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Electronics Australia

June 1985

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■ RALLY COMPUTER

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High-voltage insulation tester

Multi-band trapped antenna

Bridge adaptor for amplifiers

REVIEWS: Mitsubishi DP-205 CD player
Kenwood 780 cassette deck

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Cat X-6005 .... $69

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Cat X-6010 .... $49

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32K Cartridge Cat X-6020 .... $129

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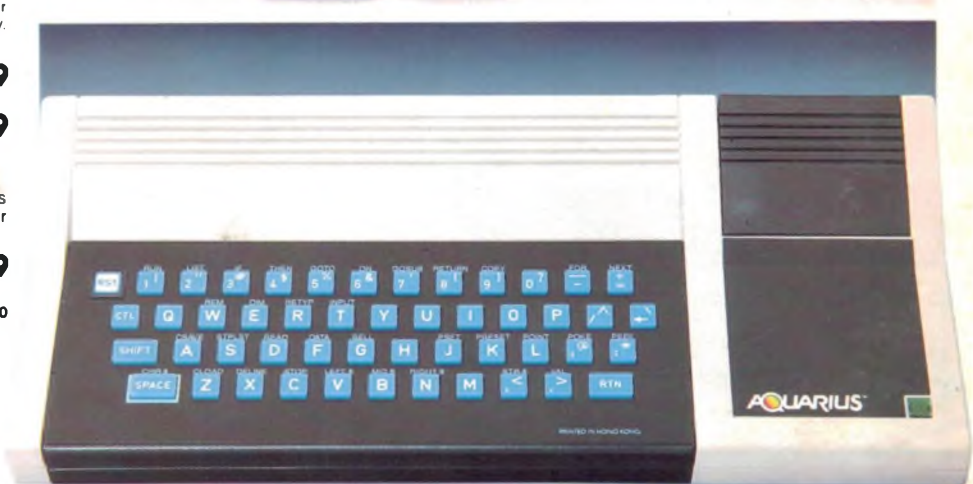
Ideal for documenting programs, keeping records or printing charts and records. You'll probably never again see one at this price!

Cat X-6025 .... $129

Paper roll to suit. Cat X-6026 .... $3.50



Aquarius Colour Computer

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A-923

THIS MONTH'S COVER

Good navigation is vital for rallying. Our new Rally Computer has all the features of a well-known commercial unit, yet can be built for a fraction of the cost. Build it and you won't get bushed — see page 42. (Photo Greg McBean).

Electronics Australia

Volume 47, No. 6

June 1985

Features

Hifi, Video and Reviews

Projects and Circuits

Personal Computers

Columns

Departments

Rally computer for cars

This Rally Computer boasts three independent road counters and a quartz clock. Best of all, it's easy to build and use. Details page 42.

What's coming

1000V Megohm Meter: featuring an inbuilt transistor inverter, our new Megohm Meter tests at 1000V and covers the range from 2MΩ to 2000MΩ. It is particularly handy for checking electrical wiring. See also page 119.

High voltage insulation tester

Build this high voltage insulation tester and check for insulation breakdown at 500V DC. It tests for 10GΩ insulation resistance and gives a much more realistic indication than a multimeter. Construction begins on page 74.

Plus/4

Introducing Software That Comes With Its Own Built-In Computer

Word processing, electronic spreadsheet, graphic plotting and file management certainly need no introduction.

But a computer that has them all built-in certainly does.

Especially for under $600*.

You could easily say the built-in software alone is worth a lot more than the price.

But then again you could easily say the Commodore PLUS/4 computer alone is worth a lot more than the price. With 64K of memory, 60K fully usable, full size typewriter keyboard, four separate cursor keys, high resolution colour graphics, extended BASIC, split screen and windowing capabilities.

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Go from one program to another at the touch of a key. For not only are they built into the computer, they're built into each other. So, for example, in one document, you can go from words to numbers to graphs to names and addresses. In just a matter of moments.

The Commodore PLUS/4. The first new computer that doesn't have one new thing about it. It has four.

For further information contact your nearest Commodore Dealer.

*Recommended retail price

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Editorial Viewpoint

by Leo Simpson

Star Wars: pie in the sky!

So the Europeans gave the elbow to President Reagan's Star Wars concept, or to give it its official name, "Strategic Defence Initiative". Not surprising, really, since the Europeans seem to have less money to throw around than the Americans. But just because the Europeans have poured cold water on the scheme and refuse to be involved does not mean that we have heard the last of it.

There seem to be two main drawbacks to the Star Wars concept. The first is doubt about its practicability. This has several aspects. For example, to be completely effective, the system has to be able to log on to hundreds of missiles (in an all-or-nothing attack this is what would happen) and destroy all of them while they are still in the stratosphere. If it misses just a few multi-warhead missiles, then the system will have failed miserably and we will all be up the creek.

Destroying the missiles is a bit of a problem too, because an enormous amount of laser power has to be focussed onto the moving target to disrupt its electronic guidance sysems or otherwise render it unusable. The necessary laser energy may well be available from earth-based power stations or nuclear powered satellites, but the defence against this form of missile damage may be as simple as a coat of reflective paint!

The other drawback is that even if the system does prove to be completely effective in destroying missiles in an all-out attack, there is a strong possibility that the Russians may simply build up other means of attack such as nuclear submarines and cruise missiles. Whatever happens, it is likely to lead to yet another round in the weapons build-up.

Such arguments about practicality unfortunately don't have much effect in stopping this sort of weapons development. A weapon doesn't have to be practical in order to be eventually developed into a potent system. A prime example of this was the hydrogen bomb which certainly was not practical in its original concept. It was crazy. In effect, Edward Teller and his crew had to build a 12-ton refrigeration plant in order to make the first bomb work. Naturally, the whole plant was vapourised along with the bomb! But that was the sort of trouble the scientists were prepared to take to prove the concept.

If you think that sort of thinking is not in vogue today, some 30 years after the hydrogen bomb was developed, think again. Edward Teller is still around and has been one of the defence advisers to President Reagan.

The real danger about the Star Wars concept is that it could indeed be developed into an effective system. The past record of the USA shows that. As such, it may tempt the USA into thinking that it could win a nuclear conflict. Or the Russians may think that is what the USA perceives. And that is an extremely dangerous situation for all of us.

The really sad part about the Star Wars concept is not that it is an outlandish scheme devised by some extremist politicians and generals, but that there are plenty of scientists and engineers around who are willing to do their best to make it work. They won't be making the world any safer or better, for any of us.

