except meter) — includes case, PCB and all components, $109
Key components are also available separately
Post and pack charges $5

The duty cycle of the LED is quite short, but the light output is sufficient to give an indication. For this reason the LED is fitted to the front panel.

Construction

A kit of parts for this project is available from Oatley Electronics (see end of article).

Everything apart from the meter, the transducer and the LED is contained on the PCB and construction is mainly a matter of fitting and soldering all the components as shown in the layout diagram.

Watch the orientation of the diodes in particular, as there are 15 of them. Also check the polarity of the transistors, the electrolytic capacitors and the zener diode. A socket for IC1 is not essential, but is suggested.

The two transformers are different and T1 can be identified by the presence of a centre-tap. This transformer mounts at the top left of the PCB, and has blue tape over the windings.

The Geiger tube is held to the board with two wire straps. Don't make the straps too tight, as the tube could fracture when the straps are soldered. Fit a short length of tinned copper wire to the board so the anode terminal can be connected. The cathode lead from the tube is long enough to be formed and soldered to the PCB.

When the PCB assembly is finished it remains to connect the off-board components. As the photos show, the PCB is fixed with four mounting screws to the lid of the case.

The meter, on-off switch and the LED indicator are mounted on the bottom of the case (which then becomes the top). The battery holder is also glued inside the case and the transducer fixes to one side.

Although not shown on the layout diagram, the on-off switch is in series with the positive lead from the battery. A cutout in the case is required for the meter movement (if added) and the on-off switch. A hole for the LED can be drilled next to the switch. The switch clips into its cutout, and glue is required to hold the meter movement and the LED in place. Solder wires to the LED before gluing it in position.

Drill an 8mm to 10mm hole in the side of the case, central to the mounting position of the piezo transducer, for the sound output of the transducer. Then glue the transducer in place.

The wiring between the off-board components and the PCB is straightforward enough, and the wiring should allow the board to be placed so the Geiger tube is under the meter movement. Incidentally, the meter movement is not essential (and is not included in the kit of parts). Also, you may want to fit the Geiger tube to a probe. In this case, use a coaxial lead capable of withstanding 500V DC.

Testing and using

When the assembly is finished, fit two AA cells to the battery holder. The current consumption of the circuit should be around 10mA to 12mA and LED1 should light.

Because of the high output resistance of the multiplier circuit, you won't be able to measure the full output voltage of the DC-DC converter as the loading effect of a typical DVM will cause it to fall dramatically. However, as a guide, the voltage reading obtained at the cathode of D10 (output of the multiplier) will be about 180V DC when measured with a DVM that has a 10M input impedance.

Depending on local conditions, you will probably hear random clicking, indicating the tube is detecting background radiation. The click rate will be between two to twenty a second, again depending on your geographical location. Try finding sources of radiation, such as the luminous face of a watch or clock, some types of smoke alarms, rocks, soil or other parts of the environment.

Be careful not to expose the counter to strong sources of radiation, as the whole thing will become radio-active and cause the tube to continually indicate radiation. ❖

Experimenting with Electronics

by PETER MURTAGH

9V power supply

Until now, all of our projects in this series have been powered by a 9V battery. This is fine for experimenting, but you will probably have found that your battery quickly goes flat if you have used it for any extended length of time. So, here is our circuit for a simple power supply to replace the battery. The design gives a steady output of +9V, with very little ripple, and also provides protection against accidental short-circuits.

We have used battery power in all our projects until now because of the safety aspect. 240V can be lethal! For this reason, our power supply circuit does not contain a mains transformer. Instead it uses a sealed plugpack. These readily available units are designed to plug directly into a power point, and provide a much safer low voltage output. Any such plugpack can be used, provided that it can supply at least 100mA (milliamps), in the range 12-15V.

Although our circuit is designed to accept AC, it will work equally well from DC. Even though DC plugpacks have more components than AC ones, they tend to be more common (and therefore cheaper) because there is more demand for them. If you're lucky, you might even find a spare unit lying around your home, and so save the cost of buying a new one. The cheapest we could find was just under $10, a 15V 100mA AC model. Why bother with our circuit? Why not just use the plugpack to power the projects?

Well, first of all, our circuit is a *regulated* power supply, and the plugpack is not. This means that our output voltage remains a constant +9V, no matter how much (within reason) the plugpack voltage varies. Plugpacks tend to deliver a higher voltage than their rating (our 12V model gave 13.8V). We want a power supply with a steady +9V.

Secondly, our circuit provides a *filtered* power supply. Filtering removes most of the 'ripple' from the supply - the fluctuations of the voltage about its average value. If you use a DC voltmeter to measure the output voltage of a plugpack, this reading won't make you aware that there is ripple present. The meter needle can't move quickly enough to show the rapid fluctuations, so it only shows the average reading. But you can often hear this ripple as a background hum with mains-powered audio equipment.

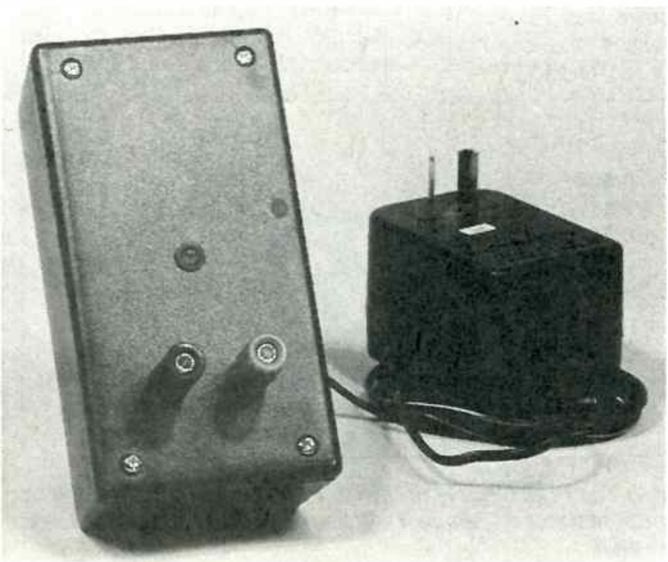
And finally, we have provided protection against accidental short-circuits. Normally, a short-circuit across the output of the supply results in its destruction. Transistors can only conduct a certain level of current before they overheat. Our circuit can be subjected to a complete short-circuit for up to half a minute without causing any damage. In fact, to test our prototype, we subjected it to a full five minute short (not really recommended) — and our unit still works!

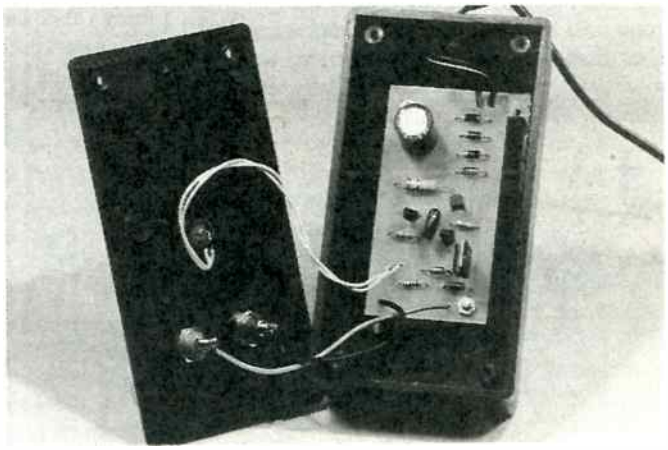
All these reasons mean that it is well worthwhile using our design to 'tidy up' the output of your plugpack power supply.

Construction

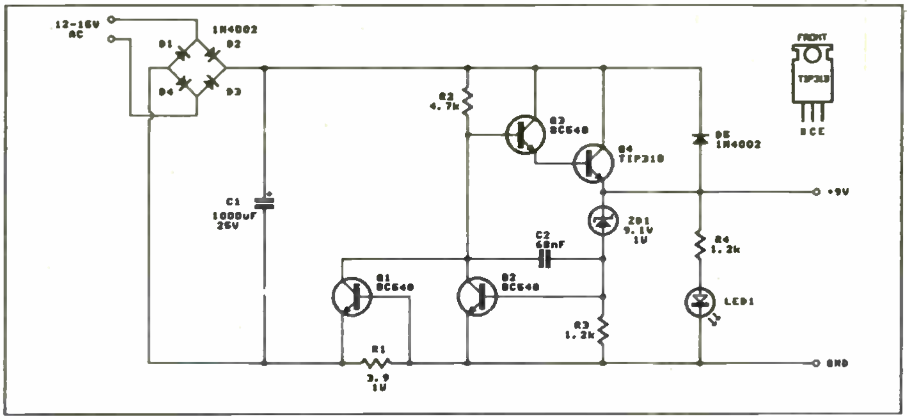
As usual, the construction of this circuit is straightforward. First solder the more rugged resistors, followed by the more sensitive components. Take care with the orientation of the rest of the components: the electrolytic capacitor, the diodes, LED and transistors. Check with Fig.3 to see which pin is which for our commonly used components.

For our new components: the zener diode (ZD1) has its cathode marked in a similar way to the power diodes. The pin layout for the power transistor Q4





Note how the PCB is mounted low in the zippy box to allow good clearance for the electrolytic capacitor and the power transistor. There is sufficient room to install a heatsink on the back of this transistor, if necessary.

The schematic diagram shows how transistors Q3 and Q4 control the flow of current to the load. Transistor Q2 provides negative feedback to reduce fluctuations in the output voltage, while Q1 protects against overload.

(TIP31B) is given on the schematic diagram. Note that its layout is quite different to that of the other transistors, Q1-Q3, even though all are NPN transistors.

A heatsink is not necessary for transistor Q4. This is because the circuit is designed to deliver 100mA, and Q4 is capable of 3A! Even so, Q4 can get quite hot during a short circuit. If this worries you, make up a simple heatsink by cutting a piece of aluminium, and bending up the ends. The larger area helps the heat get away faster. Bolt the heat sink to the back of Q4, smearing the adjoining metal surfaces with silicone grease to improve heat transfer. Make certain that the heat sink does not make contact with any other part of the circuitry.

To simplify attaching the plugpack to our circuit board, we have decided to dispense with plugs and sockets. Cut off the plug on the output leads of the plugpack and solder the two wires to the board at the '12V AC' pads. It doesn't matter which wire goes to which pad. This applies no matter whether you are using an AC or DC plugpack.

Because we believe that this month's circuit will be built as a permanent item, rather than just for experimentation, we have not included the usual photo of the breadboard pattern. For the same reason, we have mounted the board in a small zippy box, bolted to the base with 3/4" long countersunk bolts, and sitting on plastic pillars. Use only short pillars so that the larger components, C1 and Q4, don't touch the lid. The photo shows the output terminals and the LED mounted on the top of the box.

How it works

Diodes D1-D4 form a diode bridge which converts the AC from the plugpack into pulsating DC. Of course, if you use a DC plugpack, then you don't really need this bridge, but leaving it in the circuit means that you don't have to worry about the polarity of the plugpack. Either lead can be connected to either input pad.

This fluctuating DC voltage is then smoothed by capacitor C1. It does this by charging up when the voltage is higher than the average, and discharging when it is lower. When we measured the voltage across C1, using a cathode ray oscilloscope (CRO), its value was 15.6 ±0.6V. This means that the average was 15.6V, but the instantaneous voltage was continually changing between 15.0 and 16.2V.

This level of fluctuation (or 'ripple') is still too high for many circuits. To reduce the ripple, we need a negative feedback system which will counteract the variations. This is done by transistor Q2 which modifies the controlling action of Q3 and Q4. More on this feedback in a moment.

Transistors Q3 and Q4 are connected together to form a current amplifier. For obvious reasons, this setup is called the 'emitter-follower mode'. It controls the current flow, with very little change in the voltage.

This is how it works. When current flows through resistor R2, it tends to bias on transistor Q3. The emitter current from Q3 will then turn on Q4. Because all the load current effectively flows through Q4, this transistor must have a higher rating than the other transistors.

However, the output voltage of Q4 will still be close to the value of the supply rail — still higher than the 9V level we require. We need some way to regulate the voltage to the desired 9V. This is the purpose of the zener diode ZD1. Such a diode is designed to break down when reverse-biased, and while doing so, to maintain a fixed voltage drop between its cathode and anode.

Normally, diodes conduct if the forward bias is greater than about 0.65V, but won't conduct if reverse-biased. However, if the reverse bias voltage is increased to a far higher level, the diodes will break down and conduct — and if the current is not limited, they will burn themselves out! Zeners are designed to be able to operate safely in this breakdown region.

How to use this property? Whenever the voltage at the output terminals is greater than the (nominal) 9.1V drop across the zener, the zener will reduce that voltage to 9.1V by moving into its breakdown region and allowing a current to flow. The higher the voltage rises above 9.1V, the larger this breakdown current becomes. Now these changes in current affect the bias on transistor Q2, which in turn will af-

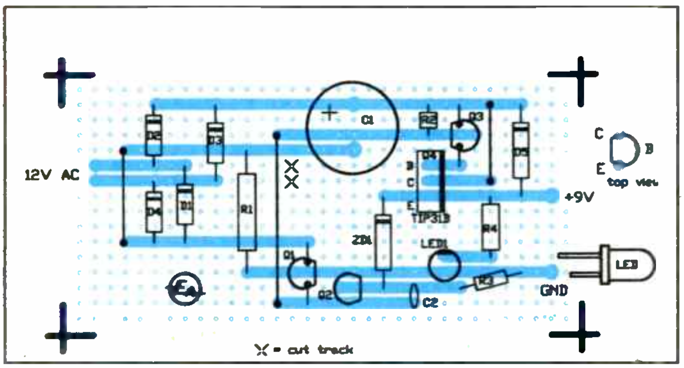


Fig.1: The overlay diagram for stripboard construction. Note that the pin arrangement of the power transistor Q4 is different to the other NPN transistors used in the circuit.

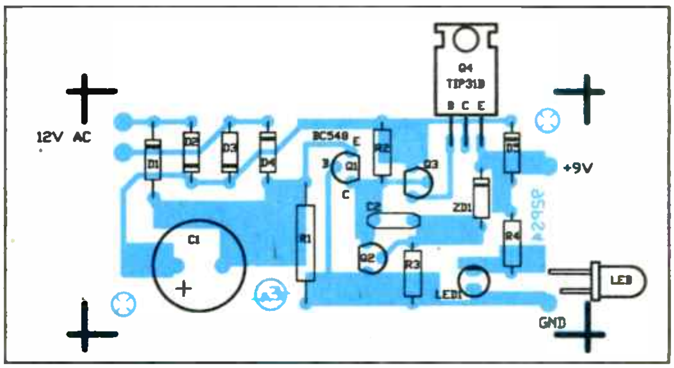


Fig.2: The PCB overlay diagram. Extra room has been left to mount resistor R1, since it will have a power rating of at least one watt.

[illegible]

fect Q3. Let's look at an example of how this works.

Suppose that there is an increase in the voltage level at the emitter of Q4. This means that there will also be an increase in the bias on Q2, turning it on harder. More current will now flow between Q2's collector and emitter. Since this collector current flows via R2, its increase causes an increase in the voltage drop across the resistor. This reduces the bias on Q3 and Q4. The net result is that the output voltage of Q4 drops, and this drop counteracts the original output voltage surge which started the whole process. Equilibrium is restored.

The output of our unit measured 9.2 ±0.002V. So the output voltage has been regulated to the desired 9V level, and the voltage variation has been reduced from 600mV (millivolts) to just 2mV.

The reason for capacitor C2 is to provide a low impedance pathway for high frequencies, to bypass transistor Q2. We only want DC changes, and 50 or 100Hz ripple fluctuations to be amplified by Q2. Our feedback circuit only works for low frequencies, to ensure a really smooth output.

Finally, let's look at the operation of transistor Q1. Its purpose is to shut off the supply if a short circuit occurs across the output. To do this, we must monitor the flow of current through the circuit. This is done with resistor R1, because all the output current will flow back through it. Here's how it works.

As the current through R1 increases, it produces an increasing voltage drop across the resistor. This voltage will eventually become large enough to bias on transistor Q1. When Q1 starts to conduct, its collector current will flow via R2, increasing the voltage across that resistor. And, as we have already seen, increasing R2's voltage tends to bias off the main amplifier. So, if too much current flows in

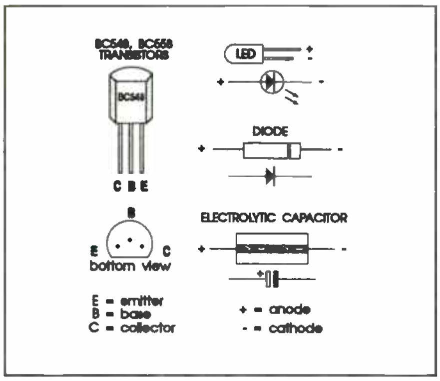
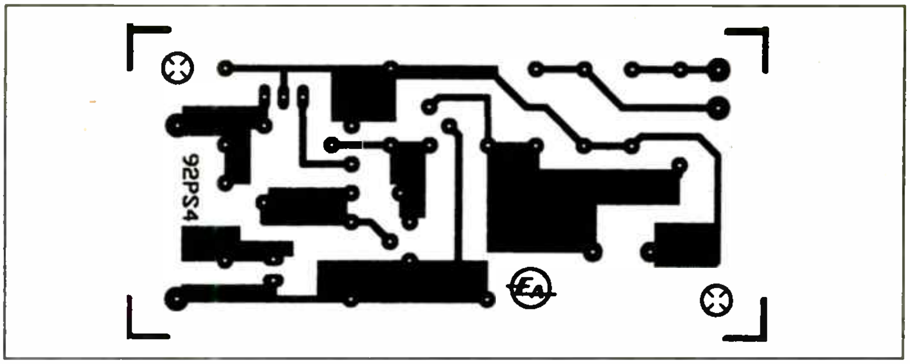


Fig.3: This shows the pin configuration of those components commonly used in this series. Refer to the schematic to identify the TIP31B power transistor leads.



This full size PCB pattern can be used by those who like to etch their own boards.

the circuit, then Q1 will reduce it. The value of 3.9 ohms for R1 was chosen to allow a current of almost 150mA to flow, at full 9V output. This is more than enough for a design which is only meant to replace a 9V battery. R1 is rated at 1W to be more than able to handle short circuit conditions.

LED1, with its current-limiting resistor R4, has been included in the design to show that the supply is working — and not overloaded. If the circuit is overloaded, the LED starts to dim as Q1 controls Q3 and Q4 to reduce the output. In the case of a short circuit, the output voltage goes to zero, so the LED turns right off.

However, during such a short, Q4 is not turned fully off. Up to 160mA still continues to flow through it, because the transistor is effectively the only load on the circuit. This is the reason we chose the TIP31B transistor — to easily dissipate the considerable heat generated.

Diode D5 has been added to protect the transistors from voltage surges from external circuits. The discharge from large capacitors could conceivably cause a voltage surge back into the power supply, and damage the transistors by excessive reverse- bias. Diode D5 will shunt any such surge around them.

Changes

While this circuit was designed to replace the 9V battery normally used in our projects, in actual fact, it can deliver quite a lot more current than that. So you can very easily convert this special-purpose circuit into a heavier-duty experimenter's power supply.

First of all, the plugpack itself must be capable of supplying the higher current required. If you do draw more current from the pack than it is designed to deliver, you will find that it will compensate by dropping the output voltage. Diodes D1-D4 can cope with 1A of current, but can be replaced with higher ratings if needed. The power transistor Q4 can deliver a full 3A, provided that power dissipation is less than 40W. While Q4 can survive without a heat sink for continuous currents around 100mA, and 150mA for half a minute, when the currents are larger it must definitely be fitted with a heat sink and can only survive far briefer short circuits.

In addition, you will need to reduce the value of resistor R1, so that your new maximum current will produce approximately 0.6V drop across it. Calculate the resistance value by dividing 0.6V by I_{MAX}. Remember to check the power dissipation required, as a larger current produces far more heat. The spacing on our board for R1 is designed to accommodate a 1W resistor, but it is large enough for 5W and 10W resistors.

Transparencies

A high contrast, actual size transparency (negative) is available for only $2 for anyone wishing to make their own printed circuit board. This special price applies for transparencies for projects in this series only. Write to *EA*'s reader services division.

Happy experimenting — and please send us your comments on the circuits we have published as well as ideas for future projects. ❖

PARTS LIST

Miscellaneous

Zippy box, 41x68x130mm
PCB 84x41mm, coded 92PS4
12-15V, 100mA plugpack
1 LED, any colour + holder
2 banana sockets
2 mounting pillars
2 counter-sunk bolts + nuts
hookup wire

Resistors

All 1/4W, 5%, except R1 1W, 5%:
1 3.9 ohm R1 orange-white-gold
1 4.7k R2 yellow-purple-red
2 1.2k R3,R4 brown-red-red

Capacitors

1 1000uF,25V C1 PC-mount electrolytic
1 68nF C2 polyester 'greencap'

Semiconductors

5 1N4002 power diodes D1-D5
1 9.1V, 1W zener diode ZD1
3 BC548 NPN transistors Q1-Q3
1 TIP31B NPN transistor Q4

[illegible]

by PETER LANKSHEAR

Understanding Automatic Gain Control — 2

Last month we looked at the origins of automatic gain control or 'AGC' and the simple systems that evolved. Now we will cover more elaborate methods and some of the faults, often unsuspected, that AGC can provide.

Advantage was soon taken of the availability of a second diode in dual valves. Balanced or full wave detection reduces the necessity for IF filtering and was used for a while, but as the signal and AGC voltages developed are halved, and a centre-tapped IF transformer winding is necessary, half wave operation became standard.

Although combined detection and AGC was used frequently right into the transistor era, it has limitations. Unless receiver audio gain is fairly high, simple AGC can limit the ability of weak to medium strength signals to drive the output valve fully, and reduces receiver gain with even the weakest signals. This is not much of a problem for radios intended only for local station listening, but it is obviously undesirable for higher performance receivers.

The usual solution is to use an independant AGC diode, with delay in the commencement of control action until the signal reaches a pre determined level. This is done by biasing the AGC diode by returning its load resistor to a point negative with respect to its own cathode.

Delayed AGC has another desirable characteristic. Once the signal generates sufficient voltage to overcome the delay, gain reduction action is more effective than that of simple AGC. Detector output increases linearly until the delay point is reached. At this stage the gain curve becomes flatter than with simple AGC, resulting in a more constant detector output over a wide range of signal strengths.

Fig.1 shows the circuit of a receiver incorporating a typical delayed AGC circuit, with the right-hand diode of the EBC3 connected by a .0001uF (100pF) capacitor to the anode of the EF5 IF amplifier. The voltage drop across the 6000-ohm cathode resistor of the EBC3 places the cathode about 3 volts positive with respect to earth. The AGC diode therefore will be inactive until its signal reaches a peak level of 3 volts.

Note that the left-hand diode of the EBC3 is used as the signal detector, and as its DC load is formed by the 0.5-megohm volume control, which is returned directly to the cathode, the detector receives no delaying bias and thus operates normally.

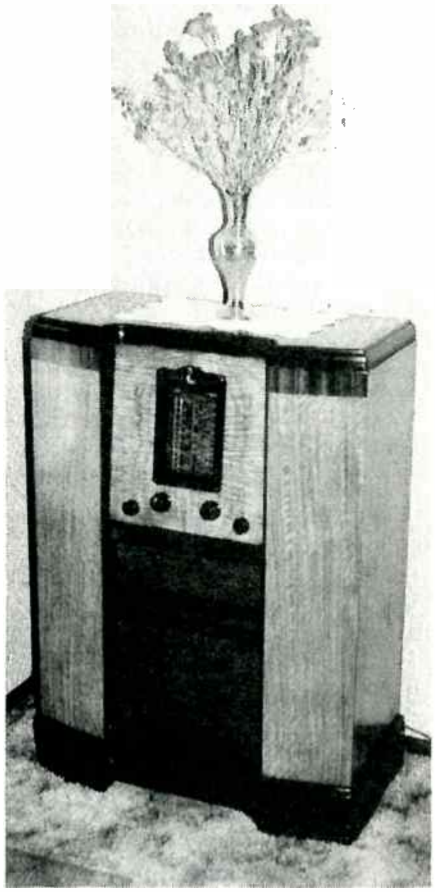
Just what is connected to a diode influences detector distortion and is least with a pure resistive load. However, AGC lines always have bypass capacitors, which make loading complex and their presence increases signal distortion. By connecting the AGC diode to the primary of the IF transformer, loading on the signal detector is reduced although not eliminated. There is still an increase in distortion at the point where the AGC diode does conduct, and as a compromise, delay voltages are usually kept sufficiently low that the transition point occurs with weak signals where good quality is not vital.

To reduce the possibility of leakage or breakdown of the coupling capacitor upsetting the AGC system, the AGC diode was often connected to the secondary of the IF transformer, but at the cost of greater distortion.

Separate AGC amp

High performance receivers sometimes have a separate AGC IF amplifier stage operating in parallel with the signal channel, to take advantage of the benefits to be gained by separating detection and AGC functions. Greater delay voltages can be used, detector distortion is minimised, and as the AGC amplifier can operate at full gain at all times, there can be an effective amplification of the control voltage. Furthermore, the selectivity of the AGC channel can be tailored for the best results.

Stromberg-Carlson's model 837 is a typical example. Reference to Fig.2 shows that the IF signal is split to feed the grids of a pair of 6B7S valves. The upper 6B7S is a conventional IF amplifier and diode detector. Coupling between the two main coils can be adjusted with the IF transformer tapped winding operating as a variable selectivity control, and the diode load resistors R10, R11, and R12 are switched to compensate for changes in detector output as selectivity is changed. Although not used for AGC, the negative voltage developed



The handsome Stromberg-Carlson 837 of 1937 had a specification to match its appearance, including delayed AGC.