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FANTASTIC! $439

Playmaster series 200 Hi fi Mosfet Amplifier

This is the one you've been waiting for. The all-new Playmaster Series 200 Integrated Amplifier is almost certainly **the best** build-it-yourself design to be published **anywhere in the world!** Feature for feature, dollar for dollar, it more than stacks up against the 'big names' in hi fi - with the big price tags to match.

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And don't forget the exclusive Dick Smith Electronics kit features:
•Solder-masked and silk-screened PCB to help eliminate errors. •Power transformer with factory-wound low voltage winding (why wind by hand?). •Special step-by-step construction manual •complete with our 'Sorry Dick, it doesn't work' repair service. •PLUS our exclusive satisfaction guarantee: you can return the kit within 7 days if you think construction is beyond you!
Cat K-3516

4 Sector Home Alarm

Once upon a time, we had a kit for a simple alarm. Then everyone started asking for an all bells and whistles kit. So we brought out the EA 8 sector alarm kit. Now it seems everyone wants a simpler kit again!!!

Here it is: designed by Dick Smith Electronics Research and Development division to suit the requirements of the majority of users.

- **Features instant or delayed inputs**
- **Wire-out-proof system - suitable for all types of sensors**
- **LED sector and control state indication**
- **Adjustable entry, exit and alarm periods**

Short form kit - suits 'building in' to whatever you like!

Easy to build - and could save your property! Cat K-3254

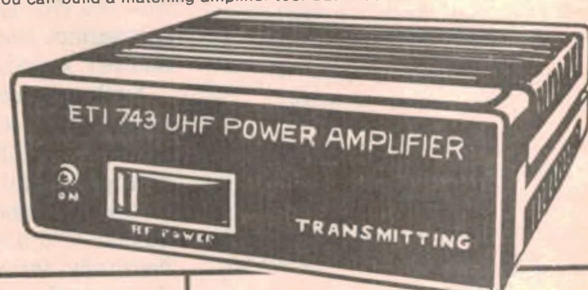
Short form kit
Does not include case

$49

UHF Power Amplifier

$129

Now a power amplifier for UHF AMATEUR AND CB radio. A very healthy 25 watts output from virtually any UHF input (from around 300mW or so.) And that could make the difference between being heard and.
The amplifier kit is complete to the last nut and bolt — including the same deluxe case used in our UHF amateur transceiver, and its matching power supply. So now you can build a matching amplifier too! Cat K-6314



Mixer Preamp

Designed to suit the 300W amp kit, this mixer preamp has 4 inputs with an impedance of 100K - suitable for most microphones, guitars, etc. Ideal also for use with 50W (K-3400) and 100W (K-3442) power amp modules. This unit provides bass, treble and presence control. Instructions supplied.
Short form kit: no case, transformer or power supply.
Cat K-3035

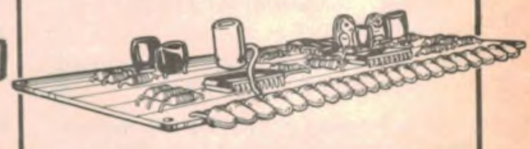
$32.95

VCR Theft Alarm

WAS $54.95

Don't let your VCR become the most talked about item behind the pub! Build this neat little kit and it will scream its head off if anyone tries to make off with your pride and joy! Cat K-3423

NOW ONLY $29.95



LED TACHO

Don't spend a fortune buying a tachometer - build your own and save! Displays engine speed in an analogue form in an illuminated row of LED's. Instructions included - a great kit! Cat K-3240

$24.50

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Build the Busker Amp

Easy-to-build general purpose microphone/guitar preamp & power amplifier, ready to build into a speaker case for a go-anywhere mini pa!

Ideal for the budding buskers in the family. Also fantastic for displays, fetes, rallies, etc.

Includes components, speaker but we leave the case to you (if you want to use away from power point you'll also need a 12V gell cell.
Cat S-3320

Cat K-3446

Short form kit
Does not include case

$79.95

Stereo Enhancer

Here's a great kit for those on a space budget! If your listening area is not exactly stereo quality, the stereo enhancer will 'widen' the sound to make it sound like it's almost designed that way!

Complete kit, including special abs case together with instructions make this one a beauty to put together - and even more of a delight to use.

As described in ETI, March 1985.
Cat K-3419

$79.95

VCR Sound Processor

Unless you're lucky enough to have one of the new hi fi videos, the sound from your VCR is probably pretty pedestrian! Now you can give it a lift with this VCR Sound Processor!
It includes an effective stereo simulator circuit, a 5 band graphic equaliser to make up for the crook audio and your (probably!) equally crook listening room plus noise filtering to get rid of tape hiss and other unwanted high frequency noise. Cat K-3422

$49.95

Speed Controller

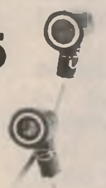
A completely new circuit offering unbelievable smooth control and torque - even at very low rpm. Yes, it's even better than the previous model! New design includes 'in line' plugs and sockets for extra convenience. Suits virtually all 'universal' (brush type) motors:
Cat K-3084

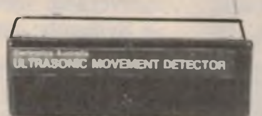
$21.95

Ultrasonic Movement Detector

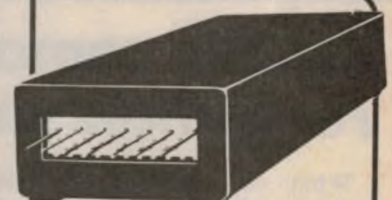
The problem with 99% of car alarms is that they cannot prevent the thief who breaks a window and reaches in for the goodies. While this kit won't prevent the window being broken, it will protect your property inside the car. Silent ultrasonic rays detect any movement and trigger the main alarm systems. Cat K-3251

$19.95





Negative Ion Generator



You've heard all about Negative Ion Generators and their benefits, now buy the kit and find out what it's all about. Many commercial units run from the mains, but our kit is safe - it runs on 12V DC, which also means that you can put one in your car! Kit includes exclusive Dick Smith emitter head, power pack and tough moulded plastic case.
Cat K-3335

$42.50

Stereo TV Decoder

TV sound can be very high quality - especially now it's being transmitted in stereo.
But 99.9% of TV sets can't take advantage of this because they're only equipped for mono sound. And 99.9% of people aren't willing to get rid of a perfectly good colour telly just to get stereo sound!
Especially when a new stereo colour TV can set you back the best part of a tidy bit!
Here's the Dick Smith Electronics-low-cost-solution.
Cat K-6325

$249

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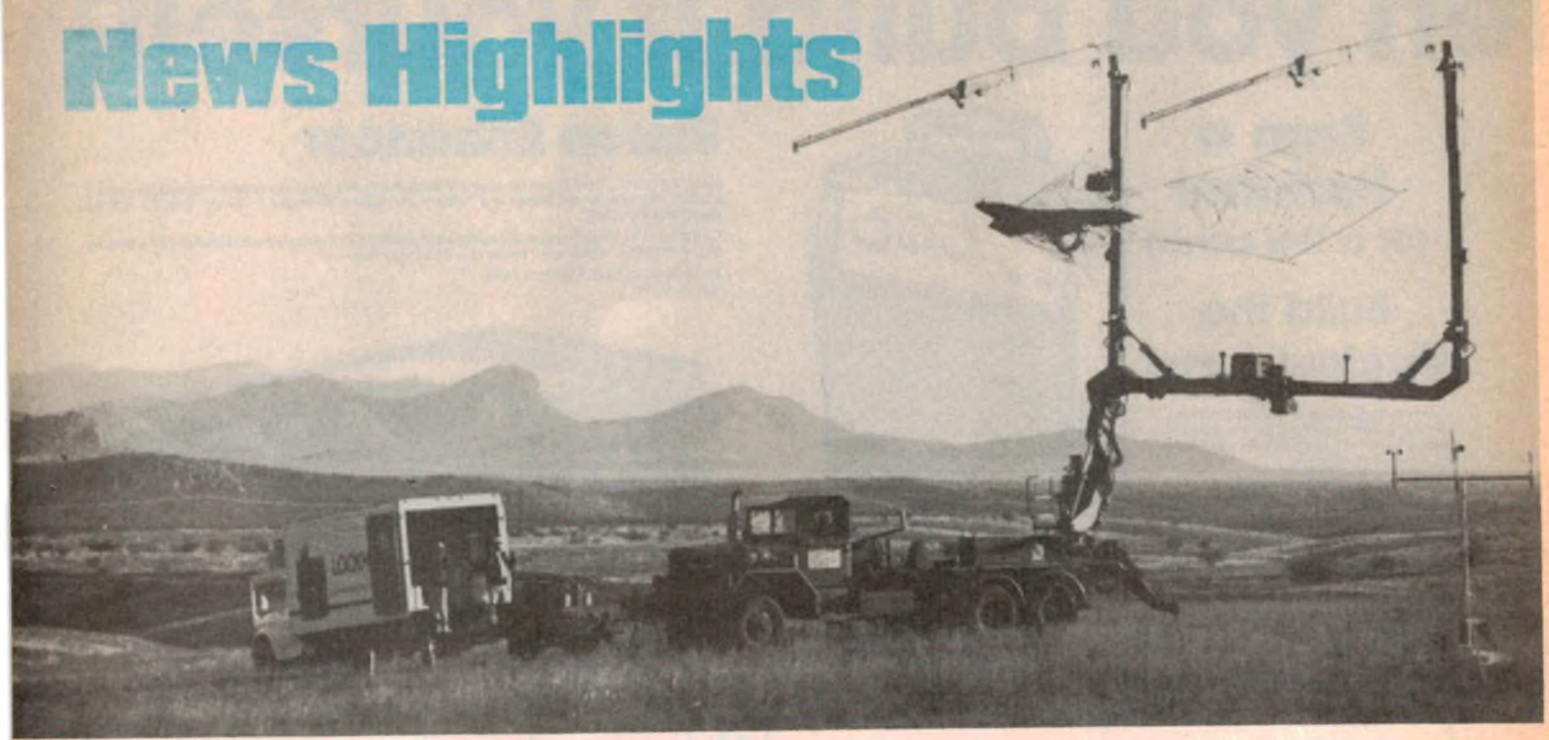
See page 84 for store addresses

A962/6.85



Aquila remotely piloted reconnaissance vehicle

What can the military have in common with radio controlled model aircraft enthusiasts? The answer lies in remotely piloted vehicles (RPVs) which can be used to reconnoitre areas which would be far too dangerous for manned aircraft.

One such RPV is the American Aquila (Latin for "eagle") which has been developed by the Lockheed Missiles and Space company of California. It is constructed of fibreglass, is about 2m in length with a wingspan of about 4m, and weighs in at approximately 100kg. Its two-stroke 19.4kW engine drives a two-blade propeller, giving the Aquila a cruising speed of 150km/h and a maximum speed, in level flight, of 200km/hour. Maximum endurance is approximately three hours.

Both its body and engine size make it difficult to detect. Because of its small size, it reflects smaller radar signal levels, it is harder to spot visually and it is much quieter than conventional aircraft.

The Aquila has been designed as a recoverable vehicle. It is launched using an hydraulic catapult set on a five-tonne truck, and recovered by flying the vehicle into a vertical ribbon-barrier braking system.

Guidance and control are vital for the success of the RPV. The Aquila carries an on-board navigation computer and an inertial package for accurate navigation and control of the vehicle. The navigation system is linked to a ground-based tracking system which periodically updates the RPV's position, thus allowing for accurate target location.

The craft contains a fully controllable video camera and the image is continuously transmitted over a secure data link to the ground control station. This provides information about possible targets, such as enemy weapon systems.

— Brian Dance.

Australia to lobby for BMAC satellite standard

Australia will be at the meeting of the International Radio Consultative Committee (CCIR) which will make recommendations on world satellite transmission standards later this year.

The CCIR as a regulatory body will be considering a major report on satellite television transmission systems. The BMAC system, which has been chosen by Australia for satellite broadcasting, forms a prominent part of this report.

Having adopted BMAC, Australia is naturally keen to see the standard taken up by other countries as well. Work done by the Department of Communications in assessing a number of systems will give Australia a strong argument to present to the CCIR in November.

AWA extends microcircuit design capabilities

Amalgamated Wireless (Australasia) Limited has made an important software exchange agreement with RCA. Along with this comes over $1.5 million worth of new design equipment.

For AWA, the agreement signals a major advance in the company's microcircuit design capabilities. The software will enable engineers to simulate a circuit's electrical performance, thus reducing initial design errors and shortening lead times.

AWA is confident that custom digital integrated circuits represent a strong growth area within Australia. The RCA agreement, which also makes its CMOS digital circuit design and simulation tools available, is an important step for this growth.

Electronic ear-tags for cattle

The management of Australia's beef cattle industry could be greatly improved by using electronic means to identify livestock, according to researchers at several Australian universities.