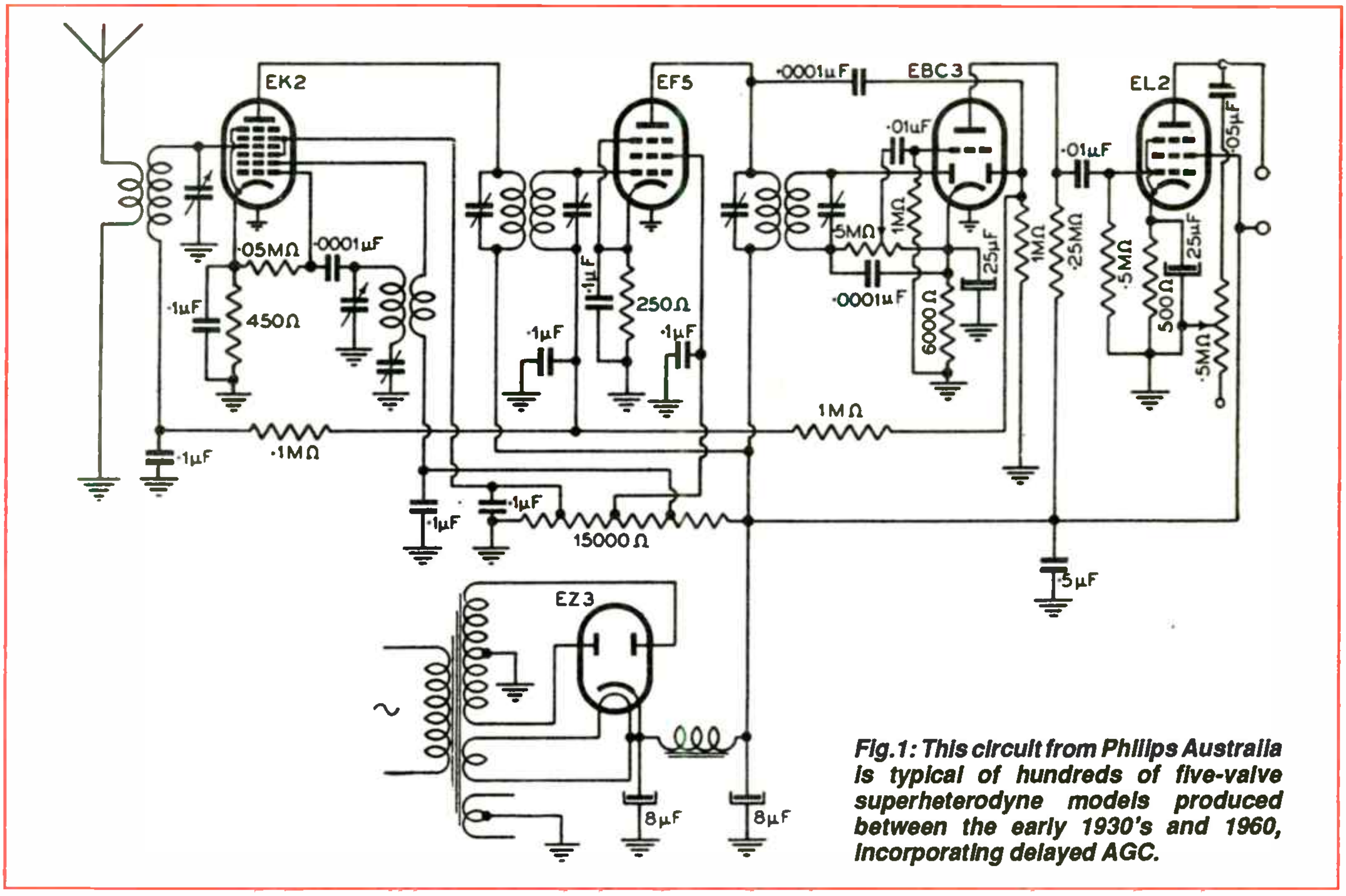


Fig.1: This circuit from Philips Australia is typical of hundreds of five-valve superheterodyne models produced between the early 1930's and 1960, incorporating delayed AGC.

across the diode load resistors does perform an additional function to drive the 6E5 tuning indicator.

The lower 6B7S AGC amplifier operates at full gain with fixed cathode bias and its output is coupled by an IF transformer to one of its own diodes, to be rectified to produce the AGC voltage in the usual manner. R16, the normal bias resistor, in series with R17 places the 6B7S cathode about 20 volts above earth, providing a much larger delay voltage than is practical with the usual combined detector and AGC valve. Resistors R14 and R15 divide the AGC voltage, so that only one sixth of the AGC voltage is applied to the mixer and IF valve.

Applying full AGC only to the RF stage and a fraction to the mixer and IF stages is good practice, but was not done as often as it might have been. AGC degrades shortwave frequency stability of pentagrid mixers of the 6A7 family, but even more important is the performance of the IF amplifier. When receiving strong signals, the IF amplifier may have to deliver 25 or more volts of signal to the diodes. This is well within the capabilities of a well designed IF amplifier, but if it is at the same time subject to an AGC bias of the same order, its own anode current will be severely reduced and the signal will be badly distorted. The effect of this distortion is the same as overmodulation.

Some designers took this into account in larger receivers and either left the IF amplifier without control, or applied only fractional AGC voltage. Other manufacturers simply relied on a 'Local-Distance' switch to bias back the RF and/or IF amplifier to cope with strong signals.

Faults and repairs

Although they have only relatively few components, AGC circuits can produce some significant faults. Fortunately, most problems are readily cured, frequently by the replacement of 'tired' capacitors.

Most common is leakage in the bypass capacitors — traditionally 0.05uF (50nF) or 0.1uF paper types. These capacitors frequently have low resistance, often less than 10 megohms. For a capacitor bypassing a screen dropping or cathode resistor, this resistance would be of no significance, but with two or three capacitors bypassing a typical AGC line, losses can be quite significant.

Many moving-coil multimeters will not give much of an indication with resistances of this order. As suitable replacements are inexpensive, it is a good idea, if there is any doubt, to replace AGC capacitors anyway. Paper dielectric capacitors are no longer available, but plastic or disc ceramic types make superior substitutes and as high voltages are not involved, ratings as low as 50 volts are adequate. Modern components are very small, and the 'original' appearance can often be retained by heating the old capacitor to melt out the wax, removing the contents and concealing the replacement inside the case.

Lead dress can be important, especially for RF and mixer stages. Unfortunately replacing AGC bypass capacitors, which are often mounted beneath coil and bandswitch assemblies, may demand patience and dexterity. These capacitors often complete the circuit between tuning coils and their tuning capacitor rotors, and to preserve stability and shortwave tracking, they should be earthed at the same point as their associated tuning capacitor wiper.

One fault in AGC systems with the diode fed from the anode of the IF stage can cause a complete failure of the receiver. In many receivers the coupling capacitor was a silvered mica ('SM') type, which functioned well for years. These capacitors were made by depositing thin layers of silver on the faces of the mica dielectric plates, with the bene-

fits of a saving in electrode thickness and of accuracy of capacitance — but they had a built-in time bomb!

If as is the case in this situation, the capacitor is exposed to a high potential between the electrodes, the silver coating tends to migrate into the mica, until eventually there is a conductive bridge between the two faces. The result is a short-circuited capacitor, which applies the receiver high tension to earth via the AGC diode.

The best replacement for one of these capacitors is a ceramic type, with at least a 350 volt rating.

One AGC-related fault gave me a lot of trouble the first time I encountered it. The receiver was a simple five valve standard superheterodyne, with a circuit much like that of the AWA in last months column. Occasionally there would be a small but irritating upward jump in volume — and typical of intermittent faults, any attempts at making a measurement caused a disturbance sufficient to make the fault disappear.

The obvious cause would be a shorting AGC bypass capacitor, but these had been replaced. Then I noticed that when the fault occurred with the AGC line disconnected, instead of increasing, the volume dropped! This provided the clue. The fault was an intermittently open .0001uF (100pF) detector load bypass capacitor. This capacitor acts as a similar manner to a power supply input filter capacitor, and when it was open circuited there was reduced audio signal and AGC voltage. With no AGC control the audio signal drop was apparent, but with AGC, this effect was masked by the increase in mixer and IF gain.

Unsuspected fault

There is an often unsuspected problem that can seriously degrade performance in receivers with an RF amplifier stage ahead of the mixer. The symptoms are that the receiver performs indifferently and there is little AGC action. As an example, the Stromberg-Carlson 837 circuit of Fig.2 has a typical broadcast band coupling coil following the 6D6 RF amplifier, and connecting the anode to the mixer grid is a very small capacitor C9. In many cases, as can be seen in Fig.3, this capacitor actually consists of a single turn of wire wound on top of the grid winding, relying only on wire insulation for separation. With one winding having the full HT applied and the other with a negative potential, even a small amount of leakage can be serious.

At this point, the resistance to earth of an AGC line is typically 2 megohms. If, for example, the insulation leakage is only 10 megohms, potentially there could be something like 50 volts positive present on the AGC line. In practice the control grids of the AGC-controlled valves act as diodes, clamping this voltage to that of their cathodes, but the grid current flow seriously degrades performance.

The simplest way to check for this condition is to apply power to the receiver with all but the rectifier and output valves removed, and then with a high resistance meter such as a digital or vac-

Fig.3: A typical RF transformer with 'top coupling' capacitance provided by a turn of the primary wire closely coupled to the secondary (just visible on the centre winding). Breakdown of the insulation can seriously upset the receiver's performance.

uum-tube voltmeter, check for the presence of a positive potential on the AGC line. If there is, disconnect the wire capacitor and replace it with a 4.7pF high voltage ceramic type.

Another possible cause of this problem is leakage across dirty wavechange switch wafers. Aerosol cleaners can be used for cleaning these, but NEVER with the power applied to the receiver — as tracking can occur, with disastrous results.

This has not been an exhaustive coverage of all valve-receiver AGC systems, or even all the faults that can occur. But we have taken a look at the circuit arrangements most frequently encountered, and hopefully given the novice not only some insight into the way they work, but also the confidence to service them. AGC is an essential feature of vintage radio. ❖

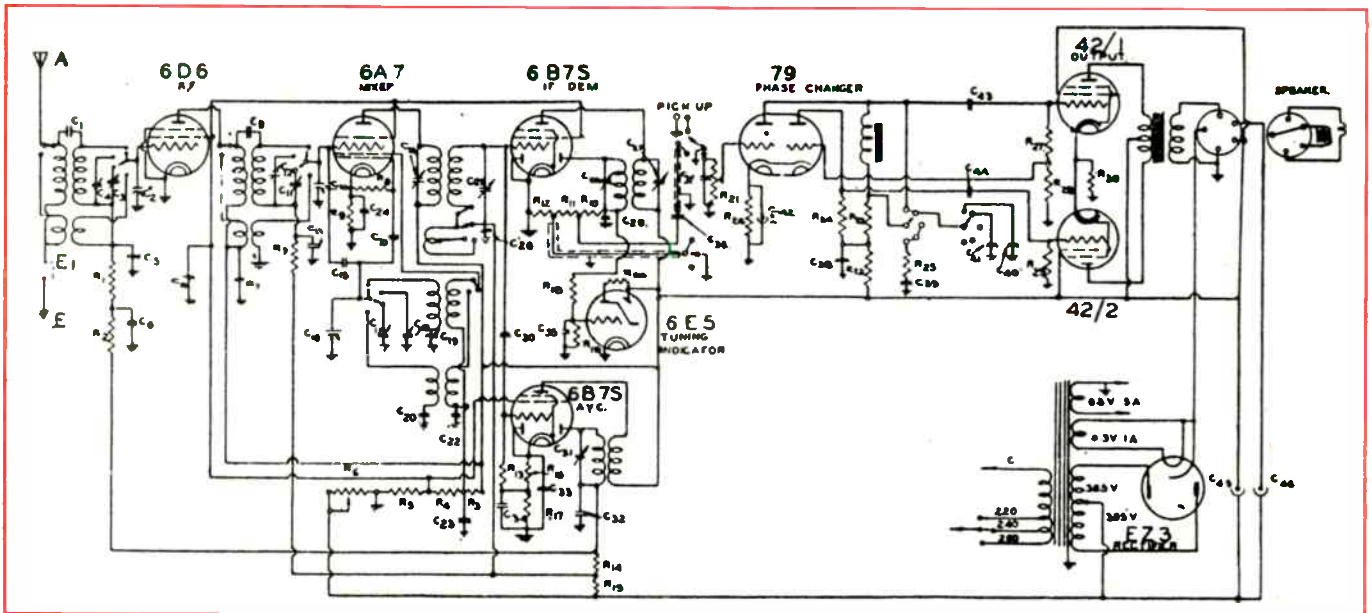


Fig.2: The circuit of the Stromberg-Carlson 837. Provision of separate IF amplifiers for audio and AGC detection reduced the receiver's distortion and optimised amplification characteristics.

NEW BOOKS

Basics of microwaves

AN INTRODUCTION TO MICROWAVES, by F.A. Wilson. Published by Bernard Babani, 1992. Soft cover, 178 x 110, 131 pages. ISBN 0-85934-257-3. Price to be announced.

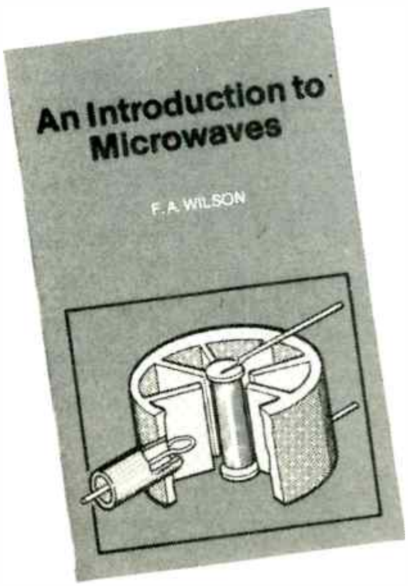
This book is not written for the expert, but it does assume some basic knowledge of electronics, including semiconductors. Three appendices are supplied to assist those not familiar with the field of communications.

Chapter 1 is an introduction to the basic concepts of charge, and the nature of electromagnetic (EM) waves — which of course includes microwaves.

Chapter 2 deals with 'Moving microwaves around': transmission lines, coaxial cables, wave guides, antennas and ferrites. And chapter 3 deals with the generation and processing of microwaves: microwave tubes and the klystron, magnetron and semiconductor devices.

The measurement of microwaves comes next in chapter 4: frequency and power. Power is measured via the resistance change in a thermally sensitive element, and usually involves barretters, thermocouples or attenuators.

Chapters 5-7 are entitled 'The Magic of Microwaves'. Ch.5 deals with communication, including cellular phones and satellite TV; ch.6 with radar; and ch.7 with heating, as applied in the domestic microwave oven.



Appendices 1-3 cover measurement in decibels, signal-to-noise ratio and AM and FM modulation.

I found the book to be well set out, easy to read, and with plenty of illustrations to assist with the explanations. All the concepts are also explained with the relevant mathematical expressions. These complement the descriptive explanations. A large amount of basic theory is covered in this small book, and the author's aim of giving an introduction to microwaves is achieved very well indeed.

The review copy came from Federal Publishing Bookshop, PO Box 199, Alexandria 2015. It is available by mail order from this address. (P.M.)

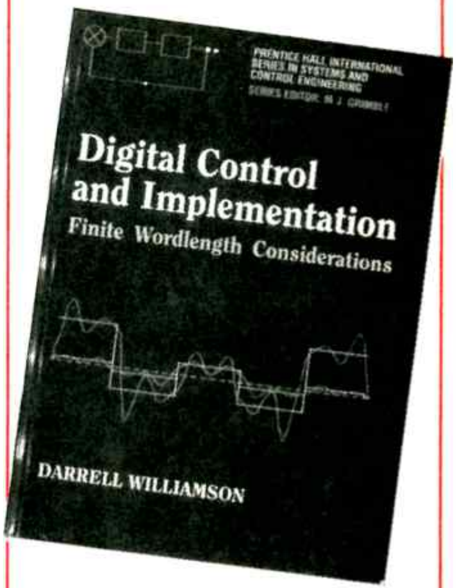
Systems and control engineering

DIGITAL CONTROL AND IMPLEMENTATION, by Darrell Williamson. Published by Prentice Hall, 1991. Soft cover, 235 x 170mm, 625 pages. ISBN 0-13-211640-5. Recommended retail price $49.95.

This is clearly a textbook, designed for students and practising engineers dealing with the application of digital control laws to high performance systems operating under fast sampling rates. Existing background knowledge of the following areas is desirable: the control of single variable systems using Laplace and z-transformations; frequency-domain lead and lag compensation based on Bode analysis; and the time-domain root locus approach.

Chapter 1 deals with open loop analysis: interfacing, modulation, sampling and multi-rate systems. Chapter 2 deals with closed loop control: design issues, analog versus digital controllers, and time-domain and frequency response methods.

'Finite Wordlength Arithmetic' is covered in chapter 3 — the significance of the finite storage register length on the numerical sensitivity of the digital control algorithm; followed by 'State Space Structures' (ch.4) — the impact of the finite wordlength on the choice of 'plant model' for controller design, and the structure of the 'controller' for controller implementation.



Chapters 5 and 6 deal with 'Linear Quadratic Filtering' — the use of predictors to approach an unbiased estimate of a variable (minimum variance) — and 'Linear Quadratic Control' which is one control strategy which can result in a stabilising linear controller with important closed loop system characteristics.

To assist with self study, each chapter concludes with a large number of problems. This study can also be enhanced by the availability of MATLAB programs.

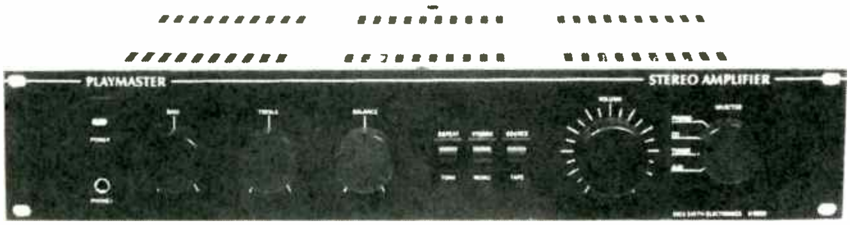
Finally Matrix, System, Stochastic and Lyapunov theory are covered in four appendices.

The book is obviously designed to give a substantial, mathematically-based treatment of the specialist area of digital control of continuous time systems. The author is Head of the Engineering Program at the ANU in Canberra.

The review copy came Prentice Hall Australia, 7 Grosvenor Place, Brookvale 2100. It is available from technical bookshops. (P.M.) ❖

New Arrivals

Now's the perfect time to check out our new April arrivals! This month you'll find a great range of new kits, tools and switches. As well, there's old favourites like our sensational Shortwave receivers.



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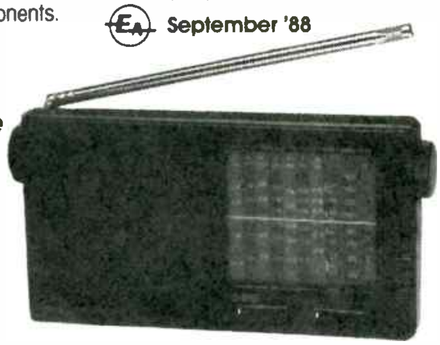

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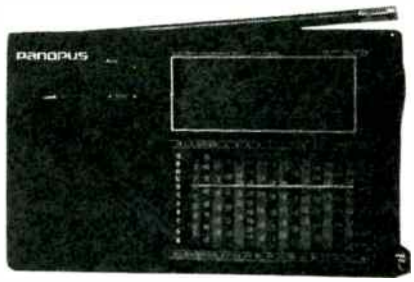

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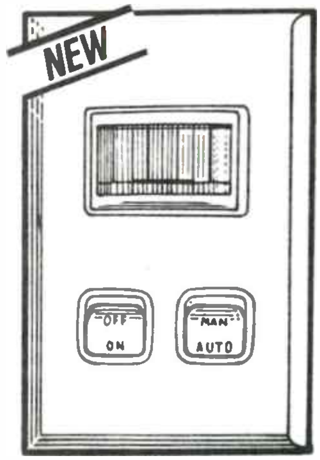

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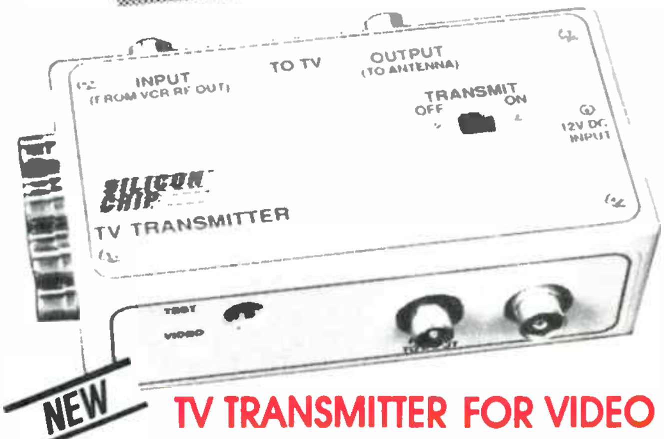

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SHORTWAVE LISTENING

by Arthur Cushen, MBE

50 years of monitoring the BBC

It was in November 1941 that Arthur Cushen of Invercargill, New Zealand, received a request, in answer to a letter reporting BBC reception in the South Pacific, to provide regular monitoring reports. These reports continued on an honorary basis until 1960, when his loss of sight resulted in the BBC employing him as its official New Zealand monitor.

It was the Empire Service which was being broadcast in 1941, when the BBC's Jack Acton made the request for weekly reports. These were sent on a special aerogramme. Those days, there was no SIO Code, and a descriptive picture of the signals was given. In all cases, the callsign, as well as the frequency in megacycles, was used.

In 1945, Jack Action commented, "Your monitoring has enabled us to expand the General Overseas Service for the period 0200-0400GMT". He also commented, "I wonder if any of our transmissions are not received in Invercargill. Reception seems to be remarkable, and is very difficult to understand that signals not sent in your direction are being received in the antipodes".

Earlier, Cable and Wireless advised of collect cable arrangements, and I commenced sending 25-word telegrams to London each week covering the reception of the General Overseas Service. In 1945, this was increased to 50 words, and over many years, some hundreds of cables have been sent to Bush House.

At this time, Jack Acton moved to Canada, along with some other BBC engineers, to set up the Canadian Broadcasting Corporation transmitters at Sackville. This later became Radio Canada International.

Jack immediately wrote to me and asked if I would monitor the South Pacific area for CBC, which was broadcasting a special service for the Navy in 1945, between 0200-0600. When that was discontinued the Pacific Service commenced broadcasting at 0600-0830. This was carried on GSW 7.23MHz 0600-0830; GSB 9.51MHz 0600-0830; GVW 11.70MHz 0600-1000; GSF 15.42MHz 0630-0800; and GWG 15.11MHz 0630-1000.

After Jack Acton left for Canada, Graeme Phillips handled the London correspondence and in July 1946, Henry Hatch first wrote to me. Henry became a familiar figure with shortwave radio listeners worldwide, as in the 1960's the World Radio Club was firmly established. This was a weekly programme for shortwave listeners, in which I had many contributions of news and listening in the South Pacific. Henry Hatch answered all my mail until his retirement in 1970, and later John Hynd handled the correspondence. Today, the department has been altered and a special Broadcasting Coverage Department has been established with Peter Gordon as the contact.

Reporting reception

In the early days, the General Overseas Service originated from Broadcasting House, but in 1957 a move to Bush House gave the External Services a greater area in which to work.

The early reports to London were of a descriptive nature, and concerned reception interference and a general evaluation of the programme. In those days, reception was only during the evenings here in New Zealand, from 0600-1030, but when the General Overseas Service was replaced by the World Service, 24 hour-a-day broadcasting followed. This meant a major extension in the hours of monitoring here in New Zealand, and checks were made during our mornings, which would be 1800-2300, and our evenings 0600-1115.

The early aerogramme reports were replaced by log sheets, and the familiar R65 sheet was introduced in 1965. This sheet has provision for 20 observations, with each block having the SIO code down the side, and across the top, Sunday through to Saturday. This allows a signal level to be given for any day of the week. In preparing these logs, the material is typed in, with the frequency and time. In the case of the BBC frequencies, they are checked from the highest to the lowest.

Today, we make 28 checks between 1800 (6am New Zealand time) and 1115 (11.15pm). Over the years there have been many more frequencies in use, but the Pacific Service is rather stable these days, using relay facilities from Singapore, Antigua, and direct transmissions from the United Kingdom.

In 1989, the BBC attempted a new type of monitoring, using the E89 form. In this, the monitor had to circle the date, time and frequency. As well as the SIO code being used, comment on interference in a code form was also shown. This was a major departure for the monitor. When completed, the form was read optically at Bush House and fed straight into the computer. However, the trial, in which I was one of the guinea pigs, did not prove a success, so monitors returned to the old E65 form. However, the Voice of

Arthur and Ralda Cushen visited the BBC World Service Studios in 1969 and were interviewed by Henry Hatch, well known for his part in BBC World Radio Club.

America also introduced an optically-read form, and the main comment from monitors is the work involved. It takes one of my staff over 40 minutes to prepare the form, and as we make 64 separate checks on VOA transmissions each day, this becomes a major task.

In washington it becomes very simple, as the optical device reads the material and puts it on to computer. There is provision, as in the BBC form, to draw attention to special information such as new forms of interference, and this can be picked up by the office before being processed.

Visiting London

In 1969 my wife Ralda and I circled the globe, visiting Los Angeles, Denver, Montreal to spend time at Radio Canada, London spending two weeks at Bush House, Hilversum spending time at Radio Nederland from where I have been broadcasting a programme since 1966. Then we went to Denmark, meeting the editor of the World Radio/TV Handbook (I have been their agent in New Zealand since the first edition in 1946), and Sweden. There we stayed with Arne Skoog, with whom I have collaborated over many years. We also attended the European DX Council Convention at Halmstad, and then returned to Wales for a convention of British listeners. Next we visited Berne, the Vatican and Rome Radio, and spent some time at Radio South Africa. Then it was through to Mauritius, Perth, Sydney and finally back to Invercargill. The time in London was spent visiting BBC installations, and included monitoring and taking part in a programme of the BBC World Radio Club. In Radio Nederland, there was an interview with the late Eddy Startz; in Denmark with the English Section, now long since disbanded; in Sweden with Arne Skoog; in Berne with Bob Thomann; and in South Africa with the staff of RSA.

The visit to London enabled me to get a better idea of what a monitor should be doing. As has always been the practice, equipment used to monitor BBC signals, or those of VOA and RCI, has always been a typical domestic receiver. For many years this was an Ekco seven tube, until 1954; then a Philips; and from 1980, a Sony ICF2001.

The aerials, though extensive at this listening post, are not used for monitoring. I use only one, which is a short inverted 'L' to tune in to London, because I do not wish to give a rosy picture of reception — one which is better than that enjoyed by listeners in a typical domestic situation.

My work for the BBC has resulted in many visitors coming to this country to look at broadcasting, and visiting me in Invercargill. Perhaps my greatest thrill was to be presented to Her Majesty the Queen on March 13, 1970 in Wellington, when I received the MBE for my services in radio and blind welfare. Her Majesty discussed briefly the work of the Christmas message. I used to listen every year, at 3am local time, and send a cable to London reporting on the quality of the reception in the Pacific. I expressed my pleasure that these days, with television there is no live broadcast of the Christmas message. This means that early morning listening on Boxing Day in New Zealand is no longer a regular event in the Cushen household.

It is interesting to note that between 1942 and 1971, I sent 1099 international telegrams to the BBC, covering all aspects of reception of the signals in the South Pacific.

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.

AROUND THE WORLD

ABU DHABI: Reception begins with clock chimes and the National anthem, followed by English announcements at 2200. The two hour transmission is announced as being on 9600, 11965 and 7215kHz. After the opening details, there is generally a reading from the Koran.

AFGHANISTAN: Broadcasts from Kabul are announced as being on three frequencies for the English service, 1800-1900. Reception is best on 6145kHz, though there is some sideband interference because the other two frequencies of 7215 and 9635kHz are blocked by stronger transmissions. It is understood that the two lower frequencies originate from transmitters in the USSR.

ANTARCTICA: After being off the air for several months, the Argentine station Radio Nacional Arcangel San Gabriel, is again operating on shortwave, using the callsign LRA36 and located at the Argentine Antarctic base. Using the frequency of 15475kHz and a power of 1000W broadcasts are made Monday-Friday, 2100-2305. A variety of languages is used, including identification in English, French, Spanish, Italian and Portuguese. The verification card is prized by many listeners, and it is necessary to send International Reply Coupons for return postage.

BHUTAN: Formerly one of the most difficult countries to hear, Bhutan with its 50kW transmitter is now well received on 5025kHz. The main problem is severe RTTY interference, but this can be overcome by some fine tuning. The programme in English is noted at 1415, with local news interspersed with short bursts of music. From 1430 to sign-off at 1500 the programme generally consists of popular music, mainly from North America. This station is difficult to verify, and few have been successful in recent months in receiving confirmation of reception of this newcomer to shortwave broadcasting.

FRENCH GUIANA: The powerful transmitters of Radio France International at Montsinery are used to carry a broadcast for Radio Japan 0200-0300 in Japanese. Two frequencies are used, 15325 and 15350kHz. At 0300 there is generally an English announcement as the station then continues with a news bulletin; but as this is not scheduled for these two frequencies, the relay is cut soon after the identification announcement.

LEBANON: Voice of Hope, which recently installed a second transmitter at their Lebanon site, is using the power of 25kW and has been heard on 11530kHz at 1900 with an English announcement. It is carrying the same programme as the old transmitter on 6280kHz, and though requesting reports to an address of Box 3379 Limissol, Cyprus, our verification was posted from the studios at Metulla, Israel. The station also advised that its Pacific operation on Guam with the call KHBN is still in the construction stage.

NEPAL: Kathmandu broadcasts on two frequencies in English, 1415-1500. The lower channel 5005kHz offers best reception, as 7165kHz is a frequency which is prone to interference.

SRI LANKA: As well as being the site of SLBC transmitters, this country also has relay bases for the Voice of America, Radio Japan and Deutsche Welle. Trans World Radio also operates a transmitter of 300kW on medium wave. Trans World Radio has announced they will use the two transmitters of Radio Japan of 300kW for a broadcast to Asia in the mornings, and later plan to use 100kW shortwave transmitter for their own service.

VOA from Botswana

The Voice of America has opened a new relay base at Gaborone in Botswana, for shortwave broadcasting. Previously, the site was used for a mediumwave transmitter, with a power of 50kW on 621kHz. Two 100kW transmitters were first put into operation in December, to be followed by a further two transmitters, with programmes beamed towards Northwest Africa.

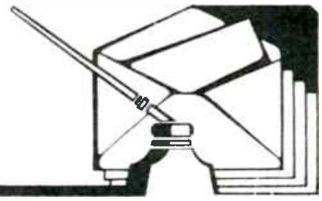
The Voice of America has faced a severe audience loss with the fighting in Liberia and the destruction of the huge Voice of America base at Monrovia. Attempts to serve the audience in Africa from stations in the US and the Philippines have not been successful, so this new base was set up in record time in Botswana. The base will use two aerial systems to cover Central and Western Africa. Later, with the next two transmitters, further coverage will be obtained over the African continent.

The station will carry mainly African language broadcasts, but there are some broadcasts in English, including: 0300-0500, 7265kHz; 0300-0430, 11940kHz; and 0430-0500, 15370kHz. The transmission for evening reception in Africa is from 1600-2200 on 15445kHz. The other transmitter will be used for African language broadcasts during this time period.

In its first few days of operation, Voice of America, Botswana, had its own identification announcement in order to familiarise listeners with the site of the new signal. The broadcast is already reaching a new audience in Africa, including those who previously relied on the Voice of America, in Monrovia. ❖

Information centre

Conducted by Peter Phillips



No, it wasn't a con at all!

It's back to that thorny 'one capacitor discharging into another' discussion, for the last time — I promise. The Dirac function is also explained (at last), and reader G.M. (who launched us into this argument in the first place) finally has his say.

Because of printing lead times, there is usually a gap of some four months before a response can appear to a topic presented in a particular issue. For example, letters arising from the content of the February issue would normally be presented in May.

You might remember that the main Information Centre topic in the February edition centred around an explanation on where the missing energy goes when a charged capacitor is discharged into another uncharged capacitor of equal value.

In case you're reading this column for the first time, a correspondent (G.M., of South Oakleigh) posed this question some time ago. Since then, following G.M's answer, I have received a virtual flood of letters offering various other solutions.

Then in February I printed a letter sent by R.V. (St. George's Basin, NSW), who suggested that the whole question is a con, as the final voltage across the two capacitors will not be 50V (as given in the original question) but 70.7V. He also offers some quite simple but convincing mathematics to support this. In other words, according to R.V., there is no missing energy.

Because of the rather contentious turn of events, I decided to contact G.M. before he read the February issue, as I wanted his reaction to the letter from R.V. After all, if R.V. is correct, then everyone else is wrong.

If you have read the February issue, I'm sure many of you will agree with R.V. (as I did). Those of you who don't will probably have already written, and under normal circumstances this whole discussion would be taken up again in May.

But in the interests of not prolonging the topic any further, I'm going to let a few readers have a say, then let the topic end with G.M's reply. Here's what one of the other readers had to contribute:

A parameter that has not been considered is inductance. While it is theoretically possible to eliminate resistance, neither inductance (or capacitance) can be eliminated. Therefore, an inductor (of small value) is effectively in series with the two capacitors when they are joined, which controls both the peak circuit current and the frequency of oscillation.

If no losses exist in the circuit, the circuit would oscillate indefinitely, except that at least one loss must be present — electromagnetic radiation. In an ideal circuit, the oscillations will decay at a rate determined by the radiation level, and the 'lost' 2500J will be entirely in the form of this radiation. Add resistance and the rate of oscillation decay will increase, with additional losses occurring as heat in the resistance.

Incidentally, the above analysis provides the solution to the January What?? in which the ideal diode prevents any further activity after the first half cycle of oscillation. This will leave C2 charged to 10V and C1 at 0V. (R.M., Ermington NSW).

Thanks R.M., you're the first person so far to raise the issue of inductance. However G.M's reply also eliminates this quantity, although the 'missing' energy is in fact dissipated as electromagnetic radiation. The next letter makes a similar point...

You have neglected inductance in your two-capacitor circuit. It oscillates! Every circuit that conducts current has a magnetic field with a value determined by the current. Even the displacement current in the dielectric of a capacitor has a magnetic field. Therefore, every circuit has inductance.

When the circuit is closed, the current flow from C1 to C2 will increase sinusoidally from zero to a maximum when the voltages across both capacitors are equal. The energy 'missing' at this instant will all be in the magnetic field of the circuit.

Reducing the inductance increases the frequency of oscillation, causing larger currents to flow as the same charge is being transferred, but in a shorter time. In fact the problem is the same as asking where the missing energy goes if a charged capacitor is shorted with a lead of zero resistance. That C1 and C2 are in series is easily seen by setting up the differential equation for the circuit. (G.F., Vermont Vic).

And here's a clue as to why R.V. is wrong! Yes, G.F., the capacitors are in series, not in parallel. Anyway, to put us all straight, here's G.M.'s reply. I've combined two of his letters, one sent before G.M. read R.V.'s letter, and the one after:

Shock, horror! when I read R.V.'s letter. If he is correct (and his maths certainly appear OK), then there are severe implications for the entire spectrum of Electrical Engineering and the Earth is also probably flat! To quote G & S: ' A paradox, a most amusing paradox.'

Not so! With due respect to R.V., he has made an elementary mistake in his reasoning. He has assumed that the resultant capacitance is equal to the parallel combination. Actually they are effectively in series, in series with the energy source. So while his arithmetic is correct, his reasoning is wrong.

To prove the point, I suggest R.V. tries the experiment with a couple of 1000uF capacitors, a high impedance measuring

Information centre

[illegible]

instrument and a power supply. He will find that the resultant voltage is 50% of the original, not 70.7% as he suggests. Naturally, make sure the target capacitor is fully discharged first.

Regarding R.V.'s comments about radiation reaching astronomical values, he needn't worry as the duty cycle in this case approaches zero for R approaching zero, and the radiation therefore occupies the entire spectrum with a value of unity.

Referring back to comments made by other correspondents, it seems they all missed the point of the problem which was — the capacitors are ideal, there is no resistance at all and there is no inductance at all. Under these conditions, an infinite current flows for zero time. Most of the solutions introduce resistance, and while this makes the question easier to solve, it is not the solution to the problem as posed.

One correspondent (D.C., Gladesville NSW) suggests that the voltage across a capacitor cannot change instantaneously. If a step function or a square wave is applied to a simple RC differentiator (see Fig.1) you can see that at the instant the value of the input voltage changes, so does the output voltage, which is taken from the other side of the capacitor.

So I don't have to type out all the maths, I suggest readers interested in the Dirac function get hold of a copy of 'Communication Systems' by B.P. Lathi, published by John Wiley & Sons, ISBN 0 471 51832 8. The Dirac, or Impulse function is represented by an infinite current flowing for zero time, and has a power spectrum ranging from -infinity to +infinity. This has implications concerning digital signal processing and explains why cosx/x correction is needed for DSP digital to analog converters such as in PCM codecs.

And finally: 'oxymoron' noun (rhetorical). Figure of speech with pointed conjunction of seeming contradictions, for example, 'faith unfaithfully kept him falsely true.' Greek - Oxy sharp, moros foolish. (G.M., South Oakleigh Vic).

And that's the end of the story. Thanks G.M., for both starting this rather lengthy topic and for concluding it.

Incidentally, I decided to take matters into my own hands and to conduct the experiment suggested by G.M. To this end I used two 1000uF capacitors connected via a switch which, in the off position placed a short across C2, isolated C1 from C2 and connected a 10V DC source to C1. In the on position it removed the short, connected the capacitors and isolated the supply from C1.

I then connected a DC-coupled CRO with a x10 probe across the circuit via a 10M resistor, giving a total loading of around 20M. I then adjusted the CRO trace so I could observe if the voltage across the two capacitors fell to 50% or 70.7%. As G.M. predicts, the voltage was definitely 50% of the initial value.

But a rather interesting issue arises out of all this — just what is a Dirac function? Here's some comments that may shed some light...

Dirac function

Since you asked in January for something without mathematical symbols on the Dirac Delta, I'll toss in a couple of comments. If you want more, then I recommend Bracewell's classic text on Fourier Transforms — and since he's a dinkum Aussie, he must be good eh! (Ronald N. Bracewell, The Fourier Transform and its Applications, 2nd Ed, McGraw Hill, 1986).

Essentially, the Delta is a notation for pulses that are faster than the resolving time of the measuring system, or shorter than an interval of interest. Hence their actual shape is immaterial, and only their integral counts, delivering a unit pulse in total. A notation often used is a spike in which the height is proportional to the integral, solely a convenience. This is not a plot of the function itself. (Incidentally, in a less refined form, the Delta had extensive use prior to Dirac, from Hermite to Kelvin and in particular by Oliver Heaviside).

So essentially the Dirac Delta is an attempt to mathematically capture a very useful beast, the impulse. Knock on a crystal glass, a tyre or a speaker cabinet to determine the resonance and the Q. Blip an impulse through an electrical network to see how it rings. In their mathematical form Dirac's Pure Impulses are infinitely sharp and infinitely fast.

More to our point, their Fourier transform spectrum is that of white noise with an infinite bandwidth. It is that bandwidth that is so important. As the resistance of a loop approaches zero, the current impulse becomes closer to a Dirac type pulse, becoming larger and shorter as the resistance decreases. A true zero resistance would give the Delta function.

This progression of rate implies an increasing bandwidth. The current step becomes faster as the resistance reduces. But an increasing bandwidth introduces another factor. As the pulse sharpens, so too the caupling opportunities increase until power dissipation by electromagnetic radiation occurs.

So to summarise, with the big pulse, when I viciously shunt capacitors the radio clicks and a sensitive compass twitches as work is done. A short pulse with some amplitude radiates out into electromagnetic space. With the soggy small step, using a resistor of large value, neither click nor twitch, merely a little warmth in the resistor, more Ohmic that Diracian.

On a similar topic, your discussion on propagation velocities for electrons and signal current interested me. Solymar (L. Solymar and D.Walsh, Lectures on the Electrical Properties of Materials, 3rd Ed, Oxford UP 1984) quotes a figure for a typical metal of about 5mm/sec in a gradient of 1V/metre. Compare this to the electron thermal velocity of about 10km/sec at room temperature. Lots of collisions and hence smoothing of current density variations.

The actual wave propagation velocity depends a lot on the details of local inductance, capacitance and dielectrics. Computer designers became well aware of this as speed requirements increased. A desktop computer of 1991 could have cache RAM cycling at less than 20ns. If I recall correctly, when the supercomputer Cray II and its competitor from Cyber were designed, different methods were used for their internal signal wiring. Cyber opted for coaxial cable (transmission line), giving a speed of between 0.9C to 0.95C. (Just to remind you, C is about 300mm/ns). Cray took the other option of using ordinary wiring.

As a result, the size of the Cray had to be kept as small as possible since every

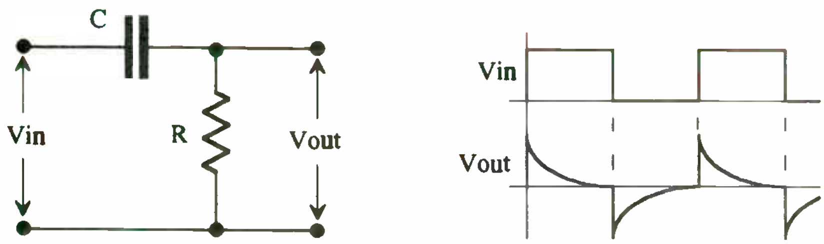


Fig.1:

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[illegible]

[illegible]

300mm of signal wire added a delay of 2ns. The final shape of the computer was almost circular, with an access to the keyboard centred within the main processors and memory. No wonder the Cray II was called the 'world's most expensive love seat'! (R.B., Auckland NZ).

Thanks R.B., for describing the Dirac function in lay terms. Most readers will probably be aware that the faster the change of a current pulse, the greater the electromagnetic radiation (light dimmers, on-off switches and so on). The Dirac function seems to be an extension of this. The next letter puts it slightly differently...

As you say, difficulties arise when you talk about zero resistance, infinite currents, zero time and infinite frequencies. These are extreme values that mess up otherwise reasonably simple mathematics, and also do not occur in the real world we try and live in.

Similar problems arose in the past when the brains of the day tried to mathematically handle step functions, impulse functions and the like used to excite electrical networks. Heaviside came up with some totally practical results for the step function, but other mathematicians did not accept his methodology as being sufficiently rigorous. They came up with some well behaved mathematical functions that would approach steps, impulses etc as a parameter was increased towards infinity.

The trick was to get a sensible answer to multiplying an extremely large number with an extremely small one. One of the functions they discovered was the Dirac Delta function which is a family of exponential decays. In this function, for positive time, if a parameter is increased, the pulse becomes higher and narrower, yet the area enclosed remains at unity. At its limit, it becomes so like a unit impulse function (infinitely high, zero width) that no one cares about the difference.

Incidentally, I think the gremlins have gotten at your mathematics again. An extra 2 has snuck into your January 'e', it should be 2.71828, not 2.271828. Have your compositors become interpositors, transpositors or juxtapositors?

Finally, I think these What??'s of yours are good for promoting a deeper understanding of electronic principles. January's sure fired me up! Very necessary if we're ever to arrive at the clever country. (P.A., Lara Vic).

It seems a typositor (about my size) snuck in the extra 2. I could say 'just testing' but I won't. Thanks P.A., both for your description of the ubiquitous Dirac function and your supportive comments.

This whole topic has occupied a lot of space in these columns, but I think it has served us well. The risk of allowing a topic to run too long is that it might becoming boring by creating a 'positive feedback loop' as one writer puts it. But it's also a way of introducing some high level theory without too much pain. Perhaps the Dirac function is now in all our vocabularies — something to discuss at the next party maybe!

VCR mods

Returning to more practical issues, here's a letter about an aspect of VCR design that the writer concerned feels rather strongly about:

Why do our VCRs need to have a TV/VCR switch? To change between a signal direct from the antenna and the signal from the VCR's modulator, one has to perform two operations — tune the TV to the VCR channel and operate the VCR/TV switch.

The annoying thing is it needn't be that way. If the buffered signal from the antenna is mixed with the RF output of the VCR, the VCR could be selected by simply selecting its allocated channel on the TV set. This is exactly what happens in VCRs that have an output in the UHF band. However machines with a VHF output always incorporate this stupid switch, even though there seems to be no technical reason for it. The service manual for my Akai VCR shows this switch provided only in the model intended for the Australian market. The European version mixes the signals just like UHF machines.

I conclude that the reason for this is political. Some pea- brained bureaucrat has decreed that Australian families shall be burdened with the inconvenience of a redundant switch. But why? Some might say the switch is no big deal. Also it's possible to split the antenna signal between the TV and the VCR and connect a direct video/audio connection as the output of the VCR. Difficult in many instances, particularly if the receiver doesn't have a direct video/audio input.

I have achieved good results with a setup using two splitters back-to-back as shown in Fig.2. In my case it was necessary to break the circuit at the point marked 'X'. A distribution amplifier was added at the output of the combining splitter to provide signal to several TV sets. (G.L., Ringwood Vic).

Strong words G.L., although a good point. Somehow I doubt if the switch you refer to is simply the result of a bureaucrat's whim. I suspect that tests may have shown interference between some TV channels and the RF output of a VCR tuned to the VHF band. Australia still has a legacy of non-standard TV carrier frequencies, although these are being eliminated by changing them to UHF. This might also explain why the TV/VCR switch is not required when the VCR has a UHF output.

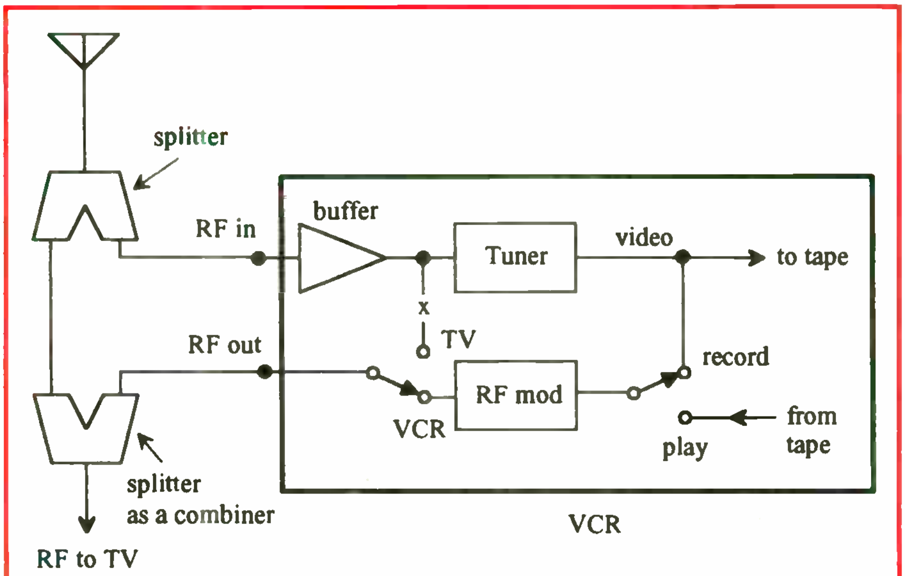

Fig.2:

Big Chars

The following letter describes how to convert Tom Moffat's 'Big Chars' program presented in December 1991 (page 99) to compile with Turbo C.

I have successfully modified Tom

Moffat's 'Big Chars' program to compile with Turbo C. I thought the information might be of use to other readers, as Borland's version of the 'movedata' function is different.

Replace _1move(1024, 0xFA6E, 0xF00, patterns, _showds()) with:
movedata (0xF00, 0xFA6E, _DS, (unsigned)patterns, 1024)
and replace
_1move(16, buffer, _showds() row, 0xB800) with:
movedata (_DS, (unsigned)buffer, 0xB800, row, 16)

I enjoy your column and doing the monthly quiz. I have enclosed a simple problem that one of my lecturers showed me many years ago. It is quite simple but has fooled some experienced technicians I have tried it on. Find the voltage across Rx. (G.B., Crafers SA).

The problem sent by G.B. is shown in

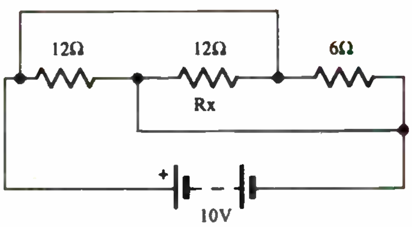

Fig.3:

Fig.3. If you can see the solution, don't let on! Thanks G.B., for both contributions.

What??

Here's a 'black box' question from Wen Liang Soong, who has provided some thought-provoking questions before. He asks: A black box has four output terminals. The resistance between ANY two terminals is 0.5 ohm. The box contains a network of 1 ohm resistors only. What is the smallest number of resistors in the box?

Answer to March's What??

Using x and y as the unknown resistors, here's the solution. First write the equation and add 1 to both sides giving $xy + x + y + (1) = 90 + (1)$. This equation can be simplified to give $(x + 1)(y + 1) = 91$. The terms $(x + 1)$ and $(y + 1)$ are the roots of the equation and all we need are two numbers that multiply to give 91. As the question says, we need whole numbers and the only two whole numbers whose product is 91 are 7 and 13.

Therefore, x = 6 ohms and y = 13 ohms. ❖

NOTES AND ERRATA

Simple Touch Light (November 1991): The component overlay diagram. Fig.2 on p.94, has the copper pattern (blue background) printed upside down. This explains why the components (black) don't connect to the PCB pads.

Logic Pulser (May 1991): The schematic diagram for this project differs in several places from the PCB overlay diagram. On the PCB diagram (p.65), the LEDs D4 and D5 are shown with the correct orientation, but their labels have been reversed — D5 should be the left LED. The other mistakes are all on the schematic (p.64).

Their corrections are: the bottom of R3 should be joined directly to the base of Q1, at the left side of R2, and not the right as shown; similarly, the top of R4 should be joined to the left side, and not the right, of R5; the top of C5 should be connected to the +V, not the -V, rail; D3 is reversed — its anode, and not its cathode, should connect to the junction of R9 and R10; and the output of U2E should be labelled pin 10, not 12.

Connecting C5 to the positive rail requires these changes to the text (p.64, column 3, lst full paragraph): 'C5 is connected ... composite capacitor charges from the voltage divider formed by *R8, and the series combination of R9 and R10* ... and the capacitor will then discharge, via R8 in parallel with the series combination of *D3 and R9.* ❖

NEW KITS FOR EA PROJECTS

Dick Smith Electronics has advised us of the release of new kits for the following EA projects:

SINE/SQUARE WAVE OSCILLATOR (March 1992): The DSE kit is complete and includes a punched and silk-screened front panel. It has the catalog number K-7340 and is priced at $59.95.

EL CHEAPO VOLTMETER (March 1992): The DSE kit includes the PCB and all components, but not the case. It has the catalog number K-4205 and is priced at only $6.95.

NEW 30W/CHANNEL STEREO AMPLIFIER (April 1992): The DSE kit is exactly as described, complete with punched and screened front panel. The catalog number is K-5600 and it is priced at $249.00.

NOTE: This information is published in good faith, from information supplied by the firm or firms concerned and as a service to readers. Electronics Australia cannot accept responsibility for errors or omissions.

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50 and 25 years ago...

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to 'Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

February 1942

Power Alcohol: Distilleries designed to produce 3,000,000 gallons of power alcohol a year from wheat may soon be open in several states. One of the main plants will be in NSW.

Chief factors governing the selection of the sites are availability of power, adequacy of water supply and sewerage capacity to dispose of waste.

Hydro Power: After final tests, the first of three identical 108,000kW Westinghouse generators, each driven by a 150,000 horse power waterwheel, will go to work at Grand Coulee Dam.

Each generator is nearly one third more powerful than any waterwheel previously built in the United States.

Power from the big machines will fill many defence requirements and peace time industrial needs in an area about twice the size of New England.