The project, which is funded by the Australian Meat and Livestock Corporation, arose because of the need to improve traditional methods of identification.

Dr Michael Yerbury, of Sydney University's Physics Department, is contributing to the development of a "light gun" which triggers an electronic tag attached to the animal's ear.

The light gun produces a high-intensity infrared beam lasting 100 microseconds. This switches on the electronic tag which in turn sends back radio waves that are picked up by a receiver attached to the gun, decoded and displayed on a small screen. The animal can be identified from a distance of 30 metres.

Once an animal is identified, information about it can be called up on a hand-held microcomputer or new information added to the record. This information can then be transferred to the main computer system.

The combined university research team were set certain goals in developing prototypes. The mechanism had to be robust and secure; it had to last over the life of an animal (10 years); and it had to be relatively cheap ($2 per tag was the original target).

Two approaches have been considered: attachment to the ear and implantation under the skin of an electronic device. The latter is less developed and perhaps holds some interesting prospects for those who can imagine the possibilities of 1984-style social control.

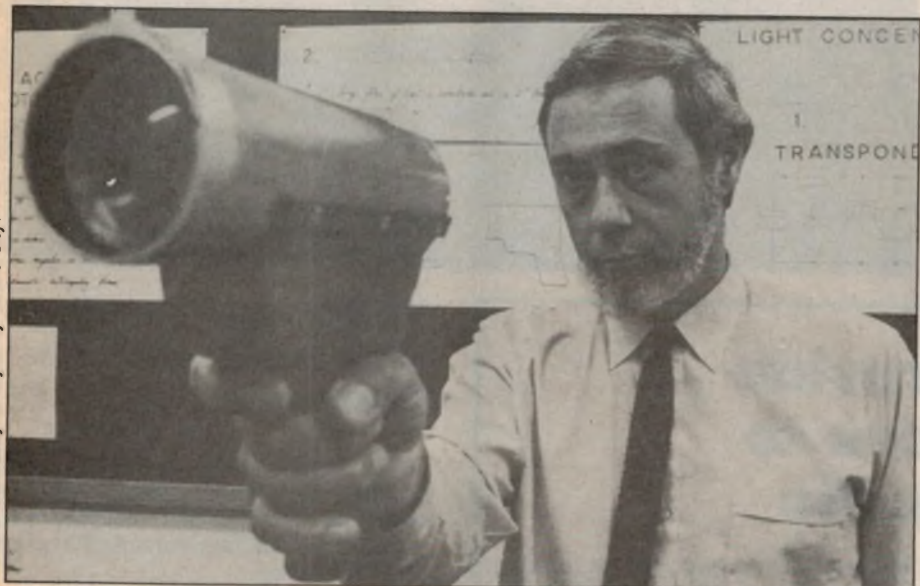


Photo courtesy of Sydney University.

The infrared light gun developed by a combined university research team.

Business Brief

Soundring Pty Ltd (PO Box 154, Cammeray, NSW 2062) has been appointed sole Australian distributor for Lenco Switzerland. Lenco manufactures a range of hifi and video equipment, including turntables, record cleaning kits, and a video enhancer.

Australia needs a silicon foundry

A senior executive from the IBM corporation said that the Federal Government should give serious thought to funding a silicon chip foundry for university educational and academic research. The executive, Dr Juri Matisoo, was visiting Australia recently to review activities at the Joint Microelectronics Research Centres (JMRCs) at the University of New South Wales and the Royal Melbourne Institute of Technology, Dr Matisoo said that Australia would suffer for the lack of such a facility.

Dr Matisoo is the director of semiconductor sciences at IBM's Yorktown Heights research centre in the US. He believes that "the people who do the research here do some excellent work, but one area which is not particularly well equipped is a facility to handle the fabrication and development of technology for integrated circuits.

"I think this is one area which the Australian Government might support. It could be done so that it becomes a national resource", he said. The cost of setting up a silicon foundry would be between $10 and $50 million, depending on the requirements. "Because it's too expensive for an individual university, one might consider that the appropriate place for that funding to come from would be the Government," Dr Matisoo said.

At present, the research team at the University of New South Wales is involved in the development of silicon solar cells and research into chips for high speed data transmission equipment for Telecom.

Megabit-chip from IBM

International Business Machines Corporation has announced the development of a new extremely small, fast one-million-bit computer memory chip.

The chip is designed to operate at a speed of 80 nanoseconds (billionths of a second). Initial samples have operated as fast as 60 nanoseconds. With dimensions of 5.5 millimetres by 10.5 millimetres, the new chip is among the fastest and densest megabit chips reported anywhere. It is significantly smaller and faster than the megabit chip announced by IBM last year.

The new megabit chip stores four times as much information in just slightly more space than that used by the 256,000-bit chip now in volume production at IBM. IBM announced last September that it is using the 256K-bit chip in the 3880 disk storage controller and in the 4381 model group 3 computer system.

Both of IBM's megabit chip designs have been fabricated on existing production lines. Perfect chips, in which every one of the 1,048,576 memory cells operates as intended, have been fabricated on each of these lines.

News Highlights

Solar power at work in the coalfields

In Victoria, the State Electricity Commission has introduced solar power into two of its three open-cut coal mines. Solar cell panels supplied by Amtex Electronics are being used to power laser levelling systems at the Loy Yang and Yallourn mines.

The solar panels are mounted in units on trailers and supply power equivalent to five 12V car batteries per two panel unit. The units are used to charge batteries which in turn power the levelling devices. These guide the dredgers during coalface cutting operations.

The panels were introduced as a solution to the problem of batteries constantly going flat on the job.

One of the battery units powered by Amtex Electronics solar cell panels.

Aussat may provide satellite services to south-west Pacific

A proposal by Aussat Pty Ltd to modify its third satellite to give it the potential to provide communications facilities for countries in the south-west Pacific, including New Zealand, has been approved by the Australian Government.

According to an announcement by the Minister for Communications, Mr Michael Duffy, the question of what services would be provided, and when, were matters for the countries themselves, in consultation with Aussat.

The design modification would allow three transponders to be switched to cover the south-west Pacific.

Depending on overall customer demand, the third Aussat satellite could be launched as early as mid-1986. Originally it was expected that Aussat's capacity to serve the south-west Pacific would have been part of the second generation of Aussat satellites, timed for the early 1990s.

Mr Duffy said it was traditional for Australia to co-operate with South Pacific nations in telecommunications matters and the Aussat decision demonstrated its willingness to continue to do so. It was possible that Australian industry could benefit from the provision of such services.