Some of the energy, all secondary or seasonal, will be used eventually to pump water into the vast semi-arid Big Bend area, 50 miles away, to restore productivity to about 1,200,000 acres of land.

February 1967

Thin Films: Delicate layers of electronically active material are making possible a new generation of solid state devices.

Less than one micron (one millionth of a metre) thick, the thin films which constitute the latest micro circuits, are revolutionising the design of television equipment, computer, communication systems, missile and spacecraft controls and a host of other electronic devices. Interest in 'electronic' films arose in the early 1920's following investigations into the nature and dynamics of atomic monolayers — thin layers of various materials only one atom thick.

The development about the same time of X-ray diffraction and similar investigative techniques led other researchers to extend these studies to include thin metal and metal oxide films that evinced valuable optical and electronic properties.

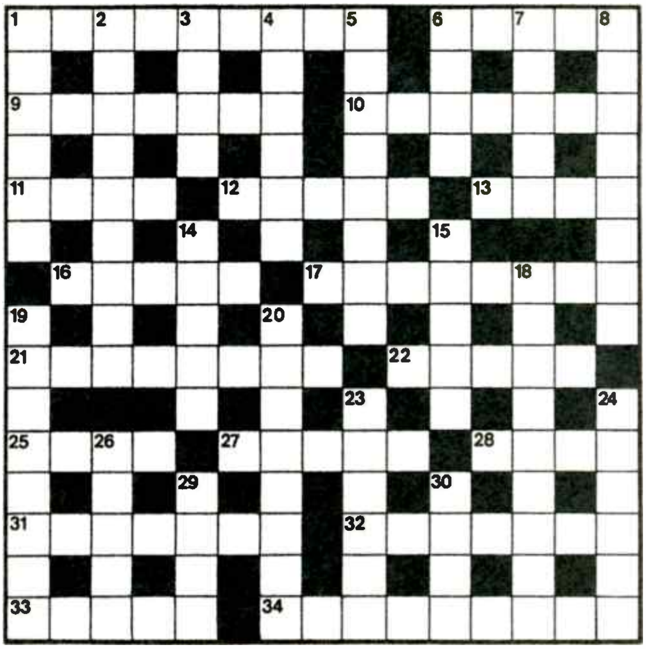
Speech Recognition: Direct voice control of typewriters, telephones, computers and other machines moved a step closer with the recent development of an experimental speech recognition system.

It was built by RCA and employs electronic circuits that function like living nerve cells.

The system identifies the smallest units of speech, called 'phonemes', by abstracting their more salient features.

Of the 40 phonemes in the English language, the machine can recognise 28. In its present form, the equipment recognises the initial consonant and the following vowel in a consonant-vowel-consonant word. ❖

EA CROSSWORD



ACROSS

1. Light sucker? (5,4)
6. Low-frequency pulsation. (5)
9. Convert from coded form. (7)
10. Shocking female of Greek myth. (7)
11. Country that launched VOSTOK. (1,1,1,1)
12. Pipes that carry cables, etc. (5)
13. Natural insulator. (4)
16. Component of security system. (5)
17. Text of opera. (8)
21. Person skilled in computer logic. (8)
22. Energy unit. (5)
25. Item of circuitry. (4)
27. Batch of EA. (5)
28. Luminous region on CRO. (4)
31. Excess data in unbuffered computer situation. (7)
32. Conductor in body. (7)
33. TV (colloq.). (5)
34. Light absorber. (5,4)

DOWN

1. Clandestine sucker. (6)
2. Obtaining data in computer. (9)
3. Parts pressed by PC player. (4)
4. Power, etc., supplied by a device. (6)
5. Type of shock. (8)
6. What you're on in stand-by mode? (4)
7. Proportional relation. (5)
8. Device with inside data light on! (5,3)
14. Hobbyist's table. (5)
15. Gas used in certain electric welding. (5)
18. Type of lens. (9)
19. Power loss contradicting 1, 8, 19, 34. (8)
20. Control for changing tone. (4,4).
23. Discrete amounts of energy. (6)
24. Like an iron alloy. (6)
26. Said of gas obeying Boyle's Law, etc. (5)
29. B & W. (4)
30. Said of components bought in large numbers. (4)

SOLUTION FOR MARCH

EA with ETI marketplace

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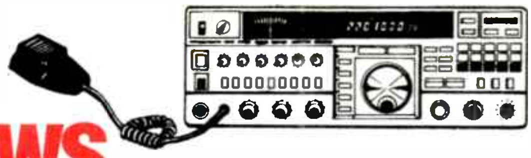
Amateur Radio News



New ARRL book on fixing RFI

The American Radio Relay League has released a newly revised edition of its publication *Radio Frequency Interference: How to Find It and Fix It*. The new book has 256 pages, and both explains the mechanisms that cause RFI, and provides cures. No doubt the book will be available here shortly via the WIA and major bookstores. However the new book can be purchased directly from the ARRL, at 225 Main Street, Newington CT 06111, USA. It costs US$15 plus US$3.00 for shipping and handling.

Darwin ARC to host SEANET 1992

The Darwin Amateur Radio Club is to host the 1992 SEANET Convention — the first time the Convention has been held outside south-east Asia. The Convention will be held from October 29 to November 1. Further details are available from Jim Jones, Secretary of the DARC, at PO Box 37317, Winnellie NT 5789.

French amateurs lose 2m during Olympics

The French amateur radio organisation REF has reported that French amateurs were banned from using the 2m frequencies 144.000 - 144.050MHz and 145.950 - 146.000MHz, for the whole of February. This was because the French authorities had allocated these frequencies for use by team members and service teams, during the 1992 Olympic Winter Games in Albertville. The French government's regulatory body DRG apparently suspended the allocation of the 2m frequencies to amateurs, for the full month and presumably for the entire country. The IARU and AMSAT are to protest at this action, which inevitably had adverse consequences for radio amateurs outside France itself as well as within it.

Atomic radiation

Continued from page 35

nual limit of 1/50th of this figure, or 1000 micro-sieverts. For those more familiar with the older unit, the REM, this equates to 100 millirem per annum.

The prismatic compass previously referred to gives off radiation, according to the Geiger counter, at a level of about 40 millirem per hour, so one could classify it as quite a 'hot' radioactive source and one to be cautious of in handling.

This is clearly a device to put well away from people in the household, and inside some shielding such as the pewter pot described earlier. However the prudent last word on exposure to radiation is that the *absolute minimum level achievable* is probably the safe level to aim for. As is stated in one of the pamphlets previously referred to:

There is still considerable uncertainty about the effects of exposure to radiation at low dose rates. This is because effects, if they exist at all, are masked by the 'normal' occurrence of disorders which may or may not be due to radiation exposure... It seems reasonable to assume that as the radiation dose becomes smaller, its effects become fewer.

What to do

In the event that this article spurs your curiosity and you realize that you have one of the many possible items described as having dials or other parts illuminated with radium and zinc compounds, there are a number of things that you may care to do.

Firstly, whatever else, do not simply throw the suspect device away. It may not be radioactive in any case but, even if it is quite 'hot', such a reaction does not solve the problem in any sort of a responsible way. It simply transfers it somewhere else, if not to someone else who may be quite unsuspecting and who does not necessarily have access to this magazine. If you are concerned that you may have a really 'hot' source, then it is possible to have the device examined by the officers of the Radiation Laboratory who come under the Department of Health in NSW. No doubt similar organizations exist in all States and would be similarly concerned and helpful.

With low level sources of radiation, the best defence is distance. That is to say, the further that you are from the radioactive source the better for your long term health, particularly if such distance is assisted by a substantial layer of lead around the source of radiation.

Apart from direct exposure to radiation and in particular the impact of the potent and highly penetrating gamma radiation, it is as well to realize that alpha and beta rays can become dangerous if they are emitted in close proximity to the tissues of the body.

While this is unlikely to happen under normal circumstances, if particles of the radioactive material are ingested through the mouth or through breathing them in, they could cause very severe long term health risks. So another important rule when dealing with radium compounds or any other source of radioactivity, is to avoid touching the material directly.

If for whatever reason you must do so, then as soon as possible afterwards, thoroughly wash your hands to remove any minute particles which may have dusted off the surface of the solid material. Even quite minute particles, when they are in direct contact with the body, can be very dangerous.

Some comments on the appearance of radium and zinc compounds may also be useful. This may help to determine probable suspect sources of radioactivity, as compared with other non-troublesome materials. Modern luminescent paint is usually a very bright green or blue-green colour and, in bright sunlight, will look almost as fluorescent as a felt pen marker ink on paper.

Such material does not hold its luminosity for very long in the dark and this is the best initial test. By comparison, radium-doped zinc salts give off a glow in the blackest of nights and are a dull sandstone or greyish coloured material and do not look at all luminescent in normal light.

Finally a word about that Polish coffee that started off this whole saga. After the dramatic response to the magnetic compass, it was quite an anti-climax when the elderly Geiger counter did not increase its 'click' count in the slightest when exposed to the coffee.

However this is not surprising, based on more recently received information from the Radiation Laboratory of the Department of Health.

They said that the Geiger counter was far too insensitive to pick up the level of radioactivity that might be associated with such a source. However their testing had not revealed any significant increase in the count rate from imported food since the Chernobyl disaster.

This should be quite a comfort to lovers of Polish processed coffee and perhaps also for those who would like to purchase those Balkan jams which seem to be so inexpensive, relative to the locally produced variety. ❖

Electronics Australia's

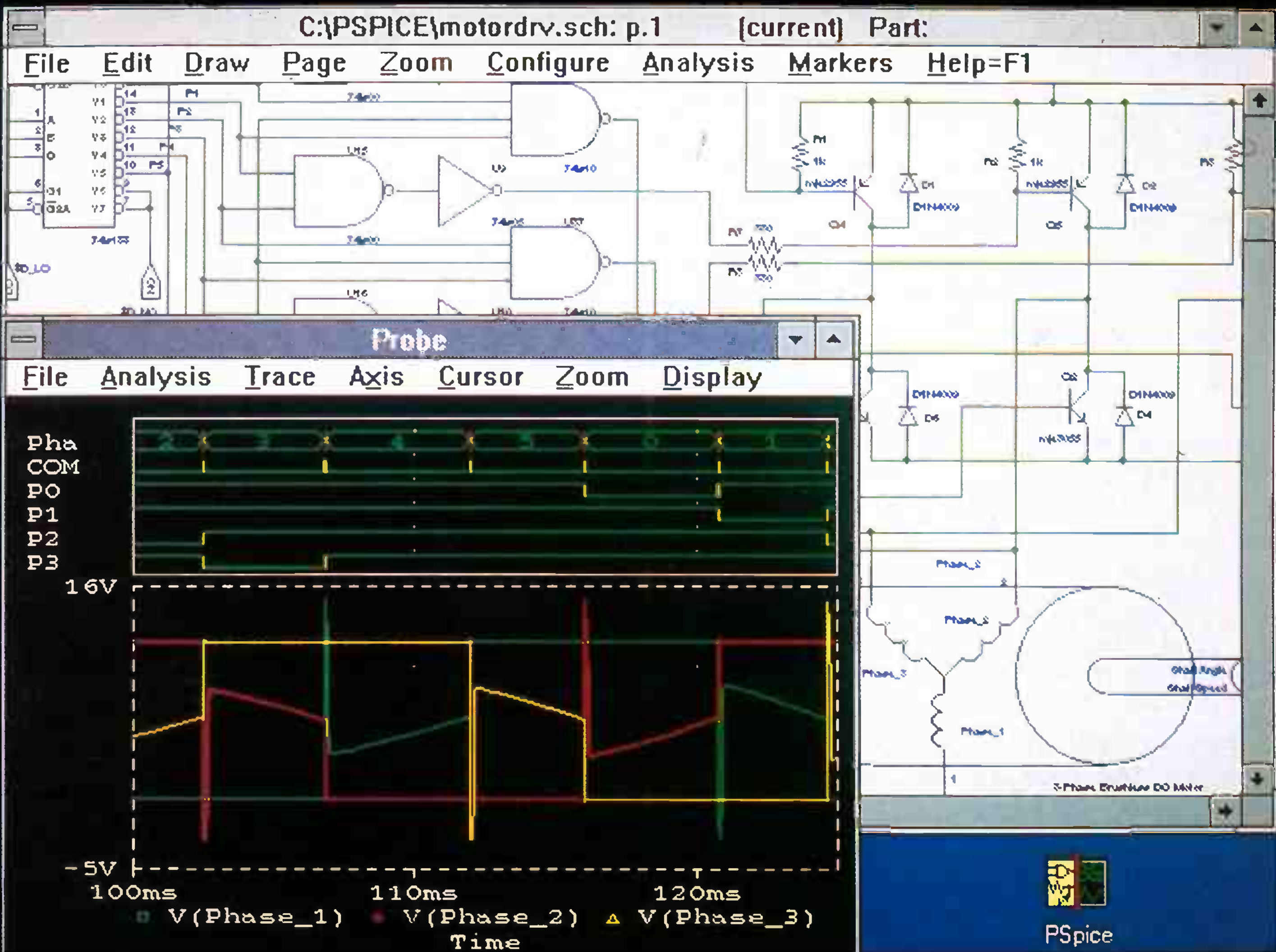
Professional Electronics

S • U • P • P • L • E • M • E • N • T

DIAGNOSTIC SOFTWARE PACKAGES FOR PC'S

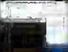
HUBBLE 'SCOPE FINDS ANOTHER BLACK HOLE

BASICS OF DC-DC CONVERTER DESIGN 3: PRACTICAL EXAMPLES



MICROSIM'S NEW FULLY INTEGRATED PACKAGE FOR SCHEMATIC ENTRY, ANALOG & DIGITAL SIMULATION: 'THE DESIGN CENTER'

Professional Electronics



NEWS HIGHLIGHTS

COURSES IN ORAL HISTORY

The Oral History Association of Australia (NSW Branch) is organising a series of one-day courses in oral history techniques, the first of which is to be held on Saturday April 4, at the Mitchell Library in Sydney. The courses are intended not for professional historians, but with the idea of encouraging more people to become involved in capturing the experiences of people in the community — especially senior citizens.

Speakers at the first course will include Stephen Rapley, of Radio National's Social History Unit; Scott Morriss of the Australian Copyright Council; and Dr Paula Hamilton of the University of Technology, Sydney.

Cost of the course to non-members of the OHAA is $30, or $20 to students, pensioners and unemployed people. Further information is available from John Rich, 5 Queen Street, Petersham; phone (02) 899 5077 (W) or (02) 569 4965 (H).

METAL HYDRIDE BATTERY FOR CARS

According to the *EEVC Newsletter*, the Ovonic Battery Company has developed a metal hydride battery with twice the energy density of nickel-cadmium types, and with a recharge time of only 15 minutes. The firm is said to be claiming that using the batteries, an Impact would have a range of 350-400 miles, with the batteries lasting the life of the car.

Gates, Hitachi, Samsung and Varta are all said to have licensed the new technology.

NEW ASTEC HEAD APPOINTED

Mr Ross Free, Minister assisting the PM and Minister for Science and Technology, has announced the appointment of Professor Michael Birt as the new Chair of the Australian Science and Technology Council (ASTEC). Professor Birt, most recently Vice Chancellor of the University of NSW, takes over from Professor Ray Martin on April 14. His appointment is for a term of five years.

Before becoming a university administrator, Professor Birt had pursued an outstanding academic career as Foundation Professor of Biochemistry at ANU, from 1967 to 1974.

WRISTWATCH PAGER

Swiss firm Swatch has introduced what is claimed as the first wristwatch ever to feature an analog display with an integrated pager.

The 'Swatch Pager' hs initially gone on sale in Switzerland and there are plans to launch it in other countries over the next two years. Two of the design concepts which helped keep the product's size down have been patented.

One is a fully integrated antenna, which is instantly recognisable as five horizontal metallic strips across the dial. The other is a battery compartment in the form of a simple extension to the strap, which slots into the case and facilitates fast, easy battery changes.

The Pager has been tested and approved by the PTT (the Swiss telecom authorities) and is fully functional from the moment of purchase. It can be contacted anywhere in Switzerland by four pre-specified numbers of the owner's choice, each of which is allocated its own instantly recognisable acoustic signal.

When the owner does not wish to be disturbed, it can either be switched off or put into 'SILENCE' mode in which case, incoming calls are stored for later retrieval.

JAPAN BUILDING E-M PROPELLED SHIP

Mitsubishi Heavy Industries of Japan is nearing completion of a prototype ship using direct electromagnetic propulsion, the *Yamato 1*. The construction of the vessel has involved an investment of 5 billion yen (about A$50 million), which has been provided by a private organisation known as the Ship and Ocean Foundation.

The *Yamato 1* is 30m long and weighs around 280 tonnes, carrying three crew and up to seven passengers. The vessel is propelled by passing a high intensity vertical magnetic field and a heavy horizontal electrical current simultaneously through the sea water, in ducts which run longitudinally in the hull. The magnetic field is generated via superconducting magnets, which are cooled by liquid helium. The combination of the orthogonal field and current causes the water to be forced out of the ducts, propelling the ship at about 8 knots.

The *Yamato 1* is essentially an experimental vehicle, to investigate the practicality of using E-M propulsion. It is believed that ultimately E-M propelled vessels could travel at up to 185kph.

UK ABANDONS LAST CT-2 SERVICE

British Telecom has apparently abandoned its Phonepoint, the last survivor of the three 'telepoint' CT-2 cordless telephone services first licensed in 1989. The reason given for the decision is the service's failure to attract sufficient subscribers for viability.

Apparently the number of people who used the service was very small, and many telephone retailers refused to stock the compact handsets because of almost negligible customer interest.

IREE-IEAUST LINK

Two of Australia's leading engineering associations have announced a three-year trial of closer association, which if successful could apparently lead to full amalgamation.

The smaller Institution of Radio and Electronics Engineers Australia (IREE) has agreed to create and manage a 'technical society' of the larger Institute of Engineers Australia (IEAust), to be known as The IREE Society. In return, IRAust will accept responsibility for accrediting electronics and related engineering courses at degree level, and will work with IREE in representation to governments and the promotion of electronics and communications engineering to young people as a career.

The IREE Society intends to provide a full range of professional development programs for its members in the field of electronics, radio communications, telecommunications and digital systems.

TELECOM TO BUILD VIETNAM'S MOBILE NETWORK

Telecom Australia International has signed a major agreement with Vietnam's domestic telecommunications carrier to jointly develop and operate a national mobile telephone service. The joint venture will initially provide mobile phone services in Hanoi and Ho Chi Minh City, before expanding into other regional centres.

TAI's managing director, Mr Ken Loughman, said the formal contracts had now been signed and work on the construction of mobile base stations was expected to commence in April.

"Initially, the agreement with the Vietnam Directorate General of Posts and Telecommunications allows for the progressive introduction of digital mobile services over the next two years," he said.

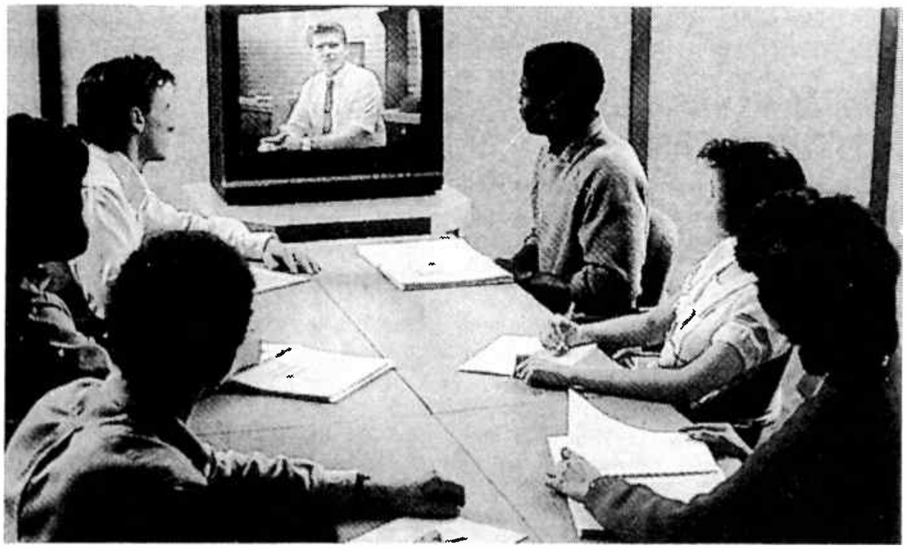
Figures currently available show Vietnam to have a population of more than 66 million, making use of less than 200,000 telephones. Mr Loughman said Vietnam's economy was showing positive growth signs and these could be expected to increase — especially with the eventual lifting of the US trade embargo.

GM INSTALLS SATELLITE NETWORK

General Motors claims to be installing the world's largest business TV satellite network, providing a direct link to 9700 GM car and truck dealers throughout the USA.

Designed and supplied by Scientific-Atlanta Inc., the GM network provides the opportunity for the live presentation, on colour TV screens, of the latest sales product information, service training and educational instruction to staff — in a totally secure and confidential way which cannot be tapped into by opposition companies. The security of the network has been achieved by Scientific-Atlanta's B-MAC integrated receiver decoders. These provide for the total confidentiality of sensitive information by scrambling the video signals. GM's VSAT-based two-way data communications network also permits targeted programming for specific geographic or other segments of the network's dealer base.

The B-MAC receiver decoders are being installed at the rate of 75 per week, with the network completion scheduled for early 1993.



INMARSAT INVESTORS BACK 'PROJECT 21'

Inmarsat and its member-country signatory investors have now committed themselves to continuing market, financial and technical studies to enable the organisation to make an early investment decision on Project 21, including a system for global, hand-held, satellite telephone service.

Announced by Inmarsat last year, Project 21 targets the introduction of the worldwide satphone system by the end of this decade.

In late January, Inmarsat signatory representatives attending a three day Project 21 planning meeting in London, stated their full commitment to the further development of Project 21, and unanimously endorsed 'an agressive work plan' leading to technical specifications for its satellite system, ground network configuration, and hand-held terminals.

GAMMA RAY OBSERVATORY FINDS NEW QUASARS

NASA's orbiting Compton Gamma Ray Observatory has found three new gamma ray quasars, detected more than 200 cosmic gamma ray bursts and captured the best ever observation of the glow of gamma radiation from the disk of the Milky Way galaxy.

Dr Carl Fichtel of Goddard Space Flight Centre in Greenbelt, Maryland is Principal Investigator for the Energetic Gamma Ray Experiment Telescope (EGRET), one of four instruments on the Compton Observatory.

Dr Fichtel says his instrument appears to have detected "still more distant and very luminous gamma ray sources, even more distant than the massive quasar 3C 279."

The EGRET team reported three sources of intense localised gamma radiation,

quasars Q0208-512, 4C38.41 and PKS0528+134, detected between May 16, 1911 and Sept 18, 1991, located in the constellations of Eridanus, Hercules and near the Crab Nebula, approximately 10 to 20 billion light years from Earth.

"The sources are emitting an extraordinary flux of gamma rays, each gamma ray photon with an energy greater than 100 million electron volts. In contrast, a visible light photon has an energy of only a few electron volt, and an X-ray photon has an energy of 1000 electron volts."

Fichtel said, "The luminosity or total energy emitted by these sources is approximately 10 to 100 million times the total gamma ray emission of the Milky Way galaxy."

AMIGA VERSION OF LISTENING POST II

Encouraged by the huge response to the IBM-compatible version of his 'Listening Post II' project and kit, Tom Moffat has produced a kit for a version to run on the Commodore Amiga. It seems Amigas are becoming quite popular among radio and electronics enthusiasts, and there have been many requests for an Amiga version. The Amiga apparently offers excellent graphics capabilities, coupled with low RFI radiation — making it well suited to this kind of work.

Like the IBM version of Listening Post II, the new version allows the computer to be used in conjunction with any reasonable quality HF communications receiver, for reception of Morse code, RTTY and weather fax signals. The hardware is virtually the same as the IBM version, but with different software.

The Amiga FAX program produces black images on a white background, just as if it were a mechanical fax stylus writing on a sheet of white paper. It uses the Amiga's highest resolution mode, 640x400 pixels, on a hi-res interlace screen. The resulting picture quality is about halfway between the IBM's EGA and VGA modes, and those who have seen the Amiga results say the pictures are very good indeed.

The Amiga Listening Post II project is available only by mail order from Tom Moffat at High-Tech Tasmania, 39 Pillinger Drive, Fern Tree, Tasmania 7054. The package includes a kit to build the circuit board and connect it to the computer. There is also a 3-1/2" disk containing the Amiga software, full assembly and operating instructions, and some sample fax pictures and Morse and RTTY files. The complete kit costs $66.00 plus $7.00 packing and postage for a total of $73.00, posted anywhere in Australia or New Zealand. Orders must include a cheque or money order and clearly state which computer version is required. A second set of software for either Amiga or IBM-PC is available for $35.00 posted or with a kit, for people who have both machines.

TOSHIBA DEVELOPS 3-D DISPLAY FOR CAD

Toshiba Corporation has developed a prototype display device that uses 768 light-emitting diodes (LEDs) to simulate and display three dimensional images of objects. The new display uses the 'afterimage phenomenon' to create realistic images that surpass those offered by the 2-D displays used in current computer graphics simulation.

The display device will initially be applied to computer aided design (CAD) of mechanical parts and architectural plans, and Toshiba expects a practical system in 1994. The company also anticipates the display will contribute to design systems incorporating virtual reality, and foresees completion of such a system by 1995.

The display device incorporates a 100 x 30mm panel mounted with LEDs, which slides 50mm back and forth at a maximum speed of 30 times per second. The diodes are computer controlled, and are switched on and off automatically.

By capturing the afterimage phenomenon effect, the display is able to represent such complex images as animations of gear movement and the flow of air currents. The objects displayed appear to be real, and can be viewed from above and different angles Image shapes can be changed in real time.

SHARP JOINS INTEL IN FLASH MEMORIES

Intel Corporation and Sharp Corporation have announced the formation of a long term partnership to jointly develop and manufacture future generations of flash memory products and technology.