Apart from NZ, countries that could avail themselves of the potential offered by the Government's decision included Fiji, Western Samoa, Tonga, Vanuatu, the Solomons, Papua New Guinea, the Cook Islands, Kiribati, Tuvalu, Federated States of Micronesia, Nauru, Tokalau and Niue.

NASA antenna for University of Tasmania

The 26-metre antenna located at the Orroral Valley Tracking Station has been donated to the University of Tasmania, according to the Department of Science and Technology.

The antenna had been used to track a variety of US spacecraft, including Skylab and the Space Shuttle. It will now be used by the University's Physics Department as part of its teaching and research activities.

One of its planned uses is in conjunction with the Australia Telescope, now under construction for Australia's bicentenary. According to researchers, the addition of the new 26m antenna at Hobart will significantly improve the performance of this telescope.

The antenna will also be available for Very Long Baseline Interferometry in conjunction with other suitable instruments. This will assist in geodynamics and geophysical research by obtaining more accurate measurements of the Earth's surface.

AT LAST!

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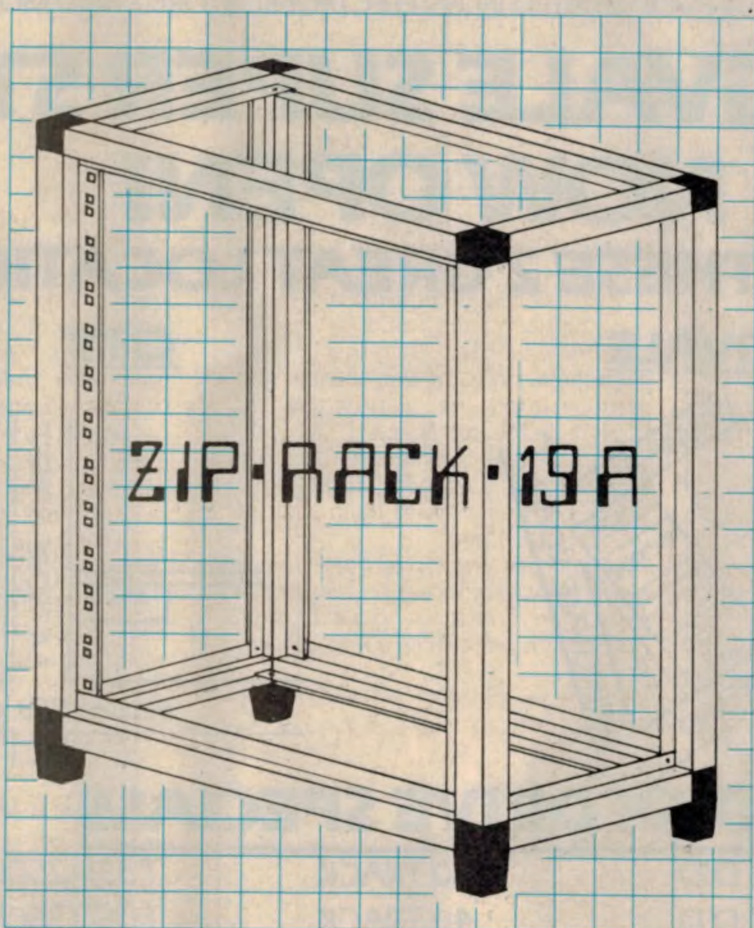

SIZE	KIT No.
6 RU	19-111
12 RU	19-112
18 RU	19-113

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* For equipment mounting

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Tools required: Small rubber mallet; electric hand drill; hand rivet tool. Twelve lengths of hollow extrusion are interlocked using eight plastic corner pieces. The plastic corners are inserted into the hollow sections using a small rubber mallet. This assembly is then made permanent by drilling and pop riveting each corner with drill (3.2 dia.) & pop rivets supplied with kit. No spanners, screws, nuts or washers. Just a clean fast fit.

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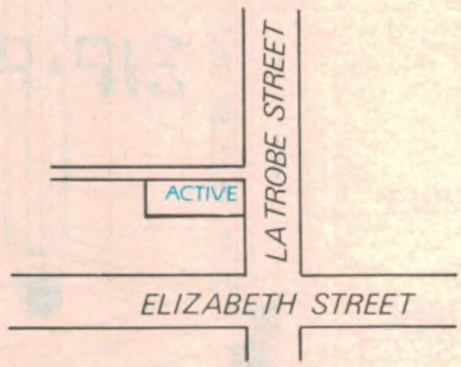

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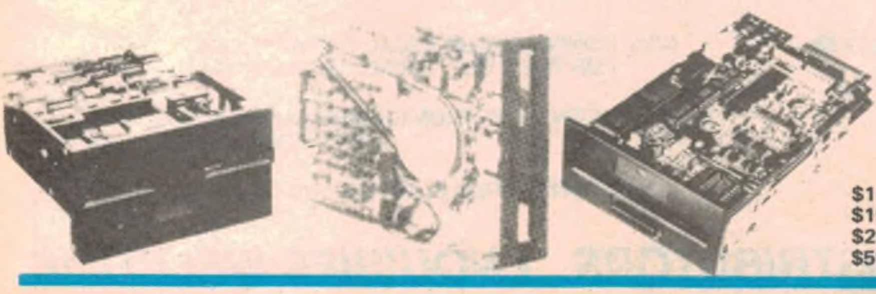

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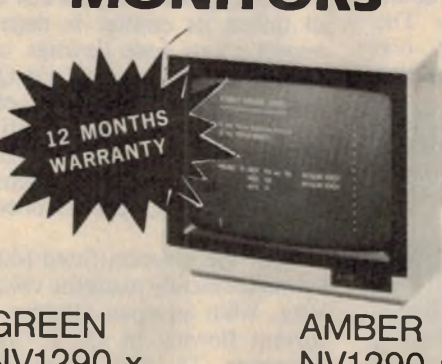

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ACTIVE - JUST ABOUT EVERYTHING ELECTRONIC

Letters to the editor

More on engineers

I have been reading the correspondence you have received on your August '84 editorial. I do not remember this particular editorial as I retain — for a while — only those issues which have a particular interest to me. Had I retained them all since R & H days there would be no room in the garage for my car!

It is apparent that your "applicants" were required (among other things) to explain the working of a "superhet" (?). In my view any electrical engineer who could not answer that one is not worth any consideration — irrespective of what the other questions were!

I am not altogether sure that your comparison to mechanical engineers (re two stroke engines) is valid. Nevertheless I have no sympathy with such people as Mr P. Stewart, who rubbished you on that account.

B. M. Ferguson,
Glenroy, Vic.

In praise of Electronics Australia

I have only been reading your magazine for five months so I am a newcomer to the ranks of your readership. You may rest assured that I will be a faithful reader for many years to come. I am very impressed with the high standard of the articles, reviews, projects and general news which appear in your magazine.

I have read with great interest the correspondence on the subject of engineers. I have found it particularly enlightening as I am a first year electronics engineering student at RMIT. You have again given me much to think about as I begin my formal education in electronics engineering.

P. Campbell,
Hawthorn, Vic.

Still more on engineers

As one who has both qualified and earnt a living as an electronics technician and engineer, may I offer the following toward your debate.

Integrated circuit technology enables technicians to develop sophisticated electronic modules for discrete functions. However, it requires an experienced engineer to successfully integrate discrete modules into reliable operational systems.

Ignorant, lazy engineers are no more numerous than similarly disposed technicians. Arrogant engineers and technicians are the greatest problem. Fortunately, they are not numerous.

As with politicians, a nation gets the engineers it deserves and regrettably Australia is doing badly. It is training, on a pro-rata basis, fewer engineers (in all disciplines) than most European and some Asian countries, eg, Japan, South Korea, Taiwan and Singapore. The situation is even worse when one considers that nearly 20% of engineering places in our tertiary institutions are occupied by assisted overseas students.

Considering the nation depends upon graduate engineers, one can start feeling concerned about our prospects of sustaining economic growth at a desirable rate. Engineering is the greatest employment multiplier in any economy.

For the answer to our national neglect of the profession, your readers may care to check the backgrounds of the 100 top leaders in business, public service, industry and politics; "Whose Who" will do as a reference. With few exceptions they will be found to have qualifications in accounting, economics, law, medicine or psychology. Engineering is not fashionable amongst the upwardly mobile.

One of the sad features of engineering training in Australia is the general lack of preparation for the management role. Far too often we find good professional engineers becoming amateur managers following promotion.

K. B. Flynn,
Aranda, ACT

Breakdown voltage test jig

I refer to the February 1985 issue, page 70. Mr Dance states that the voltmeter reads the zener "breakdown" voltage. Wrong! The voltmeter is shown across the "junction under test" and VR1 (1kΩ). The meter should be across the junction under test.

Mr Dance's explanation as to how his circuit works is also somewhat muddled. This is due to his fairly obvious belief that current flows into his circuit out of the positive rail. His statement that Q2 current "robs Q1 of base current" is positively juvenile.

In fact Q1 cannot pass any current at all unless its emitter is negative with respect to its base (leakage current of both transistors, particularly Q2 Iceo, is disregarded). The emitter of Q1 is, indeed, connected to the negative rail via the mA meter, the junction, the voltmeter and VR1. So, provided the "junction" is not open-circuited, Q1 will conduct.

With the junction fused (shorted) the voltmeter merely reads the voltage across VR1. With an open junction, the only current flowing in Q1 is through the voltmeter. There is no voltage across VR1 and thus no Q2 current.

Assuming a normal junction, there are two basic ways of explaining Mr Dance's circuit. The simplest method is to regard Q2 as a variable resistance in series with R1.

(a) with Q2 a "high R" (zero base

Omissions from stations list

I wish to draw attention to a number of broadcasting stations not included in your list in the March 1985 edition.

These are the community radio stations for the print handicapped and include 2RPH in Sydney and 3RPH Melbourne, both on 1629KHz. I understand that Brisbane and Hobart have similar stations.

According to a spokesperson at 3RPH all have been on air for more than 12 months. At least one large daily newspaper publishes a complete program for 3RPH and it can also be obtained in braille from 3RPH.

R. Ridgway,
Frankston, Vic

The omissions are unfortunate but the list was compiled using the latest available information from the Department of Communications. In fact we even made a point of phoning the DOC to ask for an update just before publication. Thanks for bringing the omissions to our attention.

Much more on engineers

I have been reading the engineers' debate, and I agree that it has been a bit one-sided. There have been far more engineers sticking up for each other than those defending your point of view. Although I am only a hobbyist and have no technical qualifications, I am no dumbo and I can see your point of view.

Thank God doctors don't have the same point of view as those engineers. Can you imagine a doctor, or for that matter a nurse, suddenly stopping in the middle of the operation to have a few hours study so he can brush up on what he is not sure about.

Given that background, I sat down again and tried to answer the five questions you asked your applicants. I could answer Question 1 on the superhet receiver fully, and without any problems. Question 2 on the complementary symmetry amplifier was a different matter. While I can answer in general terms, it's obvious that I don't have the depth of knowledge to answer it properly.

For Question 3, I could give a reasonable explanation of how a phase lock loop works, but I would be lost on the fine detail of designing the filters and selecting the loop constants. Similarly, I could describe the Schmitt trigger in Question 4, but I had to think for a long time before I realised what you meant by a three gate oscillator.

In Question 5, I could describe how a multiplex seven-segment display works, and give it's advantages. However, I couldn't say for certain why LCDs are not multiplexed.

On the face of it, and in view of your remarks, I wouldn't qualify for a job with *Electronics Australia*, and I shouldn't be calling myself an engineer. So why can't I answer your five questions? Perhaps, more importantly, why couldn't your applicants answer the questions?

Firstly, I think you made an unwarranted assumption in your editorial. You said that by selecting recently qualified engineers, or those part way through their courses, you would be hiring people who are right on top of the latest developments in technology. The only engineers who have that sort of knowledge are those who have been working for some years in the particular technology.

As other writers have pointed out, the student has a very big work load, and can't afford the time to learn about any new technology to great depth. In addition, course content is set well before the start of each year, usually in conjunction with other bodies, so it is unlikely that the syllabus will be changed during a year to include material on new technologies. It's more often the case that a new technology has been introduced, and in regular commercial use, well before it appears in a course.

Secondly comes the question "What sort of engineer do you really need?" — Note that I said what do you need, not what did you advertise for. Do you need a hobbiest, a graduate engineer or an experienced engineer? Anyone who believes that the three are interchangeable, or that a graduate engineer has the knowledge and experience to design many of your projects and produce a satisfactory result quickly and economically is in for a nasty shock.

I remember applying for a position a couple of years after graduating, only to be told by the selection committee that I was only a journeyman, and that they were looking for a master mechanic. They were quite right of course. Graduation means that you have absorbed sufficient information to be able to convince the examiners to let you loose into the world. But that is only the first phase of an engineer's training. The next, and most important phase is to learn how to apply the knowledge already gained to practical problems.