NEWS BRIEFS

- ***Precision Power Products*** of Brisbane has just renewed its contract for the sole licence to build and market the Islatrol 'Active Tracking Filter' in Australia, for the next 5 years. The contract was negotiated with Control Concepts of Binghamton, New York.
- Atlas Copco has acquired the German electric power tools manufacturer, AEG Power Tools. ***Atlas Copco Tools Australia*** will now distribute locally all AEG products previously sold and distributed by LMS Australia.
- Mr Mike Pacey has been appointed by ***Siemems*** as Corporate Development Manager in its Advanced Information Products Department. His role will be to promote the Mannesmann Tally range of printers in the southern region.
- ***AUSFAIR*** will be held at the Sydney Exhibition Centre at Darling Harbour from Sunday 28th June to Wednesday 1st July. It is designed to give Australia's 1,000,000 retailers the opportunity to source new products from Australia and overseas.
- The Society of Automotive Engineers is holding a seminar ***Automotive Electronics*** at the Clunies Ross Centre on Thursday May 14th in Melbourne. For further details, phone (03) 347 2220.
- ***Computer Expo '92***, organised by Business & Industrial Trade Fairs and the Hong Kong Productivity Council, will be held at the Hong Kong Exhibition Convention Centre, May 12-15 1992. On display will be systems ranging from document management and desktop publishing to micrographics and presentation software. For more details phone (Hong Kong) 865 2633.
- ***CIMA Electronics*** has announced a pilot project, sponsored by the Victorian Government, to ensure a smooth path from identification of user needs through to successful production of PCBs. This service will be free for ten PCB users chosen for the trial. For more information phone (03) 898 6744.
- Sydney-based ***Electrocraft*** has been appointed an Australian distributor for the Finland-based Teleste Antenna range of TV communications equipment, components and systems.
- ***3Com Corporation*** has announced a definitive agreement to acquire the data networking products business of the UK-based BICC Group. BICC is Europe's largest hub manufacturer and markets the ISOLAN networking products.
- ***AOTC*** (Australian and Overseas Telecommunications Corporation) revealed a customer-focused organisational structure for the new carrier. It will have six major business units, each with its own profit and loss accountability. Appointments to Senior Executive positions were announced.
- ***Megatec*** has appointed four new staff to its expanding Melbourne head office: Mr Russell Steel, account manager; Mr Peter Duncan, technical support co-ordinator; Ms Ida Montagmer, customer-support programmer; and Mr Owen Baker, programmer/analyst.
- The annual convention of the Australian Telecommunications profession, ***Atug '92*** will be held at the World Congress Centre, Melbourne from Monday 27th to Thursday 30th April. The theme is 'The Challenge of Choice', well suited to the new liberalised telecommunications environment. Phone (02) 957 1333 or (03) 690 6395.

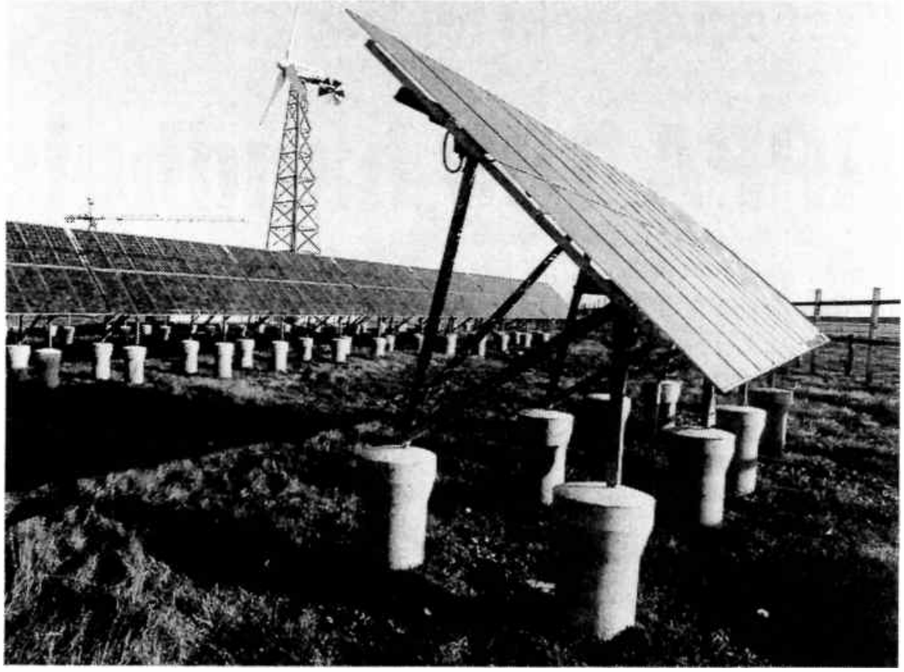
"Intel is gaining a world-class partner with Sharp, and the combined technology development and manufacturing capacity will ensure we can meet the rapidly increasing demand for flash memory products," said Mr Geoff Healey, general manager of Intel Australia.

"One of the key factors driving the growth of flash is the boom in portable, laptop and palmsize computers. In this market, flash offers distinct gains in size, power dissipation, reliability, ruggedness and speed," added Mr Healey.

Intel, one of America's largest semiconductor companies, supplies over 85% of the flash memory products sold in the world today, according to market research firm Dataquest.

The agreement calls for the two market leaders to combine their respective areas of technology, design and manufacturing expertise to foster greater flash memory market growth in both the portable computing and consumer market places.

The partnership will focus on joint design, manufacturing and process technology development of future high-density components based on 0.6 microns and smaller wafer processing.



Germany's Kiel University maintains a research and technology development centre for solar energy and wind power, on the North Sea coast. The centre produces some 20 million kilowatts of electricity annually.

HST DISCOVERS ANOTHER BLACK HOLE

Astronomers believe they have found intriguing evidence that a black hole, weighing over 2.6 billion times the mass of the sun, exists at the centre of the giant elliptical galaxy M87, based upon images taken by NASA's Hubble Space Telescope (HST).

The images show that stars become strongly concentrated towards the centre of M87, as if drawn into the centre and held there by the gravitational field of a massive black hole.

These results were reported at the 179th meeting of the American Astronomical Society in Atlanta by Dr Tod R. Lauer, National Optical Astronomy Observatories (NOAO), Tuscon, Ariz.; Dr Sandra M. Faber, University of California, Santa Cruz; Dr C. Roger Lynds, NOAO, and other members of the HST Wide Field/Planetary Camera (WF/PC) Imaging Team.

M87 is at the centre of a nearby cluster of galaxies in the constellation of Virgo, 52 million light-years distant, and contains more than 100 billion stars. One of the brightest galaxies in the local universe, M87 is visible in even small telescopes.

Early in this century astomomers discovered a gigantic plume or 'jet' of plasma apparently ejected out of the M87 nucleus. Later, the jet and nucleus were found to emit strong radio and X-ray radiation. However, the nature of the central 'engine' of this activity has long remained a mystery.

In 1978, the late Peter Young of California Institute of Technology, leading a team of astronomers, announced that the central portions of M87 visible from the ground appeared to be dominated by the gravity of a massive black hole.

However, prior to the HST observations, more recent ground based observational and theoretical studies have failed to confirm this picture.

Lauer, Faber, Lynds and co-investigators on the WF/PC imaging team used the new images obtained with the HST Planetary Camera to explore the central structure of M87 much closer into its nucleus than is possible from the ground. The images show clearly that the stars in M87 become densely concentrated towards the centre, forming a bright 'cusp' of light at the heart of the galaxy.

The central density of stars in M87 is at least 300 times greater than expected for a normal giant elliptical galaxy, and over 1000 times denser than the distribution of stars in the neighborhood of the sun. In fact, the ultimate central density of stars in M87 may be even higher, but its measurement is beyond the resolving power of even HST.

"The central structure of M87 is a striking departure from what the normal core of a giant elliptical galaxy would look like," said Lauer. "It strongly resembles a stellar cusp associated with a black hole." The cusp is visible as the steady increase in brightness of M87 towards its centre. Theoretical work suggests that such a cusp may form as a central black hole grows and cause the centre of the galaxy to collapse outwards.

Lauer emphasises, however, that the HST images alone do not prove conclusively the black hole's presence. "It looks like a 'duck' but we haven't heard it 'quack' yet," he observed. Follow-on HST spectroscopic observations are needed to measure the velocity of stars orbiting within the nucleus.

High velocities would be evidence of a black hole and would provide astronomers with direct measurement of its mass.

MARCH LAUNCH FOR AUSSAT B1 SATELLITE

The first of AUSSAT's B-series replacement satellites (AUSSAT B1) was planned for launch in March.

AUSSAT B1 was air freighted from the Hughes Aircraft Company's Los Angeles plant on 27 January, and was due to arrive at the Xichang launch site in China on Thursday 30th January.

The satellite scheduled for launch from Xichang on board a Long March 2E rocket on the evening of March 8th 1992.

Once in orbit it will replace the first of AUSSAT's first generation satellites, which is nearing the end of its commercial operating life. ❖

APPA 105 handheld DMM

A new model has been added to the range of digital multimeters produced by the Taiwanese Corporation APPA. The APPA 105 shows quite a few improvements over the the APPA '90 series' reviewed in *EA* for April 1991. This new meter offers improved accuracy over a full range of measurements, and has a 3-3/4 LCD readout (maximum reading 3999).

My first impression on seeing the APPA 105 DMM was how rugged it looked — indeed you might even say how 'Fluke-like' in appearance.

Not only has the meter retained its original solid casing, but it is also enclosed in a very substantial wrap-around protective holster. Just how substantial this holster is becomes obvious when you compare the mass of the meter itself (370g) with meter-plus-case (600g). It almost doubles the weight!

The meter sits snugly in this holster, either face-up for viewing or face-down for protected storage. To remove the meter, you simply flex the overhang of the holster away from the top or bottom, and out it slides.

The holster provides a fold-out arm to support the meter at 45°, plus a grooved slot to allow it to hang vertically from a hook or screw. I was pleased to see that the probe holders are far better designed than on the previous models. Attaching them to the holster rather than the body of the meter allows them to be far more substantial. The probes are held very firmly, both in their storage and measurement positions.

Another improvement on the APPA 105 is the reduction on the number of positions on the rotary selector. This has been achieved by having auto-ranging scales for voltage, resistance, capacitance and frequency; and AC and DC sharing the same location for each of the four ranges provided.

There are eight pushbuttons just below the readout. The first is the function key which toggles several selector positions between their alternatives: AC and DC current; resistance and continuity testing; diode tester and capacitance; and frequency and an external adaptor input.

The second button allows you to set either a minimum or maximum reading which is automatically upgraded. Variations in the readings will continue to be displayed on the analog bar graph, while the digital display shows the lowest (or highest) value recorded.

The 'REL' button allows relative readings to be made. It zeros the display and stores the original reading as a reference value. The variation only is then displayed. Very useful for effectively removing lead resistance or capacitance from a reading.

The 'HOLD' button freezes a reading until released, while 'STORE' records the value permanently in its memory. The value stays there until the power is turned off, and can be read via the 'RECALL' button at any time.

'PWR RST' restores the display after auto power off (activated after 30 minutes), while 'RANGE' allows the auto-ranging to be turned off, and a fixed range to be selected.

Ranges

There are five DC voltage ranges: 400mV ±(0.3%+2d), and 4V, 40V, 400V and 1000V ±(0.1%+2d). AC voltage ranges are: 4V, 40V, 400V and 750V, ±(0.5%+5d) 50-60Hz, and ±(1%+5d) 40-1kHz.

Current ranges for both DC and AC are 4mA, 40mA, 400mA and 10A; with the DC accuracy being ±(0.4%+2d) for all but the 10A range which is ±(0.8%+4d); while the AC accuracy for the same ranges is ±(0.6%+5d) and

±(1%+5d). The six resistance ranges are: 400 ohms ±(0.4%+4d); 4k, 40k and 400k ±(0.4%+2d); 4M ±(0.6%+3d); and 40M ±(1.5%+5d).

Capacitance is measured in six ranges: 4nF ±(1%+40d); 40nF, 400nF and 4uF (<20uF) ±(1%+4d); and 40uF (>20uF) ±(53%+8d).

There are five ranges for frequency: 100Hz, 10kHz, 100kHz and 1MHz, with an accuracy for all of ±(0.1%+4d). The meter also has the usual continuity tester (audible alarm if <40 ohms) and diode tester.

Inside the case

The APPA 105 has a similar construction to the previous APPA models. Three screws secure the front and back of the sturdy case, and internally the components are located on two boards fixed together with enough space between them for the rotary switch mechanism.

The switch has a good positive feel and clicks firmly into each of its switching positions.

Power for the meter is provided by two AAA cells in a holder at the bottom end of the case. This holder is connected to the circuit board by two wires, which must be very carefully positioned when re-assembling the case.

It is very easy to let the wires wedge under the rotary switch, or become pinched between the lead sockets and their sleeves which are connected to opposite halves of the case.

Summary

Quite a few measurements were made to test the accuracy of the APPA 105. These included: 10 resistance values ranging from 1-1000k; six capacitance values from 1nF-1uF; five frequency values from 5-1000kHz.

Readings for one DC voltage and one DC current were also made. All of these measurements were within the stated accuracy of the meter — in fact, most were well and truly within it. Of course, the lowest scale reading for resistance and capacitance required the use of the 'REL' key to remove the effect of the test leads.

One change in design from the original meters is that the test probes are now insulated right to the very tip. Only about 2mm of the actual metal tip protrudes.

This modification is very suited to use with dangerous voltages, preventing accidental shorts, but I found it a nuisance when working with low voltage circuits. Alligator clips slid off the tapered points, so I couldn't make my permanent ground connection when testing a PCB circuit, etc.

Also previous APPA models had a groove just behind the tip of each probe. I found this feature very useful for holding the probe on resistor leads, etc.

Unfortunately, these grooves have now disappeared. Apart from these minor points, I found the meter to be extremely well protected, very easy to use and accurate in its measurements.

The changes to the way you select quantities to be measured are a distinct improvement.

I particularly like the reduction in the number of positions on the rotary switch, achieved by using the toggling action of the 'Function' key. Also the extra features like 'MAX/MIN' could prove to be very useful.

The price for the APPA 105, including tax, is $358.80. For further information, contact Geoff Wood Electronics, 229 Burns Bay Road, Lane Cove 2066; phone (02) 428 4111 (P.M.) ❖

Chip mimics brain cell

A two-man British-American team of researchers claims to have developed a prototype of a silicon chip that mimics the operation of a human neuron brain cell.

The chip consists of 88 transistors and when an electrical current is applied to the circuit, the chip responds in the same way a brain neuron does to an electrical impulse. The new chip may prove an important step in the development of a new generation of artificially intelligent machines. It was invented by researcher Misha Mahowald of the California Institute of Technology and Rodney Douglas of the University of Oxford.

Mahowald said that while the chip represents the way a neuron handles electrical current, the development is a far cry from a fully operational brain cell.

"I don't think the chip is that important. It is not an application in itself. Instead it is a technique that we can use in further research", Mahowald said.

She noted that while it is well known how a brain cell emits and absorbs electrical and chemical changes, scientists still are at a loss to explain how those signals translate into such things as cognition, feeling and other functions of the brain.

Tandy subsidiary GRiD Systems is promoting its pen operated handheld computers for use by nurses in hospitals — to maintain patient records during their rounds. The company has also announced a radio transceiver that attaches to the handheld machines and links them with a PC network at a rate of 19.2kbps.

Sematech unveils five year blueprint

Sematech officials have predicted that US chip makers will pull even with the Japanese in chip manufacturing capability, by the end of 1992. And if the US government and Sematech members agree to fund the groups new five year plan, the US may well get ahead of the Japanese in chip-making technology.

Sematech unveiled its blueprint for boosting the competitiveness of the American chip and equipment industries at a recent press conference at its Austin, Texas headquarters.

At the core of the plan is the development of the necessary hardware and software technology to create a highly computer-integrated chip factory, enabling chip makers to bring new products to market in volume at least 25% faster than today. The factory would be able to produce components with features as small as 0.2 microns.

The Sematech program comes at a time when Sematech is lobbying both the industry and Congress to continue the US$200 million-a-year subsidy program, which is split evenly between the Sematech members and the US government.

In the four years since the consortium opened its doors, it has been able to boost the competitiveness not only of US chip makers, but also of the many chip equipment firms it contracted with to develop the advanced equipment. During the next five years, Sematech's objective clearly spells out its desire to help both the chip and equipment industries.

"Now is the time for industry and government to capitalise on our momentum. We have an opportunity to concentrate on building a sustainable competitive equipment infrastructure. Sematech has shown that generic precompetitive cooperation can work in America," said William Spencer, president of the research consortium.

In an obvious effort to blunt any criticism or skepticism about its achievements, Sematech also released a long list of its technological achievements. In the document, Sematech says it will have achieved all of its original goals by the end of 1992.

For now, Sematech will be able to go ahead with its new plan which has been approved by its board, as well as by the Defense Advanced Research Projects Agency (DARPA) — the agency that provides the federal funds to Sematech.

LSI, Micron set to leave Sematech

At least two and possibly three of Sematech's smaller members have given the chip consortium official notice of their intent to leave the joint technology development venture. According to the latest reports, LSI Logic and Micron Technology have filed the required notice of intent. It then takes another two years before they will actually be leaving the consortium under Sematech rules.

Sematech officials had previously confirmed that two of its members had given notice of their desire to leave. But they would not identify the companies involved. Sematech president William Spencer at the time also said two or three other companies had expressed an interest in joining Sematech.

Industry analysts like VLSI Research president Dan Hutcheson said the decision by LSI and Micron is understandable, considering the fact that "both have been hurt financially, making cutbacks and laying-off people. What they are dealing with is whether it is viable to provide welfare for the entire chip industry when they can't even support themselves."

Although disappointing, the departure of the two smallest members will not seriously impact Sematech, as both companies probably paid only the minimum US$1 million annual contribution.

Software converts Macs for multimedia

Apple president John Sculley has been talking about multimedia for almost four years. But at the latest annual MacWorld Expo in San Francisco, he introduced QuickTime, a piece of operating software that will instantly turn millions of existing Macintosh computers into highly sophisticated multimedia machines. "In many respects, QuickTime may be the most important thing Apple has ever done."

"QuickTime allows even the most unsophisticated user to create seemingly complex multimeda presentations. If you can point, click, cut and paste, you can now produce professional multimedia presentations," Sculley said.

And in an aggressive move to broaden the market for Macintosh-based multimedia, Apple announced it is also making QuickTime available for Windows 3.0, allowing millions more Windows users to prepare multimedia productions.

Essentially QuickTime allows users to use data such as segments of a tape television news cast, a rented VCR movie, or some footage shot with a home camcorder and play those images back on their Macintosh.

Using familiar cut, paste, and other typical editing functions controlled by the mouse, users can incorporate segments of full motion images into any application document, including a letter, database record, or on a spreadsheet. Those productions can be sent on disk, CD-ROM, or over a network to other Macintosh users, who in turn will be able to view the complete document including the full motion segments on their screen.

Sculley said in his opening address that QuickTime should not be confused with true multimedia. The latter involves hardware and specialised application software products aimed at mostly professional users. QuickTime, on the other hand is part of the Macintosh operating system and requires no special software or hardware, other than the image input sources, such as a VCR, stereo, or microphone.

Virus infected Novell software

Novell, the world's leading vendor of personal computer networking software has informed nearly 4000 of its customers that the networking software they bought earlier last year was infected with the 'Stoned III' virus.

In a letter to customers, Novell officials said the disks from which thousands of production copies were made had accidently become infected with the bug. Novell issued the warning after it received numerous calls from customers complaining their system has been invaded by a virus that originated on the Novell diskette. Although the virus is said to be relatively harmless cleaning up networks containing hundreds or thousands of machines would be a time consuming and costly process.

US chip sales to rise in 1992

Despite all of the problems in the semiconductor market during 1991, US companies recorded an overall 7% increase in sales to US$27.9 billion, according to an annual report on the industry released by the US Department of Commerce.

In 1992, the US industry is expected to grow by an additional US$8 to $30 billion. However overall employment in the US industry — which declined by 7000 in 1991 — will decline further, as companies try to stay lean and increase profitability. After shedding another 3000 or so jobs in 1992, the US chip industry employment will be down to 160,000.

"What we have seen is a lot of cutbacks in support personnel. Companies are just cutting their bottom line as much as they can," said Robert Scott, a senior industry analyst with the DoC's Office of Microelectronics & Instrumentation.

On the positive side, the DoC report notes that US chip companies increased their overall capital expenditures in 1991 by 15%. In the past US firms have traditionally reduced such expenses in recessionary years only to come out of a slump with too little capacity to handle new demand.

"It is a shuffling match right now. People are trying to figure out where the market is going so they can get into position for the upturn," Scott said.

In another positive trend, the chip trade deficit between the US and the rest of the world was cut into half during 1991. But rather than stronger exports, the reduction was due in large part, to the decline of imports of DRAMs and other foreign-made chips. And the deficit with Japan actually increased from US$2.19 billion in 1990 to $2.38 billion.

"Overall, US semiconductor companies are treading water. The recovery isn't here yet, but it is not as bad as some people though," Scott said.

Cray-3 sale is cancelled

Cray Computer has lost a key contract for its new supercomputer to its major competitor Cray Research, prompting a big sell-off on Wall Street in shares of the start-up.

Cray's first and only customer, the Lawrence Livermore Laboratory announced it had decided to cancel plans to buy Cray Computer's first 'Cray-3' supercomputer, a machine designed around ultra-fast gallium-aresenide chips. Instead, the weapons lab has opted for Cray Research's latest C-90 model.

The decision follows a December 8 test in which the Cray-3 failed a key portion of a performance test. The cancellation is a major blow for Cray Computer, which was founded as a spin-off from Cray Research by the company's founder, Seymour Cray. The deal with Lawrence Lab would have been worth US$30 million in 1992 revenue. Cray said it still expects to ship its first computer in 1992, to another unnamed customer. Industry analysts believe the Cray-3 has lost its competitive edge to the C-90, which is almost as fast and has far more software available. The company's only hope for survival may be the next generation Cray-4, which Cray said will be ready for shipment in two years, but it is doubtful whether Cray's financial reserves are strong enough to pull the company through the next two years with little sales momentum. ❖

[illegible]

Secrets of simple DC-DC converters - 3

In this final part of this series we will examine three practical DC-DC converter circuits, designed by using the methods given in Part 2. We conclude the series with a discussion of some novel secondary loading and regulation techniques, together with practical circuit notes.

by ANDREW PIERSON

The circuit diagram for a useful DC-DC converter which generates two completely independent regulated 12V, 150mA supplies from a 5V input rail is shown in Fig.6. The two 12V sources may be connected in series for 24V, or used in a ±12V configuration. The input rail voltage tolerance is ±10%, and the conversion efficiency of the inverter circuit itself (neglecting rectifier diode and regulator losses) is 84.5% at full output power (2 x 12V @150mA).

The primary drive circuit uses the arrangement previously described in Part 2. Note the presence of the 10,000uF input reservoir capacitor, which helps to avoid the introduction of ripple onto the supply line. If further ripple reduction is necessary, a 0.1 ohm decoupling resistor may be inserted in the 5V supply line. At full rated output power the converter will draw 1.4A at 5V, and will operate at a frequency of approximately 6kHz.

The waveform is symmetrical, and measures 10Vp-p at the collector of the oscillator transistor. Capacitor-input bridge rectification is used for both secondary windings. The 1,000uF filter capacitors ensure a very clean output rail, as the raw supply line ripple at full load *before* regulation is only 50mV p-p.

In order to maintain control of the induction stroke, both supplies must be run with a minimum load current equal to approximately 15% of I_{max} (see Part 2). The regulator circuit shown is a series-shunt type, which is configured to maintain a minimum load current of 23mA with no external load connected. At full load current and with 5V input the shunt component falls to 12.5mA, thus improving efficiency.

The nominal output voltage adjustment range is between 11V and 13V, although this will depend on the voltage accuracy of the zener diode used. The voltage regulation from no-load to full-load is better than 0.8%.

With 5V DC input, the output from both bridge rectifiers falls from 21V at minimum output load to 16.8V when both supplies are fully loaded (i.e., 20% regulation), so there is still plenty of margin for correct operation at reduced input voltage.

The waveforms in Figs.7, 8, 9 and 10 were taken from this converter circuit when it was operating at full rated power. The X (time) scale is uncalibrated, and is adjusted to display two complete cycles of operation. The Y (voltage) scale and DC reference levels are quoted for each individual waveform.

Note that these waveforms can also apply generally to the theoretical circuit

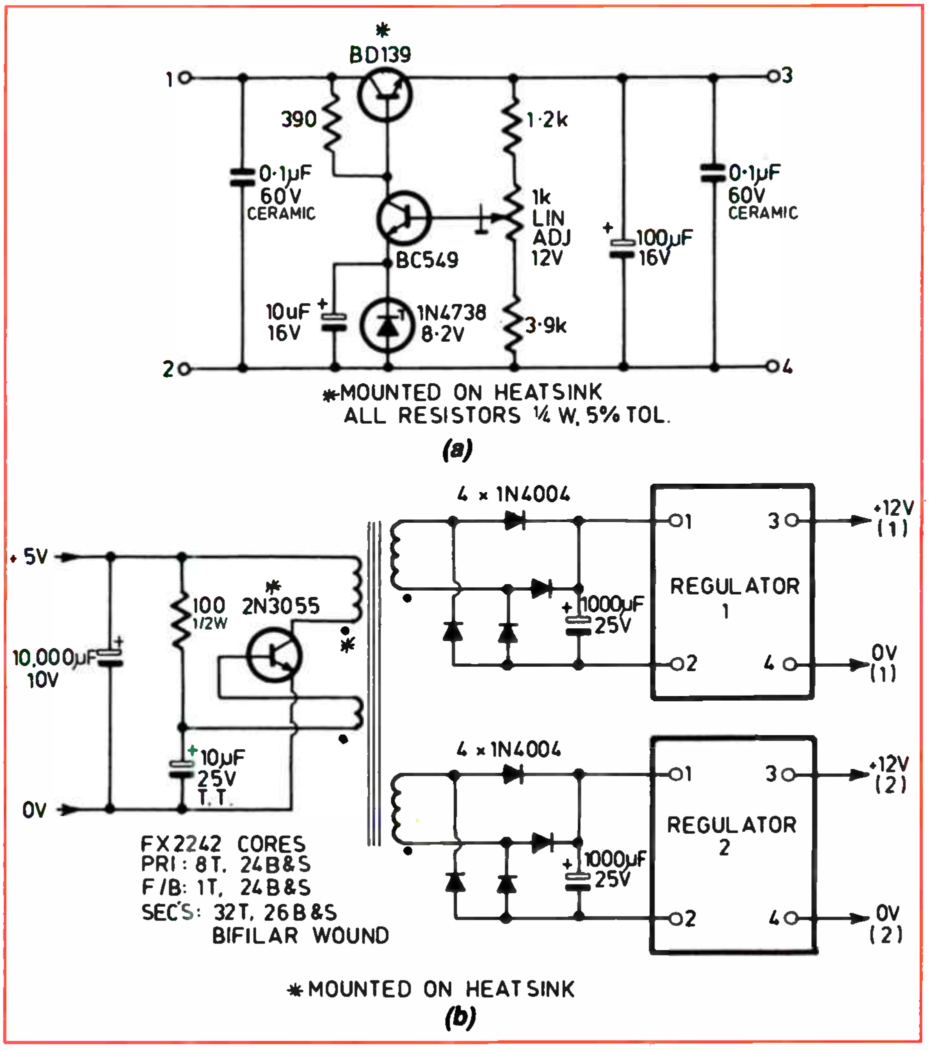


Fig.6: A useful DC-to-DC converter which generates two independent 12V/150mA supplies from a 5V input rail. Each output is regulated using the circuit shown.

of Fig.1 in Parts 1 and 2, if the secondary winding (shown disconnected) is heavily loaded via a capacitor-input bridge rectifier.

A high voltage DC-DC converter

Fig.11 shows the circuit schematic for an HT converter which uses the voltage doubler secondary configuration and a feedback-type voltage regulator, to maintain a constant output potential under varying load conditions.

The circuit operates from a 12V supply, and can deliver an output of between 55V and 320V into an 18k load (5.7W max.) with a maximum ripple voltage of 500mVp-p.

Under control of the voltage regulator, the inverter's DC input voltage will vary between 1.25V and 10V to achieve the above voltage range with an 18k load. The operating frequency ranges from approximately 3kHz at 55V output to about 6kHz at 320V output.

In order to achieve control over a wide range of output voltage, the base-emitter junctions of the two BC549 transistors have been used as a voltage reference diode.

If it is not required to maintain control of the output potential down to as low as 55V, the thermal stability of the circuit may be improved by including a zener diode in the emitter circuit of the second BC549 (the comparator transistor) and then redimensioning the voltage sensing network.

The voltage doubler secondary configuration has been used in this circuit mainly to illustrate the use of this technique. However, much better voltage regulation will be achieved if the number of secondary turns is increased and the voltage doubler is replaced by a capacitor-input bridge rectifier.

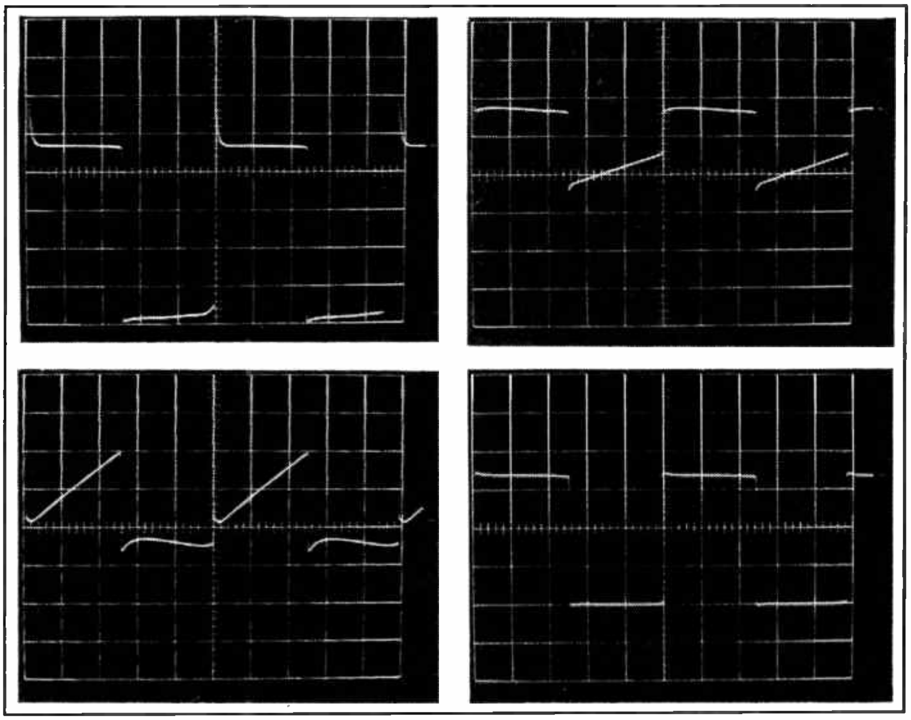


Fig.7, 8, 9 & 10: Waveforms taken from the converter circuit of Fig.6, when operating at full rated power. Fig.7, at upper left shows the collector voltage (Y = 2V/div); Fig.8, at upper right shows the base voltage (Y = 0.5V/div); Fig.9, bottom left shows the waveform across the 10,000uF bypass capacitor (Y = 0.2V/div); Fig.10, bottom right shows the voltage waveform across a secondary winding (Y = 5V/div).

An EHT converter

Fig.12 is a circuit diagram for a regulated EHT converter which uses the induction stroke to generate a low current EHT potential of up to 1.6kV.

Regulation is achieved by means of a feedback-type input voltage regulator (see Part 2). This unit was originally designed to deliver an output potential of 1.25kV into a resistive divider chain of 2.5M (IL = 500uA).

Under these conditions, the regulator is supplying 3.5V at 400mA to the inverter itself, which operates at an efficiency of 45%. The feedback regulator stabilizes when approximately 4.6V is developed across the sensing resistance Rs (Rnom = 9.2k). At 1.25kV output, the pulse

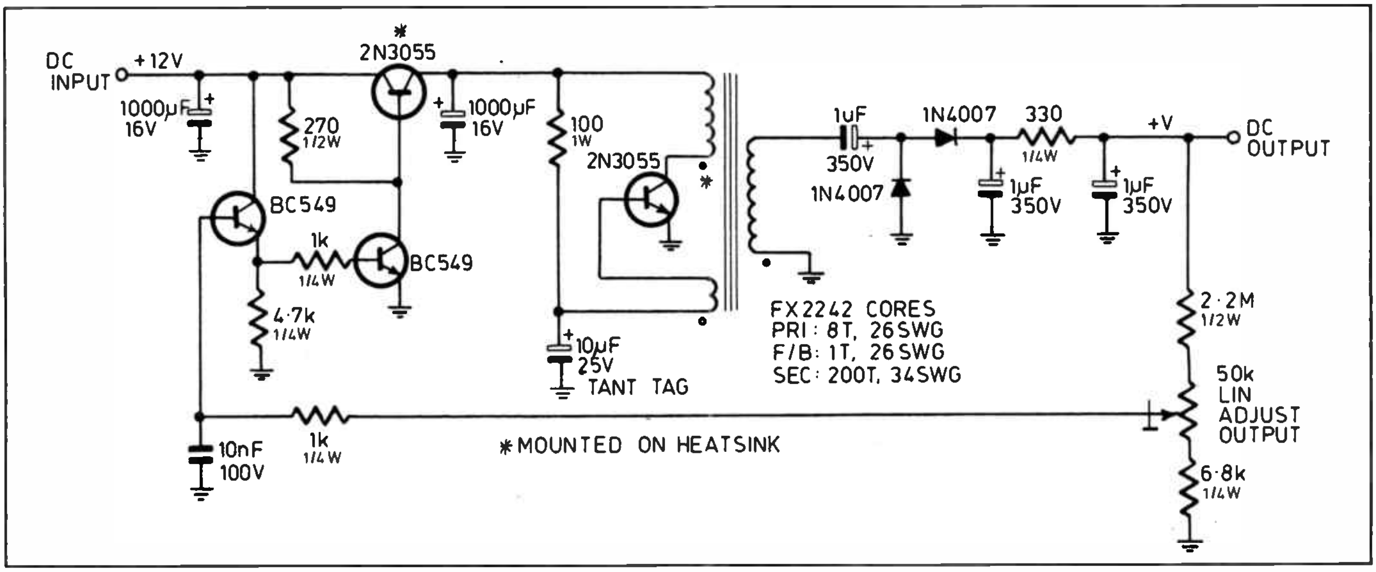
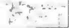


Fig.11: An HT converter which uses the voltage doubler secondary configuration, plus a feedback type voltage regulator.



amplitude at the collector of the oscillator transistor is 25V p-p, and the operating frequency is approximately 3.3kHz.

The cores specified for the transformer in this circuit are FX2243 types, and a two-section former is used. The primary and feedback windings are wound on one section, and the secondary is layer-wound on the other, as described in Part 2. As FX2243 cores are expensive and may now be difficult to obtain, any core of similar dimensions which will accommodate the layer-wound secondary may be used. To save winding space, a scramble-wound secondary would probably be satisfactory but it would need to be wound very carefully, to minimize potential differences between adjacent wires.

Independent stroke loading

It is possible to load the power and induction strokes independently, by using two separate half-wave rectifiers. This enables the quite different characteristics of each stroke to be fully used.

For example, it is possible to generate a few hundred volts at high current by using the power stroke, and simultaneously *from the same winding* develop several kV at low current by using the induction stroke.

Because the power and induction strokes are opposite in polarity, the two potentials must also be opposite in polarity. This means a positive HT and a negative EHT, or vice-versa. This disadvantage may be overcome by using two separate secondary windings.

Whilst it is possible to avoid loading the power stroke, the induction stroke must ALWAYS be loaded (see the warnings in Part 2). The one exception to this rule is the special case covered near the end of part 2.

The design procedure for independent stroke loading involves a certain amount of empirical 'juggling'. It will usually be necessary to employ two separate secondary windings, and the respective number of turns on each should be adjusted to produce the appropriate potentials at the required currents. Bear in mind that the regulation of the supply derived from the power stroke will be very much better than the supply derived from the induction stroke (see Part 1).

The above procedure can be very useful at times. For example, the commercial circuit discussed in the next section makes successful use of this technique.

One final note of warning: if you are developing high and low voltages simultaneously, remember that the rectifier diodes associated with both supplies will each have to withstand a reverse potential which is equal to the sum of both output voltages! In this regard, see the comments relating to diode PIV rating in Part 2.

Other techniques

Let's examine a commercial blocking oscillator DC-DC converter circuit, and see if we can make sense of it. Fig.13 is the power supply unit from the 16K memory expansion module for the now-obsolete VZ200 computer; its function is to develop -5V and +12V from the 9V input supply rail.

Although I have not had a chance to examine it physically, the circuit is worth studying because it makes use of some circuit techniques not previously discussed.

At first glance, the primary drive circuit looks quite different to our standard design, because the bias and feedback paths to the base of the oscillator transistor are in parallel.

However, if we change these to a series arrangement and ignore the 1502C transistor for a moment, the circuit suddenly becomes familiar. With the arrangement shown, both the forward bias and the AC feedback can be controlled by the collector-emitter impedance of the 1502C transistor.

The voltage waveform at the collector of the oscillator transistor is half-wave rectified to produce the +12V rail. Because the rectifier diode only conducts when the voltage swings positive, it must be using the *induction* stroke. If you're not sure of that, re-read Part 2.

Note that here the induction stroke is being tapped from the primary winding, and not from a secondary winding. Since all the windings are tightly coupled together, this doesn't make any difference to the basic theory. It's a useful technique to remember because the pulse amplitude and direction at this point may be more convenient.

Now we can explain the regulation system used in this converter. The +12V output rail is fed, via a 12V zener diode and a limiting resistor, to the base of the 1502C control transistor.

As soon as the output voltage rises to approximately 12V the base-emitter junction begins to conduct, thus turning on the 1502C's collector-emitter junction. This, in turn, decreases the activity

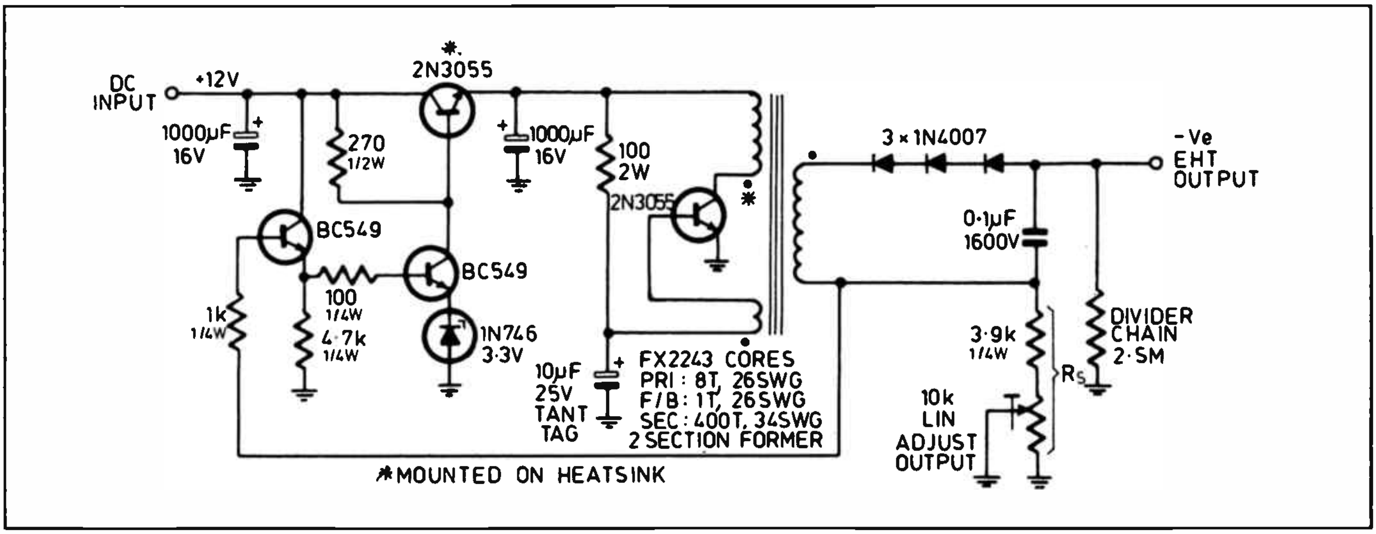


Fig.12: An EHT converter which uses the induction stroke to generate up to 1.6kV at a low current. Regulation of the output is again achieved using a feedback circuit.

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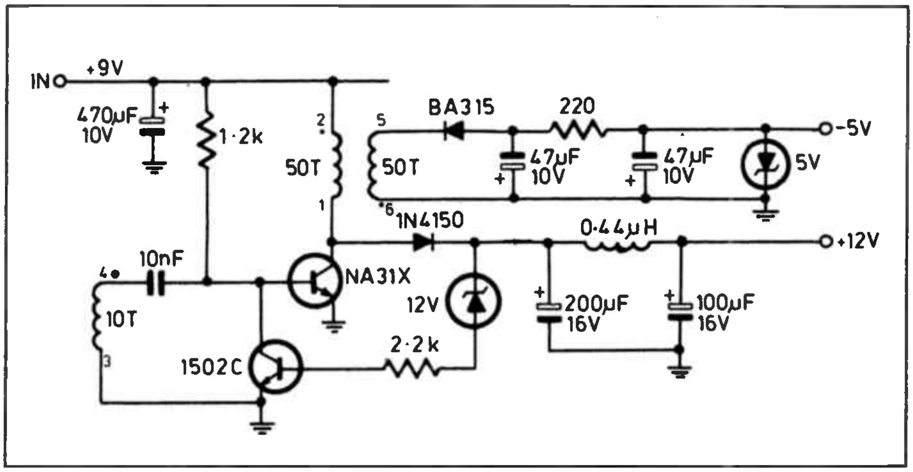

Fig.13: The power supply circuit used in the 16K DRAM memory expansion module for the now obsolete VZ200 personal computer.

of the oscillator, and by virtue of the negative feedback loop stabilizes the output voltage at a nominal +12V.

The secondary winding feeds another half-wave rectifier, to produce the -5V rail. This time, the *power* stroke is used, in conjunction with a constant-current zener diode regulator.

Practical circuit notes

1. **Manipulating the value of R:** Apart from core flux level considerations, the maximum output power is set by the ability of the oscillator transistor's collector-emitter junction to switch adequate current. This is, in turn, determined jointly by the base-emitter current and the h_{FE} of the oscillator transistor itself.

Since the feedback winding is in series with the forward bias resistor R, the peak value of forward base current is set by the value of R, augmented by the positive swing of the AC feedback voltage.

The value given for R (100 ohms) allows good efficiency in a wide range of circuit applications, but when operating with input voltages below 5V, it may be necessary to reduce the value of R to obtain sufficient power output.

When the output power requirement is only small, the value of R may be increased to gain improved conversion efficiency. After altering the value of R, the value of the bias bypass capacitor C may also need adjustment to obtain the optimum feedback level.

2. **Choice of oscillator transistor:** The 2N3055 is the preferred oscillator transistor because it has a low transition frequency (f_T), and is therefore inherently stable in the circuit configurations shown.

You should be aware that if a transistor with a much higher f_T is substituted, the possibility exists that spurious modes of high frequency oscillation could occur.

This problem may usually be cured by introducing extra capacitance across the collector-emitter junction. The value used should be large enough to kill the spurious oscillation, but not great enough to significantly degrade the oscillator's switching time.

3. **Using smaller core sizes:** A 36mm diameter core was chosen as the standard size for the design procedures given, because it is readily

available and can cope with high power levels, if required. However, for low power applications it makes sense to use smaller potcores. They are cheaper, lighter and operate at a higher frequency — making filtering and soundproofing easier. Note, however, that with the standard 8-turn primary the maximum DC input voltage will be limited when cores with small cross-sectional areas are used.

As an example, the maximum input voltage for an 8-turn primary on a 14mm core (the smallest available) is about 4.5V. With 4.4V input, this tiny core is capable of producing over 2W of output power at an operating frequency of 28kHz.

When operating cores near their limits, it will be necessary to adjust the values of R and C to obtain optimum performance. For instance, in the example given above the value of R was 200 ohms (this will depend on the h_{FE} of the oscillator transistor) and the feedback had to be increased by fully bypassing R with a large value electrolytic capacitor.

The range of potcores available from agents who handle Philips ferrites is 14mm, 18mm, 26mm, 30mm and 36mm diameter (the standard size used in this series).

Lower levels of output power call for smaller oscillator transistors, and here the BC639 and the BD139 may be successfully employed, provided that the warnings given above are heeded. When choosing an oscillator transistor, remember to also take into account its likely power dissipation under overload conditions.

Reference

For those readers requiring a reference on the *conventional* transistor blocking oscillator circuit (e.g., the type which has been used for the vertical oscillator in TV receivers), a good description can be found in pages 263-268 of *Understanding Oscillators* by Barry Davis (Published by Prentice-Hall of Australia, and available from Tandy Electronics).

The power blocking oscillator (as described in this series) differs from the conventional type in several ways. Firstly, power is being extracted from the secondary circuit. The primary (collector circuit) and feedback (base circuit) power requirements are therefore much greater. The impedances of the transformer windings are much lower, and the forward bias resistor is only 100 ohms (or even less in some cases!). The result of all these differences is that the circuit behaves more like a grossly overdriven Armstrong oscillator (see pages 91-94 of the reference).

The 'off' or 'blocking' period is determined by a different mechanism from the oscillator described in the reference above. In particular, the capacitor associated with the feedback winding is not part of a frequency determining network, but acts instead as a bypass capacitor for the forward bias resistor. In power blocking oscillators, the main factors which influence the operating frequency are the construction of the transformer, the input supply voltage, the secondary rectifier configuration and the output load current.

This brings us to the end of this series on DC-DC converters which use the blocking oscillator principle. The techniques described here should give you a general idea of what can be achieved with just a few parts and your imagination.

I hope that the information I've presented has encouraged you to experiment with and make use of these intriguing devices. ❖

[illegible]

Digital Speakers

This idea was originally submitted for inclusion in Circuit and Design Ideas. However we thought it warranted special attention, due to its revolutionary concept. We haven't actually built a set of these speakers, but careful analysis seems to suggest the idea is sound. The idea was sent to us by Don E. Morgan (Pine Creek, Qld), unfortunately without photos to show a prototype. As well, the description is rather scant, but you should be able to get the idea. Don writes...

Digitally recorded sound is now a standard, and most of the distortion produced in a sound system is due to the digital to analog conversion process. But the only reason for D to A conversion is to drive analog speakers, meaning most of the distortion could be eliminated if a loudspeaker system could reconstruct the analog sound directly from the digital signal.

At first glance, this appears rather difficult, due to the on-off form of a digital signal. However, it must be remembered that each level of volume is represented by the number of bits in a binary word, while the frequency of the sound is represented by the change in the number of bits. In other words, the bits themselves are meaningless — it's their combination and how the combinations change that give the sound.

A digital signal representing sound is therefore a series of binary *words* that contain a varying number of bits. The more bits available the better, as the resolution (or number of discrete volume levels) is increased. The frequency of the change is anything from DC to 20kHz, although the binary words are presented at a fixed rate, usually around 40kHz.

A digital speaker therefore needs to produce a sound that varies in intensity depending on the value contained in the binary word. As well, the speaker system needs to be able to cope with intensity variations extending from DC to 20kHz. As it turns out, the latter requirement is easy; it's the first requirement that's the most difficult.

The whole premise of a digital speaker relies on the presence of a *fundamental* sound source. This sound is then digitally modulated and reproduced by the speaker system. While there is no such thing as a fundamental sound, there is a fundamental waveshape — the sine wave.

However, a sine wave represents a single frequency, and most sounds contain a number of frequency related sinewaves. What is therefore needed is a fundamental sound source that contains an infinite number of sinewaves. Those who have studied Fourier analysis will know that a square wave meets this requirement, making the square wave an ideal fundamental sound source.

The frequency of the square wave is not all that important, but it will set the minimum frequency the speaker system can reproduce. For the purposes of the experiment, I chose 50Hz as it allows the fundamental sound source to be developed directly from the mains. The only problem here is the switching tones used by supply authorities to switch off-peak hot water systems. However, a separate oscillator overcomes this.

Basically, you need as many speakers as bits in the digital word. The quality and size of each speaker is not important, although all speakers need to be the same. As well, larger speakers are easier to work with. An enclosure is not necessary, although some form of mechanical support system is needed.

The speakers are mounted one on top of the next, spaced by 50mm or so, giving a vertical stack. The bottom speaker can be regarded as bit 0 and the top speaker as bit 13 (or whatever). The cones of each speaker need to be mechanically coupled, using an arrangement that corresponds to a digital code.

For example, if the useful radius of the cone is 50mm, the first speaker cone (bit 0) is connected to the one above it (bit 1) with a rod attached to the radial extremity of both cones. The cone of bit 1 is then connected with a rod to the cone of bit 2, this time moved towards the centre by 50mm/14 (for a 14 bit system).

This sequence is repeated throughout the stack, with the top speaker (bit 13) connected to the one beneath it with a rod located as close to the centre of the cone as possible. Use the lightest possible material for the rods, such as rigid plastic tubing.

Once the mechanical system is complete, connect the fundamental sound source so that one lead feeds the same terminal of all speakers. The other lead of the sound source becomes the common. The digital signal is then connected so that bit 0 of the binary word connects to the remaining terminal of the speaker at the bottom of the stack. The other binary bits connect to speakers 1 to 13.

The fundamental sound source supplies the power to the system, and the binary input signal switches the speakers on and off. You'll need some form of interface between the digital sound source and the speaker system, as a digital gate won't be able to handle the current. I used a bank of transistor switches as buffers.

The output voltage of the sound source will determine the maximum sound level, so adjust it to suit. Just be sure the signal is a perfect square wave, as otherwise sound 'colouring' will occur. As you can see, when the digital code is zero, no speakers operate. When any bit in the code is a one, that speaker will reproduce the fundamental sound, but with a load that depends on the mechanical coupling it has to the rest of the speakers.

The closer the coupling is to the outside of the cone, the less the loading, and the less the cone movement. All cones will move with it, but by a different amount. The power to move each cone is supplied by the fundamental sound source, and because all harmonics of the sound spectrum are contained in the sound source, any frequency is available.

To enhance the look of the unit, fit the speakers into a tube made of mesh to allow the sound to escape in all directions, giving a more natural effect. The colour of the mesh is not important. For a stereo system, two speaker units are needed, placed in the usual left-right positions.

Some interesting effects can be obtained by swapping bits. For example, if you swap bits 0 and 13 of the digital signal, otherwise intelligible sound becomes 'spaced out'. The effect is rather disorientating as just when you expect a loud sound, everything becomes soft. However, this only occurs when either of these bits are used. At other times the sound is normal.

A more interesting sound is achieved by swapping bits from the left and right channels. If bits 6 and 7 of the left channel are swapped with the corresponding bits from the right channel, a ping-pong effect occurs, but only at one sound level. Suddenly the singer is on the other side of the room, but only for an instant. In short, the combinations are unlimited, and the effects mind-blowing in some cases.

For those with no sense of adventure, just sit back and listen to pure digital sound. You'll be amazed...