This is perhaps the most important phase in an engineer's training, and can make or break his future career. In fact it is so important that learned Institutions such as the IEE (UK) used to insist that it be carried out under the direct supervision and guidance of one of their qualified members. The Australian Institutions were not so demanding, but still regard it as a critical portion of the training. That is why they have had the two classes of membership, "Graduate" and "Member".

It is unrealistic to expect an undergraduate, or a recent graduate to carry out design work quickly and efficiently. Remember that they are still learning, and if there is no experienced engineer to guide them, they are going to learn by making mistakes.

Perhaps what you really need is to employ an experienced engineer. That means one who gained his experience in those fields you want to write about. He should also be able to design equipment that can be put together from average commercially available components, and still meet the design specifications without having to specially select one transistor or other component from a batch. He should know about printed circuit layout, and in particular, the layout rules for power supply rails for digital circuits. He must know how to design a piece of equipment that will work the first time without a lot of cut and try. He must know how to design test points into a circuit, and how to go about cost efficient designs.

Certainly such an engineer will cost you much more per hour than an undergraduate or recent graduate. But he will also produce much more per hour than the other two, and the overall cost per job will be less, with fewer missed deadlines. In fact you will end up saving money.

Now, why couldn't I answer all your questions? Simple. In all my years of experience, I have never had to design or make a detailed assessment of the design for a complementary symmetry amplifier, a phase-lock loop, nor a liquid crystal display. With so much else to learn, I haven't had time to study any of these in detail. I would be surprised if many of your applicants would have had the time or opportunity to gain the practical experience needed to answer your questions confidently. As for the average reader of EA, how long has it been since you published sufficiently detailed articles to allow them to answer your five questions properly?

Finally, you ask what is wrong with engineers that they don't take an active interest in electronics. Why should they? How many professionals do you know in other professions that take an active interest outside office hours, and whose work is the same as their hobby? Why shouldn't engineers go home and relax, take up sport, read about other topics, or enjoy being with their families. What is so special about electronics that engineers should devote their whole life to it?

A. M. Fowler, MIE Aust,
North Balwyn, Vic.

voltage), Q1's forward base voltage and collector current will both be high.

(b) with Q2 a "low R" (maximum available positive Q2 base voltage), Q1 forward base voltage and collector current will both be low.

There are other considerations, caused by varying Q1 current varying the VR1 voltage. Quite probably it's enough to say that Mr Dance's circuit reminds me of a dog chasing its own tail.

With the voltmeter connected across the junction the reading might at some point remain steady. This could be assumed to be the zener voltage (irrespective of current change).

There is a better way and I enclose a circuit of my own zener/diode tester (to be published).

B. M. Ferguson,
Glenroy, Vic

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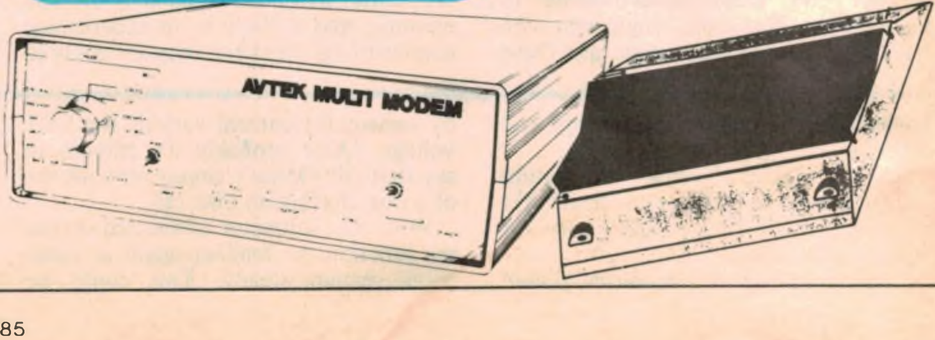

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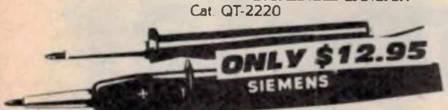

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Electronics in scientific instruments

A look at the x-ray spectrometer

One of the most invaluable instruments ever developed for the mining industry is the x-ray spectrometer. Here we take a look at how the instrument works.

by A. B. HOLLEBON

In the eyes of many people the main use of x-rays is for medical purposes, such as the examination of broken bones, or for engineering purposes such as the examination of welds in high pressure pipelines. However, this form of radiation is also very widely used to investigate the composition and structure of materials and even the very structure of atoms and molecules themselves.

One of the most widely used of these techniques is x-ray fluorescence spectrometry in which a powerful beam of x-rays is used to excite a sample of material and so cause it to emit fluorescent x-rays of its own. An examination of the wavelengths and intensities of this emitted radiation then allows a complete chemical analysis of the sample to be made without in any way altering or destroying the original sample.

How it works

The complete instrument consists of several separate stages, each performing separate tasks under the control of a central programming unit.

The first step in the process is the generation of a powerful x-ray beam which is used to excite the sample. This is followed by a system which splits the radiation emitted by the sample into individual wavelengths. In the majority of instruments these wavelengths are then measured one at a time by a single measuring system. The results are then printed out directly or may be fed to a computer for further processing depending on the type of work being carried out.

X-rays to excite the sample are generated in a conventional x-ray tube. This is essentially a large vacuum tube diode. The filament is heated by a current from a transformer in order to emit a copious supply of electrons, and a potential of up to about 100,000V is applied across the tube in order to accelerate the electrons towards the anode. When these electrons collide with the anode they suffer a very rapid deceleration and give up part of their energy in the form of x-rays.

These x-rays then pass out of the tube through the thin beryllium window. Only a very small part of the energy of the electrons appears as x-rays and the remainder appears as heat in the anode. As much as two or three kilowatts of heat may be generated in this way and this heat has to be removed by circulating water through the anode.

The sample to be analysed is placed as close as possible to the x-ray tube window so that the maximum possible radiation intensity illuminates the surface of the sample. Under these conditions the sample emits x-rays of its own and this radiation is passed on to the spectrometer for separation and measurement.

Secondary x-rays

Every atom in the sample consists of a central nucleus which is positively charged, surrounded by a number of negatively charged electrons which move in fixed orbits or energy levels, as shown in Fig. 1. When an x-ray quantum collides with an atom it is capable, under certain conditions, of raising an electron from its normal orbit to one of a higher level.