Incidentally, Mantovani playing *April in Paris* sounds great — especially with bit 1 of the two channels reversed. ❖

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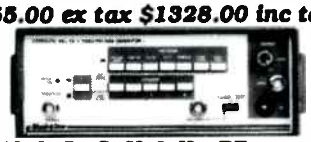

● Tests TV, VCR, Monitors etc ● PAL B, D, G, H, I, K ● RF, Composite Video and IRGB Outputs ● Separate or Mixed Syncs ● Trigger Output ● Colour Bars, Greyscale, Crosshatch, Dots, Lines, Focus, Purity etc. ● Over 50 pattern combinations ● 1V or TTL IRGB ● 5.5, 6.0 and 6.5MHz Sound Carriers ● Internal/External Sound ● Mains Operated ***$755 (ex tax) $869 (inc tax)***

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Serial DAC has readback

National Semiconductor's DAC0854 simplifies system design by integrating a 2.65V reference, four output amplifiers, and four 8-bit digital-to-analog converters (DAC). This complete 5V quad DAC also features a data readback function. Data readback adds diagnostic capability at the chip level in applications such as automatic test equipment, processor-controlled instrumentation, and industrial monitoring equipment.

This data readback function permits users to verify the digital data path between the host processor and the DAC0854, and performs a distributed memory function. By writing a data word to the DAC0854 and having it read back to the processor, the designer can verify that the correct digital code has been received by the converter. The DAC0854's serial data I/O allows easy interface to the COPs family of controllers, and to standard shift registers or microprocessors. In addition, the input is double-buffered to allow all four DAC outputs to be updated simultaneously.

Four DAC reference inputs are provided to give the user maximum design flexibility — allowing independent range selection for each DAC. The output voltage of each DAC can range between 0.3V and 2.8V. The DAC0854 has a guaranteed voltage output settling time over temperature of 2.7us and a maximum power dissipation of 95mW. A 'power fail' feature enables the DAC0854 to flag the host processor should a power failure occur on the system.

For more information circle 273 on the reader service coupon or contact National Semiconductor, 16 Business Park Drive, Monash Business Park, Nottinghill 3168; phone (03) 558 9999.

True 64-bit RISC processor

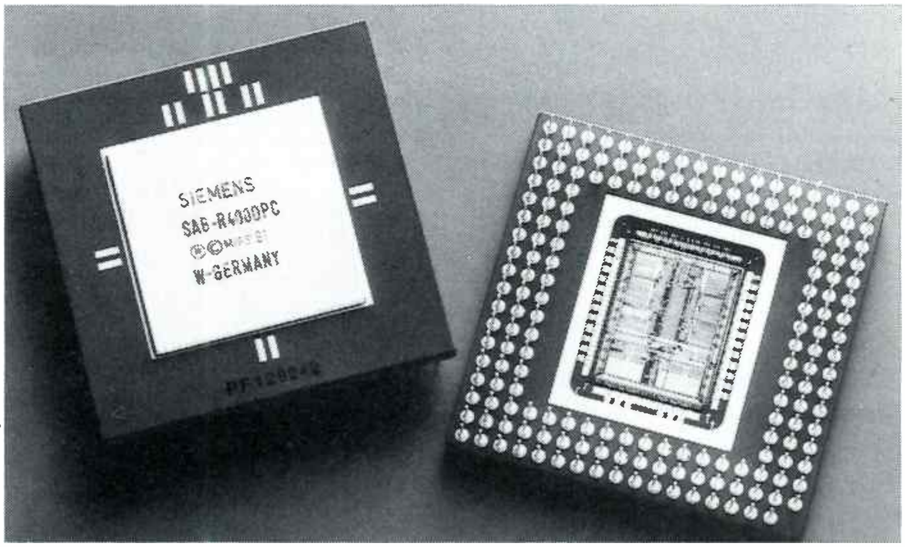
Siemens has delivered samples of a RISC (Reduced Instruction Set Computing) processor with true 64-bit capability, both internally and externally. The R4000 uses the RISC architecture of MIPS Computer Systems, California.

With its well balanced architecture, the chip fits technical as well as commercial applications. Main areas are high-end PCs, workstations, servers, robotics, telecom applications, as well as future multimedia computers. Samples of the R4000 are already available and mass production is expected to start before July 1992.

The 64-bit processor comes in three versions: the SAB-R4000PC (PC stands for primary cache), for which the main applications are in desktop PCs and in embedded controls; the SAB-R4000SC (SC: secondary cache support), which has its strength in workstations and servers; and the SAB-R4000MC, which is used in multiuser/multiprocessor systems as well as in fault tolerant applications.

The R4000 runs at a clock rate of 50MHz and an internal frequency of 100MHz. First data throughput simulation deliver 60 SPECmark at 50MHz. As a true 64-bit processor, the R4000 offers 64-bit characteristics across the board: 64-bit general purpose registers, 64-bit floating point registers, 64-bit operations and 64-bit virtual addresses for memory management. The chips are fully software downward compatible with the R3000 processor. All user applications which run on the R3000 will also perform on the R4000.

For more information circle 272 on the reader service coupon or contact Siemens, 544 Church Street, Richmond 3121; phone (03) 420 7111.



3.3V LCD VGA controller

Cirrus Logic has announced the sample availability of a 3.3V single chip LCD VGA controller, for designers of portable computers. The device called the CL-GD6411 is being supplied to customers who will initially use it as a prototyping and system development vehicle for 3.3V notebook computers.

The CL-GD6411 provides 64 shades of gray on a monochrome LCD and is capable of directly driving a 512-colour active-matrix LCD. Its 'SimulSCAN' feature lets it simultaneously drive an LCD panel and an analog CRT monitor. Mapping of colours into shades of gray is accomplished by having the CL-GD6411 track the red, green and blue colour data written by the CPU into the internal RAMDAC and simultaneously perform a 'sum-to-gray' operation on the data. The results of this operation, representing colour mapping values of the RAMDAC contents, are used to create images on the screen. The full 256 colours of VGA Mode 13 can be mapped into as many as 64 shades of gray using this feature.

Cirrus Logic has integrated into the CL-GD6411 virtually all of the functions that must be performed by an LCD VGA controller. These include host bus interface logic; LCD panel interface for data and control signals; full LCD panel power sequencing logic; a complete RAMDAC; and memory control logic that allows the complete video memory to be implemented using only two 256K x 4DRAMs.

The only other components required to create a complete 3.3V LCD VGA and CRT control subsystem are two DRAMs, a clock sythesiser, and (if a dual-panel LCD is used) an additional 'frame accelerator' memory. The entire solution would occupy less than four square inches of board space, making it ideal for notebook motherboard designs.

Power line monitor chip

The MID400 is an optically isolated AC line-to-logic interface device for monitoring the ON or OFF status of an AC power line. Its logic circuitry operates from a standard 5V supply, and is packaged in a compact 18-pin plastic MINI-DIP. The optical isolation provided by the MID400 makes it suitable for power-to-logic interface applications such as industrial control, medical equipment computers and other failsafe type monitor systems in which status information about the AC line is essential.

For further information circle 274 on the reader service coupon or contact KC Electronics, PO Box 307, Greensborough 3088; phone (03) 467 4666.

20GHz bias tee

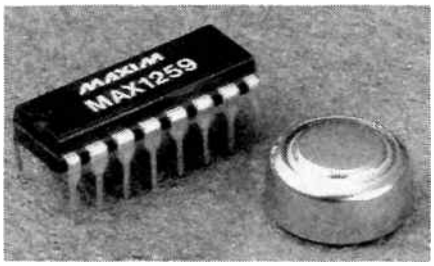
The A3N1001 is a wideband bias tee, developed by Anritsu for applications where a DC bias is required to be superimposed on a high frequency signal. By using this device, DC bias can be superimposed without distorting the waveform. The bandwidth of the A3N1001 is 100kHz to 20GHz. It offers a maximum response time of 20ps, with an insertion loss of 0.2dB, low reflection at 12dB (min) and a maximum bias voltage of +/-30V DC.

For more information circle 278 on the reader service coupon or contact Alcatel Australia, 58 Queensbridge Street, South Melbourne 3205; phone (03) 615 6666.

Backup battery manager

The MAX1259 battery manager will switch CMOS RAM, a real time clock, and other continuously powered circuits from the main supply to the backup battery during primary power loss.

The chip is pin compatible with the industry standard DS1259, but consumes only one third the power and costs less.



The new MAX1259 requires only 3.3mA of supply current in operating mode and only 100mA in backup mode. This low supply current makes it ideal for monitoring +5V supplies in portable and nonvolatile equipment.

It provides 250mA of output current at a switch drop rate of only 0.2V, making it possible to backup several CMOS RAM chips at once. A battery failure output below +2V, and a power fail output signal, indicates when the primary power supply is low as well. Applications for the MAX1259 include handheld instruments, controllers, computers, automotive systems and uninterruptable power supplies.

For more information circle 271 on the reader service coupon or contact Veltek, 22 Harker Street, Burwood 3125; phone (03) 808 7511.

Light/frequency converter

Minute changes in light intensity can now be detected and measured with a new level of accuracy through use of a light-to-frequency converter from Texas Instruments. The device, the TSL220, which comprises a large-area photodiode and a patented BiMOS current-to-frequency converter, can be connected directly to a microprocessor or a digital control circuit.

Because the device converts light to digital signals that are not distorted by external influences such as noise, it is able to measure extremely small amounts of change in light intensity. It is well-suited for a wide variety of precision light measurement and position detection applications. Light sensing applications for the TSL220 include lighting control systems, environmental light level monitoring, burner flame control in heaters and solar monitoring. The device can also be used in photo light meters and exposure timers, as well as to adjust electronic display brightness to compensate for ambient light levels.

The TSL220 has an extremely wide dynamic range (118dB). The output is typically over 100kHz in office desk lighting and only 1Hz in the dark. The device also offers high levels of noise immunity, resolution and sensitivity (0.01% change in illumination). At the same time, it offers a choice of output frequency range. A single external capacitor can adjust the output frequency for a given light level input to match the TSL220 to the input frequency range of a microprocessor.

For more information circle 277 on the reader service coupon or contact Texas Instruments, 6 Talavera Road, North Ryde 2113; phone (02) 878 9000.

Flash memory on controller chip

Motorola has unveiled the 68F333, a microcontroller which integrates non-volatile flash electrically erasable programmable read-only memory (EEPROM) on chip. The combination of flash EEPROM on a single chip provides designers with added flexibility and versatility for high-performance 32-bit applications. Alterations or updates to electronic modules can be made by simply reprogramming the software rather than replacing the entire module.

The Bavarian Motor Works (BMW) has announced plans to use the new microcontroller in its next generation four cylinder series automobiles. The 68F333 will give BMW the technology to optimise the performance of their vehicles, regulate transmissions, control emissions and fuel efficiency.

The 68F333 is a member of Motorola's 68300 family of 32-bit embedded control devices. The family also includes the 68332, 68331 and 68340. Like its predecessors, the 68F333 is modular in design and uses the central processing unit based on Motorola's 68020 (CPU32). The 68F333 combines a collection of sophisticated onchip peripherals to improve overall performance, including a queued serial module (QSM), a single chip integration module (SCIM) and a time processing unit (TPU). All modules are interconnected by the intermodule bus (IMB) which allows features and options to be interchanged for different applications.

For more information circle 275 on the reader service coupon or contact Motorola Australia, 673 Boronia Road, Wantirna 3152; phone (03) 887 0711. ❖

NEW PRODUCTS

Supertwist LCDs

Handoks HDM 16216H-U10 is the latest addition to its range of supertwist alphanumeric Liquid Crystal Displays.

The HDM 16216H-U10 is a two line x 16 character LCD with a character height larger than normal — a very viewable 8.09mm. This display is ideal for those applications where the normal 4 or 5mm character height is not sufficient.

The extra advantage of this display is its very wide viewing angle and high contrast, due to the use of supertwist technology. Viewing angles of up to 100° are now available for LCDs.

The options of electroluminescent backlighting add further versatility to this new display. The display is driven via the 8-bit parallel interface powered by a single +5V rail. The HDM 16216H-U10 provides all this at a very competitive price.

For more information circle 243 on the reader service coupon or contact M.B. & K.J. Davidson, 17 Roberna Street, Moorabbin 3189; phone (03) 555 7277.

Fast data acquisition

Datel's HDAS-534/538 data acquisition system's 250kHz throughput rate is claimed to be three times faster than other data acquisition systems. Each functionally complete Hybrid Data Acquisition System contains a multiplexer, instrumentation amplifier, sample-hold, analog-to-digital converter, three-state outputs, onboard reference and internal clock.

Late last year Datel released an even faster 400kHz system, the HDAS-524/528. The lower cost HDAS-534/538 is pin and functionally compatible with the HDAS-524/528, allowing for future throughput upgrades for a designer's system.

The HDAS-534 features four differential input signals and the HDAS-538 has eight single-ended inputs. Additional multiplexer channel expansion is accomplished through use of a double-level multiplexing scheme.

Packaged in a small 40-pin DIP package, power dissipation is minimised to just 2.6W. An onboard instrumentation amplifier is characterised for gains of 1, 2, 4, 8, 10 and 100, allowing unipolar or bipolar input ranges from 100mV to 10V full scale.

The gain range is selectable through an external resistor.

For more information circle 244 on the reader service coupon or contact Quiptek Australia, PO Box 129, Moorabbin 3189; phone (03) 532 1328.

VOR/ILS service monitor

For servicing radio equipment on board aeroplanes and helicopters, Rohde & Schwarz has developed the Radiocommunication Service Monitor CMS57. This compact tester can handle a wide range of radio measurements on board aircraft — from the conventional radiocommunications to navigational aids and instrument landing systems.

The CMS57 features not only all the measuring and test facilities of the universal radiocommunication tester CMS52, but also a high precision VOR/ILS generator that delivers the signals for VOR (VHF Omnidirectional Range), ILS (Instrument Landing System) and MB (Marker Beacon), in the RF as well as the AF range. A large backlit LCD (9.8 x 21cm) is provided for the clear display of all essential measuring and test parameters. Thanks to the compact size and low weight of the CMS57, tests can be carried out not only on board or in the workshop, but also on the runway. The CMS57 allows complex test routines to be programmed and run without using an external controller. During an automatic test run, the individual steps and their results can be stored on a memory card, or output on an external printer.

For more information circle 241 on the reader service coupon or contact Rohde & Schwarz, 63 Parramatta Road, Silverwater 2141; phone (02) 748 0155.

IC extractors and inserters

GK Industries has released the WK-7 kit which includes DIP IC extractors and inserter tools for ICs of between eight and 40 pins. All of the tools are CMOS safe, when engaged with conductive surfaces, and include grounding lugs where appropriate.

The kit consists of: extractors ex-1 for 14-16 pin devices; Ex-2 for 24-40 pin chips; MOS-1416, MOS-2428, MOS-40 inserters for 14-16, 24-28 and 36-40 pin ICs respectively.

For more information circle 249 on the reader service coupon or contact Electronic Development Sales, PO Box 822, Lane Cove 2066; phone (02) 418 6999.

NEW PRODUCT!

PCB jack sockets

Neutrik has introduced its new range of PCB mounting 1/4" jack sockets, designated the NC3FDH6 series.

The new connectors are designed for mounting directly to printed circuit boards and are fully compatible with existing 1/4" mono and stereo jack plugs.

The new design features the complete separation of contacts and elements providing the plug retention force.

As a result, contact wear has been dramatically reduced, with no visible contact wearing apparent after over 10,000 plug insertions. All contact elements are gold plated for maximum signal integrity.

The connectors are designed to 'dove tail' fit with adjacent connectors, providing a compact and stable assembly which does not require front panel fastening.

Another interesting version is the 'double jack', a twin jack in a vertical array with the same footprint. The compact nature of this connector permits its use in 1U rack mounting enclosures.

Fore more information circle 245 on the reader service coupon or contact Amber Technology, 5 Skyline Place, Frenchs Forest 2086; phone (02) 975 1211.

IR detector cards

'Magic mirror' infra red detector cards are claimed to be an invaluable service aid when testing remote controls, low power laser and infrared beams used in burglar alarms, etc.

To use them is simplicity itself. Position the active triangle section of the card to within 1cm of the infrared source, and if any infrared light is being emitted, an orange glow will be emitted from the card. Hence the reason for calling them mirrors.

If the card has been stored in a dark case or pocket for some time, the reflected image will be dull when exposed to infrared light. But it returns to its former brightness after exposure to ordinary daylight or fluorescent lighting for about 30 seconds.

This rejuvenation will last for some days and can be repeated as often as required. The life expectancy of the active material is in excess of 10 years.

The card uses no batteries and is sealed in a clear durable waterproof pouch which is hard wearing and easy to clean. It comes in various shapes, including credit card, key fob and spatula sizes. The spatula is small enough to test a video recorder's LED in situ.

Magic mirrors are currently available

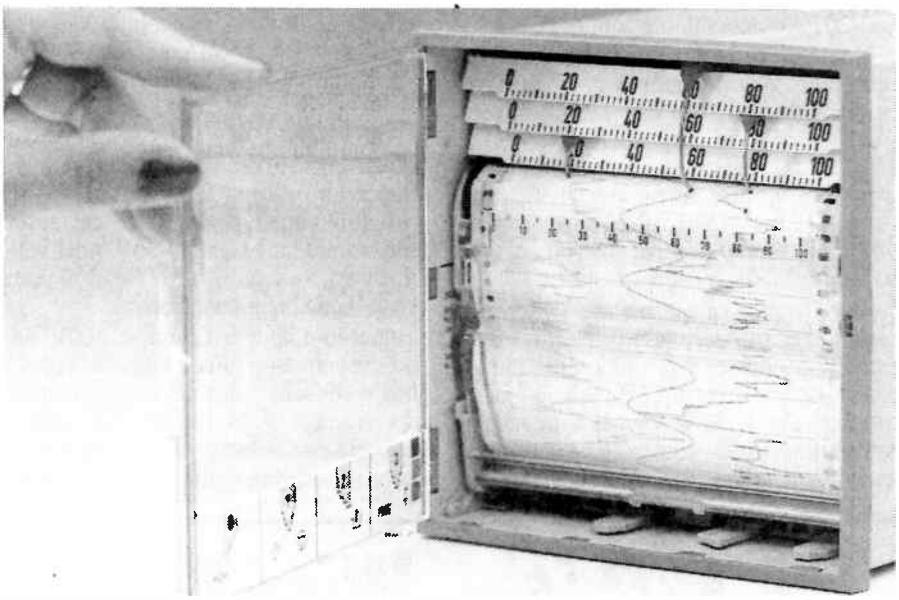
Low cost process recorder

Siemens' new Sirec 2010 dotted-line and continuous-line recorders offer high quality and a variety of functions at low cost. The units have a mounting area of 144 x 144mm and a mounting depth of 260mm. The dotted-line and continuous-line recorders are designed for standard signal ranges of 0 to 20mA, 0 to 1V and 0 to 10V. They are equipped with connectors for thermocouples and resistance thermometers.

The recorders trace three measurands in different colours, using three robust and independently operating writing systems that are contactless and hence non-wearing. Digital signal processing permits reliable sensing of pulses lasting only 300ms. Hour and event marking on the chart are supplementary functions supplied as standard. The paper speed can be set in 12 stages from 1 to 1200mm/hr. A pen-lift function prevents ink blots forming during service passes.

The dotted line recorders record up to six measurands (selectable by pushbutton) in six colours.

For more information circle 242 on the reader service coupon or contact Siemens, 544 Church Street, Richmond 3121; phone (03) 420 7449.



direct from their UK manufacturers, who would like to find Australian agents. Their price is £7.66 + VAT.

For more information circle 246 on the reader service coupon or contact Electronic Consultant Service, 6 Nethersole Street, Polesworth, Tamworth, UK, B78 1EE; phone (44) 0827 33 0392.

Remote control power switch

In a move to make increased security more convenient for vehicle owners, Down Under Communications has announced the development of the Heddolf HD-201 wireless remote control switch.

Now you can conveniently control almost any 12-volt unit or system. Turn on or off lights on your car, boat, camper, truck, tractor or any vehicle; use the HD-201 as a secret ignition switch by disabling ignition to prevent theft; turn on or off low voltage lighting systems and or remotely control 12-volt relays, sound and radio systems.

Key features of the remote switch include: use of radio transmitter/receiver technology for remote ignition disabling; a compact receiver module which easily mounts near a 12V source; a keychain transmitter which transmits up to 15m away; and when activated the HD-201 prevents the unauthorised starting of a vehicle, etc., with an ignition key or by 'hot wiring'.

The recommended retail price for the remote power switch is $99. For more information circle 247 on the reader service coupon or contact Down Under Communications, PO Box 146, Fawkner 3060; phone (03) 359 9720.

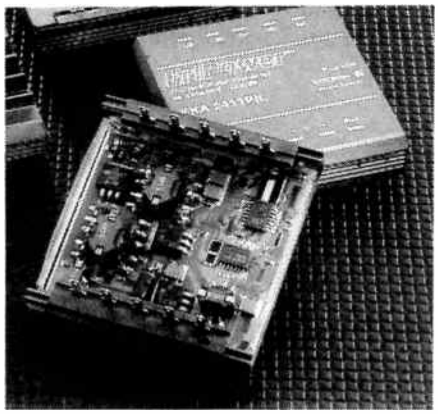
40W DC/DC converter for 24V

Ericsson Components has introduced the PKA2411, a 40W low profile Oncard DC/DC converter for 24V battery systems. Using a switching frequency of 300kHz and hybrid technology, the converter provides a 5V/8A output at 80% efficiency with a footprint of just 76 x 76mm, and a height of 19.8mm.

Power density is 0.35W/cm^3 with natural convection cooling and ambient temperature ranges from -45 to +65°C, with full output power over the entire temperature range and 19-36V input voltage range. Reliability is MTBF>200 years at +45°C ambient temperature.

Input-to-output isolation is 500V DC and the converter offers a built-in voltage shutdown facility, operating at a minimum input voltage of 14V, in order to prevent unnecessary discharge of the batteries.

For more information circle 270 on the

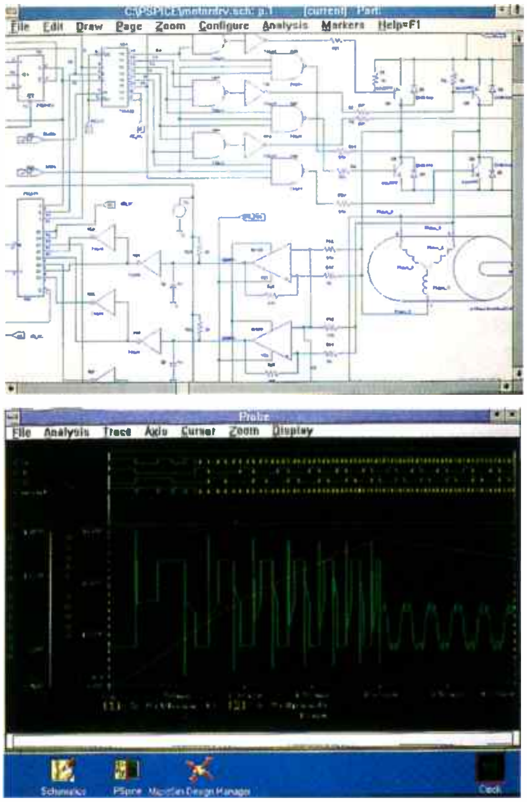


reader services coupon or contact EC Capacitors, 59 Radford Road, Reservoir 3073; phone (03) 462 2855.

Diamond files

Scope Laboratories has released a five piece diamond file kit, code NF-D5. The firm claims the files could become a 'technician's best friend' not only because of extended wear life, but also due to their wider range of uses. This includes their ability to reshape glass panels, or renovate the hardened tip of a Phillips screw driver that is dangerously worn.

For more information circle 248 on the reader services coupon or contact Scope Laboratories, PO Box 63, Niddrie 3042; phone (03) 338 1566. ❖



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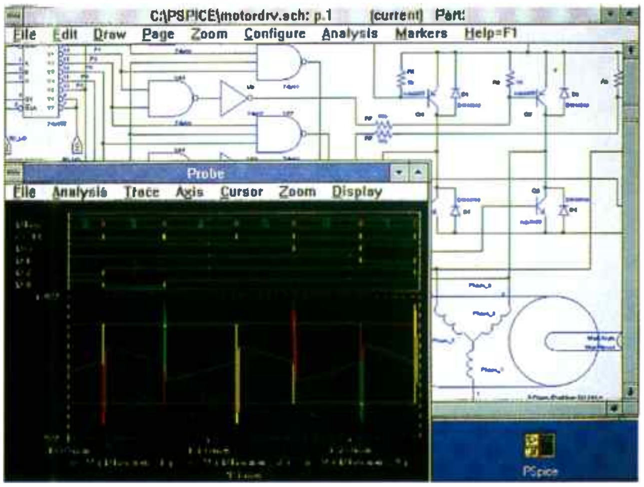

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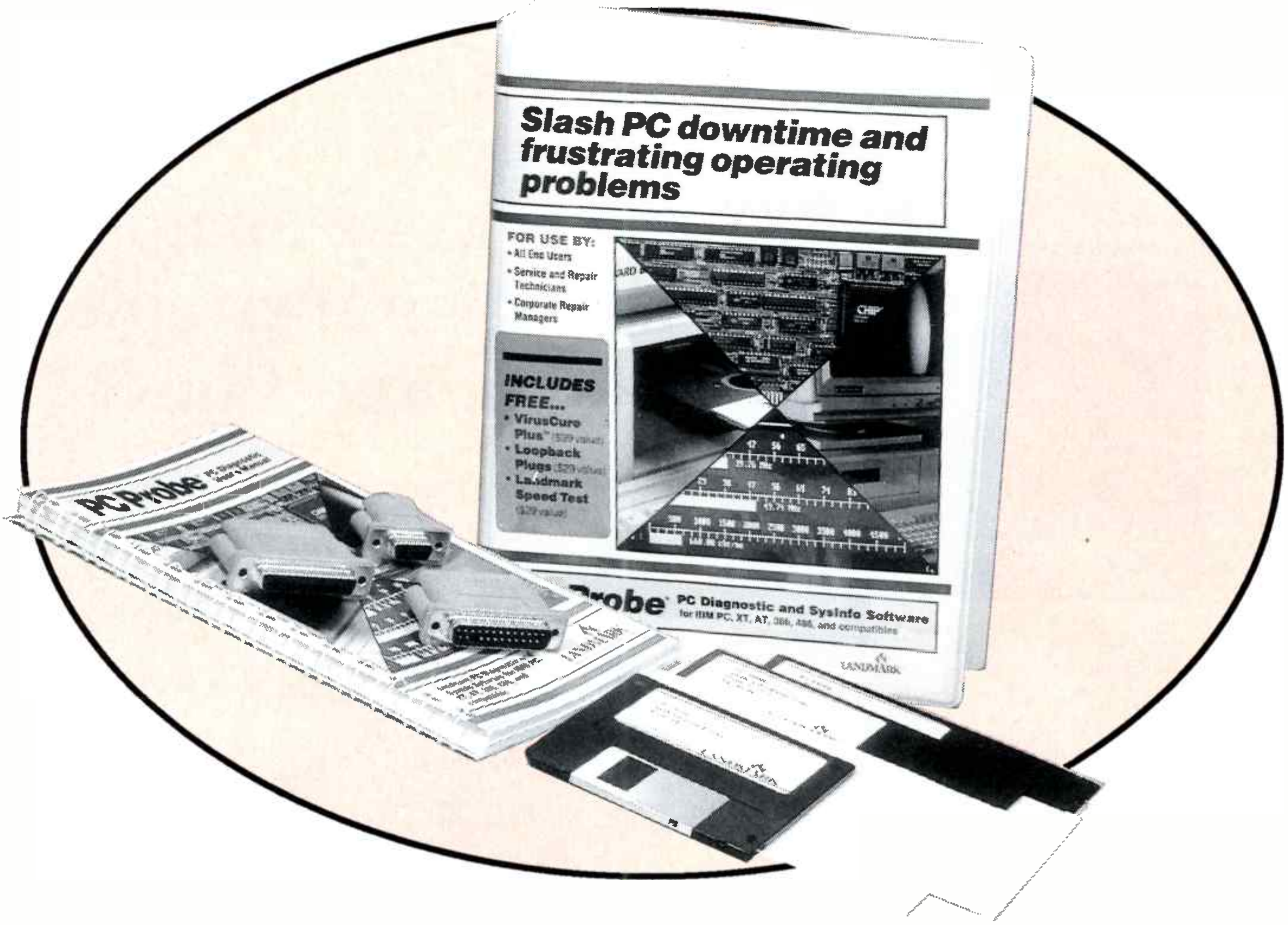


PC Probe and Supersoft diagnostic software For PC's

These two diagnostic kits can perform an extensive range of tests on any IBM-compatible machine, to help you enhance and maintain its performance. They can determine exact hardware configuration of your PC, show the performance level of each of the major system components, carry out a number of useful utility functions, and have the potential to spot trouble *before* it cripples the machine.

While the idea of delving into a PC's internals to find out what's going on may seem daunting to even the most technically inclined PC user, diagnostic software can turn this complex task into a simple menu-driven program where the machine effectively analyses itself, then reports its findings.

You can then assess your system's capabilities, track down or confirm suspected fault conditions, or simply satisfy yourself that the PC is performing correctly after being repaired or upgraded.

The biggest advantage here is that even if you only have a general knowledge of a PC's inner workings, you are able to both test and diagnose the machine down to a chip level without even opening its case. In practice, this has the potential to save you substantial servicing costs — or at the very least, provide an educational 'window' into your PC's operation.

Both PC Probe and Supersoft are packaged as complete diagnostic *kits* which include 'loopback' plugs for test-

PC Probe and [illegible] [illegible] software For PCs

ing the parallel and serial ports, and versions of the software supplied on both 5.25" and 3.5" diskettes.

As it happens, they also come from the same company: Landmark Research of Clearwater, California. The similarity really ends here though, since the two packages appear to aimed at distinctly different groups of PC users.

PC Probe

In short, PC Probe is a software package for the technically minded user who wants to maintain their PC's performance and reliability. This is quite a broad description however, since it has sufficient features to be of use to a professional computer technician, yet offers an amiable menu system (with a versatile online help system) which should suit non-technical users wanting to learn more about their machine.

Once PC Probe's software is loaded, it immediately scans the machine's internals to determine the system configuration (number of hard drives, BIOS type, and so on), then greets the user with its main menu screen — as shown in the associated screen shot.

This offers a series of nested pull-down menus which can be activated directly from the PC's keyboard, or by using the popular 'point and shoot' method if the system is equipped with a mouse.

You're then able to access PC Probe's generous number of testing features, which include a wide range of performance 'benchmark' speed tests (for the hard disk, main processor, etc), a series of diagnostic routines for the system's major components, and a set of utility functions for system maintenance (reconfiguring the hard disk, altering the CMOS RAM, etc).

The various diagnostic features of PC Probe caught our interest in particular. These are arranged in the three general areas of I/O Cards (parallel, serial, games, etc), System (motherboard), and Drives (floppy and hard), where the tests may be individually 'tagged' and run as a sequence of repeating events, or simply executed as a single once-off task.

With this system, the user can predefine a series of tests on a particular section of the computer's hardware which (say) may have been giving trouble, then instruct PC Probe to perform the checks on a continuous basis. The software will then display an appropriate error message should the fault occur, and as a bonus, can pass the information on to a 'results log'.

The SuperSoft diagnostic kit comes complete with serial port 'loopback' plugs (as does PC Probe), and a set of dedicated POST ROMs to replace the system BIOS chips.

This logging facility is especially handy for long-term 'soak' or 'burn-in' testing, where the software can be instructed to automatically record any errors as they occur, without the need for operator intervention.

The actual error messages can be directed to a printer or a disk file, then the accumulated information scrutinised at leisure. By the way, it's also useful if you've activated some of the software's more rigorous memory checking procedures (such as 'Galrow' tests) which can take hours to complete just a single pass.

Other than its benchmark, diagnostic and utility functions, PC probe also offers a wealth of general information about the system's configuration (video card chipset, ROM locations and size, etc), and believe it or not, the ability to display a series of graphics images of a typical PC's internals.

Eight of these high-resolution colour images are supplied on the PC Probe disks in the common PCX format, and can be displayed via the software's Pictures menu (or any other PCX-compatible graphics program). According to the manual, these pictures can be 'informative and educational to yourself and others'. We can't argue with that...

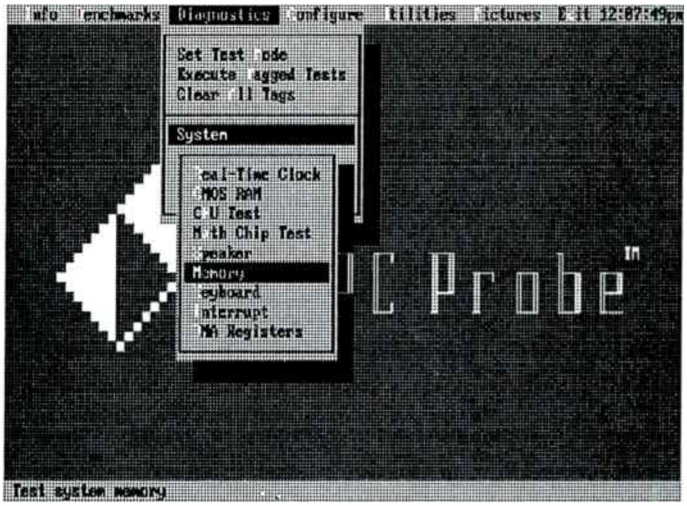
By the way, PC Probe's manual is refreshingly concise and well written (despite the odd spelling mistake), and contains a *very* useful troubleshooting section to help interpret the results of the software's investigations.

It also includes a full glossary of computer terms, a very comprehensive listing of common motherboard chipsets, and general information on a PC's operation.

Besides the actual PC Probe software, the supplied disks also include copies of the well-known Landmark Speed Test program (*Speed200*), and the anti-virus software *VirusCure* from McAfee Associates. These are both useful programs, with VirusCure's impressive list of known viruses making interesting reading in itself.

Unfortunately, we didn't have a few captured viruses for Viruscure to bump off, so its effectiveness couldn't be


PC Probe and SuperSoft diagnostic software for PC's



PC Probe's main screen with it's elegant mouse-driven, pull-down menu system.

And SuperSoft's more mundane main menu screen, where the various options are selected by simple keystrokes.

tested at the time — nevertheless, its operation is quite straightforward and the scanning procedures seem very thorough. So as a general maintenance and system information kit for your PC, PC Probe certainly has all of the features that you should need.

SuperSoft

Unlike PC Probe, the SuperSoft diagnostic kit seems to be aimed more squarely at technically minded PC users and the PC service industry itself. As you can see from the shot of the program's main screen, it has a simple menu system with a rather plain-vanilla appearance — no snazzy mouse-driven pull-down menus here.

In fact, this no-frills approach is quite representative of all of SuperSoft's functions, which tend to get on with their job in a very businesslike manner and offer little in the way of extraneous information.

The actual range of tests offered by SuperSoft are in fact quite similar to that of PC Probe, since as you would expect, there are a finite number of *useful* software-driven system tests that can be performed on a PC.

So not surprisingly, SuperSoft can also show detailed information regarding the system configuration, perform an elaborate series of diagnostic checks (and log the results), and carry out a range of useful utility functions.

It's in the testing procedures where the real difference between SuperSoft and PC Probe can be seen. For example, SuperSoft has a more elaborate scheme for controlling its diagnostic tests, where the user can program the testing sequence to a high degree. That is, you can select the number of times each test will be repeated in a sequence, then how many times the actual sequence will occur — you can even instruct SuperSoft to pause, stop, or continue the looping (sequencing) process in response to an error condition.

In general, SuperSoft's diagnostic routines are really quite powerful, and tend to represent the more serious nature of the program when compared to PC Probe. Even the supplied manual has a rather purposeful look, with its stark cover and plain page layouts. However in our case, the manual appeared to be at least one revision behind the actual software, since a couple of SuperSoft's more elaborate features weren't documented. Fortunately the program provides a context-sensitive help system, which relieves the situation somewhat.

It's also interesting to note that unlike PC Probe, SuperSoft does not provide any real benchmark speed testing (short of determining the processor clock speed). Again, this is not all that surprising when you consider the area at which this diagnostic kit is aimed — that is, maintaining or restoring the machine's correct operation, rather than seeing how fast it can go.

What the SuperSoft kit *does* have however, is replacement chips for the PC's ROM BIOS, the fundamental 'firmware' for the entire machine. When installed in the motherboard, these devices will take total control of the system's critical circuitry and perform a continuous sequence of low-level diagnostic tests. The results of the tests are displayed on the PC's monitor (if it's operational), and also reported by a coded pattern of beeps from the system's loudspeaker.

In fact, this is really an elaboration of the normal range of system tests which are incorporated the standard BIOS chip of every IBM-compatible PC. These are known as the Power On Self Test ('POST') routines, and are responsible for the single beep that you hear as your system boots up, which is the BIOS indicating that all of the boot-up tests have been successful.

If a PC refuses to access the disk drives or has a serious memory problem (or even worse!), the POST routines are the only tests at your disposal since the machine cannot load or run any other software. This makes the SuperSoft BIOS chips an extremely valuable asset to any serious diagnostic arsenal.

So in practice, the overall tenacious nature of SuperSoft's diagnostic routines (both software and firmware based) means that you have an excellent chance of tracking down the cause of a PC fault, without having to touch any servicing equipment.

It's more than just a window into your PC's operation, since it has the capability of pursuing a fault right down to the chip level.

Conclusions

Just how useful the PC Probe and Supersoft diagnostic kits are to a PC user will depend upon their technical knowledge, or perhaps their desire to learn more about a computer's inter-

nals. However even if you don't fall into the above categories, you'll have no trouble in using either software package for the more straightforward tasks like confirming that your system is operating at its full potential, or determining the machine's exact hardware configuration.

Yet it's worth noting that an inexperienced user *could* cause irreparable damage to the hard disk data with the hard disk formatting option, or easily cripple the system by altering the CMOS setup table. While these useful, but potentially harmful options are available in both diagnostic packages, PC Probe has the option of setting a password on both functions so as to avoid trouble — a nice touch.

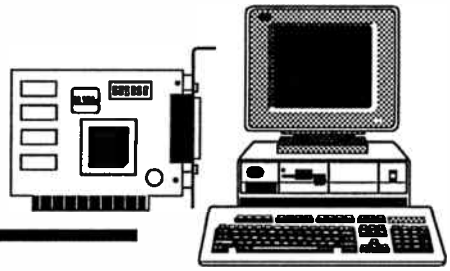
On the other hand, a technically inclined PC user should be able to use both diagnostic kits to great effect. When it comes to tracking down a system fault, the SuperSoft kit in particular (with its diagnostic ROMs) should ferret out the cause in short order. The question then is, who would really have the inclination, time or bravado to dive in with a soldering iron and replace a chip or track down a dry joint?

It's an interesting point. Chances are that most PC servicing workshops cannot afford (or justify) the time taken to faultfind a system component down to a chip level, and would simply replace the card, drive or whatever, and throw away the old one — even a motherboard fault would tend to be resolved in a similar fashion. Most of us would probably take the same approach, and avoid the headaches...

So if your PC is down for the count, or even just acting up, both PC Probe or SuperSoft could save you a service fee by indicating which system component is at fault, and therefore providing you with the opportunity of replacing it yourself. Other than that, running the checking routines on a regular basis will verify that the system is in proper working order, and *that* must be worth something for the peace of mind.

PC Probe with VirusCure Plus and the SuperSoft diagnostic kit (including the POST ROMs) are priced at $199 and $685 respectively, and are available from Interworld Electronics & Computer Industries at 1G Eskay Road, Oakleigh South, Victoria 3167. For more information on their large range of PC diagnostic products, call (03) 563 7066. (R.E) ❖

Computer News and New Products



80 x 2 switcher for ATE

Keithley Instruments' new two-slot switch system, Model 7001, can handle up to 80 channels of two-pole switching.

This is claimed to be the highest density switching of any half-rack mainframe in the test and measurement market, reducing the amount of hardware required. It also simplifies system set-up and minimises equipment costs.

The Model 7001 and three new switching cards combine with more than 30 other Keithley cards to offer switching capabilities from 30mV to 1.3kV, 10fA to 5A and DC to 500MHz.

Another advantage of the system is its full channel status display. The Model 7001's front panel shows the open/closed status of all channels simultaneously.

Inserting any of the new high density cards in the slot automatically configures the slots in the mainframe and the display. By allowing users to check the card configuration and channel status at a glance, the Model 7001 simplifies system programming, modifying and debugging. The display provides error messages, help and set-up and configuration prompts. It also provides scan control.

Although it is easy to program and control switching via its IEEE-488 port, the Model 7001 can also program and control a scan (channel spacing, scan spacing, number of scans) without direction from a computer.

This frees up the computer to process data or monitor other aspects of the test. The system can scan up to 200 channels per second, for high throughput.

For more information circle 162 on the reader service coupon or contact Scientific Devices, 2 Jacks Road, South Oakleigh 3167; phone (03) 579 3622.

Anti-virus 'Scan'

McAfee and Associates has released its latest shareware version of the anti-virus software package 'Scan'.

Version 85 allows for the detection and removal of generic boot sector and generic partition table infectors. The program recognises 76 new viruses, and claims to recognise 973 computer viruses, which includes variants.

Several new options have been added to the program, as well as enhancements being made to the existing ones.

For example, it is now possible to exclude specified files when adding validation codes, which reduces problems associated with self-modifying programs.

Also internal scanning of files compressed with PKLITE can be skipped by use of the /NPJKL option, and Scan can now use options stored in a configuration file for repeated use of the same option setting.

For more information circle 161 on the reader service coupon or contact Doctor Disk, 201/64 Kippax Street, Surry Hills 2010; phone (02) 281 2099.

Fast data acquisition card

The PC-30D data acquisition card is built for the PC-AT bus and is fitted with dual-channel DMA to allow access to all the host PC's available memory, without leaving gaps — even at full capture speed. It can sample at up to 200kHz, and a 16-sample FIFO buffer has been added to ensure error free operation at 200kHz.

The card has 16 analog input channels, 24 digital I/O lines (configured as three 8-bit ports) and four analog outputs (2 x 12-bit D/A and 2 x 8-bit D/A), which give the card good control capability as well as data acquisition.

Another strong feature of this card is its channel list capability. The channel list will allow the user to specify which of

the channels they wish to sample and in which order, with the list capable of 31 entries. A block mode is also available to give near simultaneous sampling, so that over 16 channels the difference between the first and last sample is only 75 microseconds.

For more information circle 163 on the reader service coupon or contact Boston Technology, PO Box 415, Milsons Point 2061; phone (02) 955 4765.

Op-amp models for SPICE

National Semiconductor's new SPICE op-amp macromodel libraries simplify the job of designing linear circuits through use of precision SPICE macromodels given to the design engineer for free. The 50 new macromodels cover National Semi-conductor's complete line of high speed VIP amplifiers, BiFET and CMOS series.

Improvements that National Semiconductor has made to SPICE macromodels include: good modelling of input transconductance characteristics when JFET, CMOS and Bipolar input stages are used; unlimited capacity to add poles and zeroes, resulting in a more accurate transient response; the models' supply current — no internal ground is used; accurate output stages are used; few non-linear elements are used, thereby reducing simulation time; and both 1/f and white noise are modelled for improved accuracy. To provide what is claimed as the most accurate models in the industry, National Semiconductor compared each SPICE macromodel with the actual setting response of the op-amps on the test bench.

The models work with the popular PC-based, PSPICE simulator from MicroSim Corporation as well as Berkely SPICE and other SPICE versions. The 5-1/4" SPICE models diskette includes an ASCII-formatted netlist of each model, an easy to run demonstration program, and a functional evaluation copy of SPICE. The models are also compatible with schematic entry packages from OrCAD

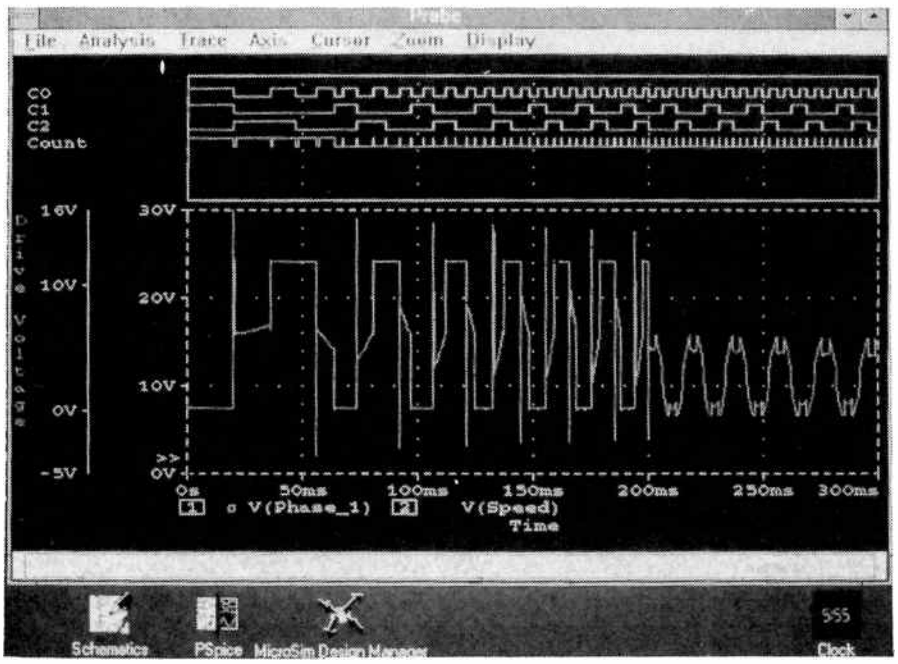
Integrated simulation from MicroSim

MicroSim Corporation has released the 'Design Centre', providing a fully integrated environment to capture, simulate, and analyse analog-only, mixed analog-/digital, and digital only circuit designs. The Design Centre significantly simp-lifies the design engineer's job by allowing circuit simulation and analysis activities to be performed within the circuit drawing environment.

The program gives 'native' support for both analog and digital circuits at all levels of the design process, including simulation with PSpice. The analog and digital algorithms are tightly coupled within the same program. Hence, only one circuit need be defined, only one simulation need be run, and only one graphical interface is needed to analyse the results of a amixed analog and digital circuit.

You can select from three systems: Windows-driven, or DOS with a shell manager, or direct management of the Design Centre programs. Prices range from $2450 to $29,900.

For further information circle 170 on the reader service coupon or contact Technical Imports Australia, PO Box 927, Crows Nest 2065; phone (02) 925 0311.



and IntuSoft. The 'SPICE Model Library-Operational Amplifiers' diskette is distributed at no charge and will be updated when needed.

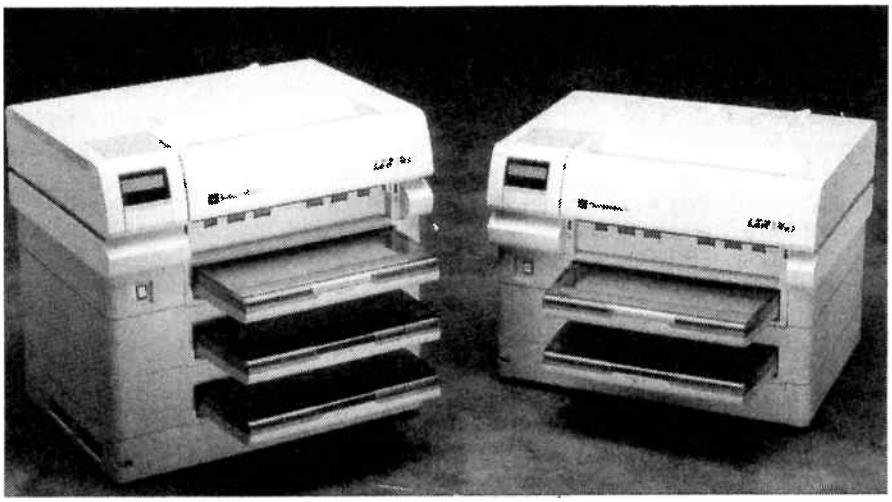
For more information circle 166 on the reader service coupon or contact National Semiconductor Australia, 16 Business Park Drive, Monash Business Park, Nottinghill 3168; phone (03) 558 9999.

Data plotting and analysis

DSP Development Corporation has released version 3 of its software program, DADiSP, a graphical worksheet for the display and analysis of data signals intended for engineers and scientists. DADiSP puts powerful data analysis tools on the desktop to manage and interpret large amounts of technical data, visually and interactively.

Version 3.0 includes an enhanced user interface, an extensive set of matrix and statistical functions, powerful 3-D and 4-D plotting capabilities, and presentation quality output. This is in addition to all the features found in the previous versions 1.05 and 2.0. Mouse support has also been included and hardcopy plotting capabilities have been extended to include colour and monochrome PostScript and HPGL plotting. DADiSP operates under MS-DOS on the PC AT, PS/2 and compatibles, as well as under X-Windows on workstations from SUN Microsystems, IBM, DEC, Hewlett-Packard and Concurrent. The DADiSP 3.0 user interface and powerful analytical features are the same across all hardware platforms.

For more information circle 165 on the reader service coupon or contact Interworld Electronics & Computer Industries, 1G Eskay Road, Oakleigh South 3167; phone (03) 563 7066.



A3 laser printer has 400dpi

Dataproducts Corporation has introduced the LZR1560, an affordable, high resolution, high performance laser printer that accommodates paper sizes up to A3. The new printer includes as standard a single paper bin. Double and triple tray units are available as options.

Producing 15 pages per minute, the LZR1560 series can operate at a duty cycle of 30,000 pages per month.

Each model comes equipped with AppleTalk, RS-232 Serial, Centronics parallel and SCSI hard drive ports, making it functional for both stand-alone applications or in a networked environment. It has been designed specifically for almost any graphic design, engineering, desktop publishing, accounting or general office application.

The LZR1560 is equipped with an Adobe PostScript Level 2 RISC-based controller and features 4MB RAM memory (expandable to 16MB). This combination enables the LZR1560 to print even complex pages at its rated speed.

PostScript Level 2 incorporates Display PostScript, Adobe Type Manager and other enhancements to increase the speed of PostScript tasks.

The new A3 printer produces high resolution graphics at either 300 x 300 or true 400 x 400 dots per inch (dpi), and does not require the use of 300 x 300dpi resolution enhancement methods.

Printed at 400dpi, posters, tabloid size newspapers, two-up newsletters, large spreadsheets and B size engineering drawings may be suitable as camera-ready art in many applications. The 400dpi feature is effective with both text and graphics files, enabling users to see significant improvements in greyscale imaging.

For more information circle 167 on the reader service coupon or contact Dataproducts, 2/10 Rodborough Road, Frenchs Forest 2086; phone (02) 451 3533.

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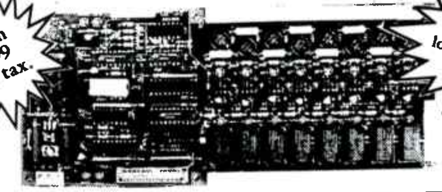

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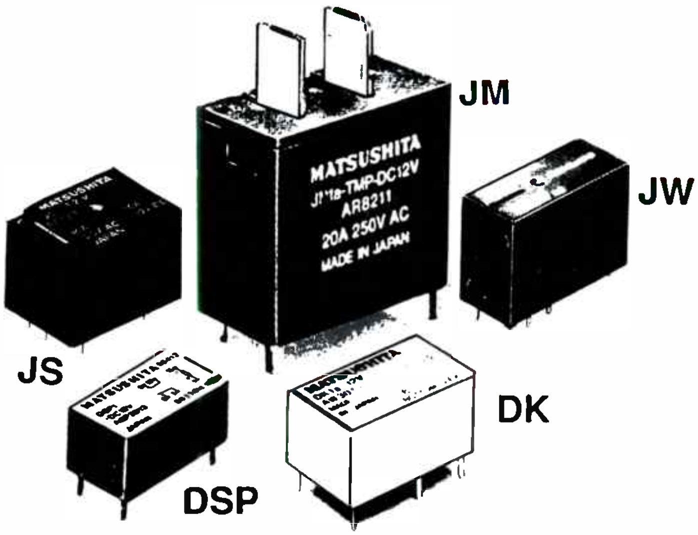

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