However an atom in this state is unstable and the electron quickly falls back to its original level. As it does it releases the extra energy which it had in the higher orbit in the form of an x-ray quantum. The wavelength of this quantum is inversely proportional to the amount of energy released.

The Quantum Theory

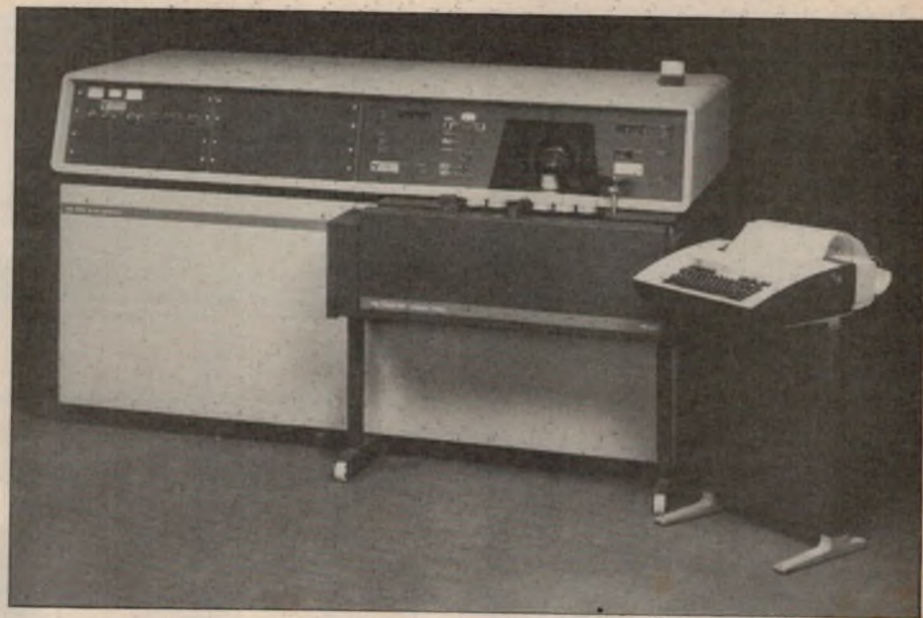
The basis of the quantum theory was laid down by the German physicist Max Karl Ernst Planck in 1900. The theory indicates that radiation from a body travels in the form of "energy packets" called quanta or photons. These quanta possess the properties of both wave motions and of particles, and the energy of one quantum is equal to its frequency multiplied by a number known as Planck's constant.

When energy is emitted or absorbed by a body, the total amount of energy involved is always a whole number of quanta. It is impossible to have a process which involves fractions of one quantum.

In the case of the x-ray spectrometer described in the accompanying article, the first part of the instrument which splits the radiation into its individual wavelengths makes use of the wave-like properties of the x-ray quanta. However in the measurement part of the instrument, the operation of the counters makes the quanta appear to behave as particles. The apparent discrepancy between these two types of behaviour is resolved if the quantum is pictured as a small "packet" of waves travelling as a distinct entity.

The energy levels in the atom are different for every chemical element and, therefore, an examination of the wavelengths in the radiation emitted by the sample indicates which elements are present in that sample. Also the total amount of radiation of a particular wavelength leaving the sample is proportional to the percentage of that element in the sample. It is therefore possible to identify which elements are present, and to estimate their concentrations, by identifying the wavelengths and measuring their intensities.

A typical x-ray spectrometer therefore consists of an x-ray tube to excite the sample, a system to separate the emitted radiation into individual wavelengths, and a system to measure the intensity of the wavelengths. Such an instrument is known as a wavelength dispersive spectrometer. An alternative approach, known as energy dispersion, separates the x-ray quanta on the basis of their energy. However the wavelength dispersive method is the most widely used and is the type described in this article.



A Philips PW1400 spectrometer fitted with an automatic 6-position sample loader and output printer.

Wavelength dispersion

The wavelength dispersion system depends on the properties of crystals and the fact that the atoms in any crystal are arranged in a regular pattern. For our purpose these atoms may be pictured as being arranged in a series of layers lying parallel to the surface. If a beam of x-rays is allowed to fall on to the surface of the crystal it will be reflected in a manner somewhat similar to the reflection of a beam of light. This means that the reflected beam will leave the crystal at the same angle that the incident beam met it as shown in Fig. 2.

However only a small fraction of the original beam is reflected at the surface of the crystal. The remainder penetrates the crystal and is reflected at the various layers of the atoms within the crystal. The beam leaving the crystal is therefore the combined reflections from all the crystal layers. If all of these reflected waves are in phase their effect will be additive and a strong beam will result. On the other hand if they are out of phase, cancellation will occur and there will be no reflected beam.

For a given x-ray wavelength and a given crystal, reflection occurs only at particular angles and these angles are predictable by means of the Bragg equation.

$$n\lambda = 2d \sin \Theta$$

where n may be any whole number, λ is the wavelength, d is the distance between the atomic layers in the crystal and Θ is the angle at which the x-ray beam meets the crystal.

The complete spectrometer is therefore arranged as shown in Fig. 3. Fluorescent radiation leaving the sample passes through the primary collimator which consists of a series of closely spaced parallel metallic plates. This collimator produces a parallel x-ray beam which is then allowed to fall on the crystal. In order to examine the whole range of wavelengths which may be present, the crystal is slowly rotated so that the angle Θ is gradually increased.

Reflected radiation leaving the crystal passes through the secondary collimator and then enters the detector. In order to meet the requirements of the Bragg equation and to satisfy the requirement that the incident and reflected beams are at the same angle with respect to the crystal, the secondary collimator and the detector must be moved at twice the angular velocity of the crystal.

If this motion is continuous and the

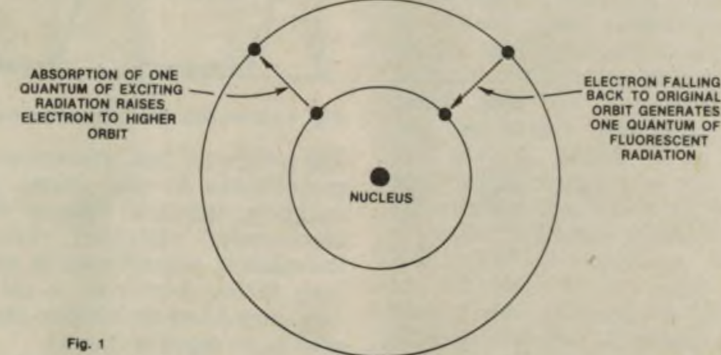


Fig. 1

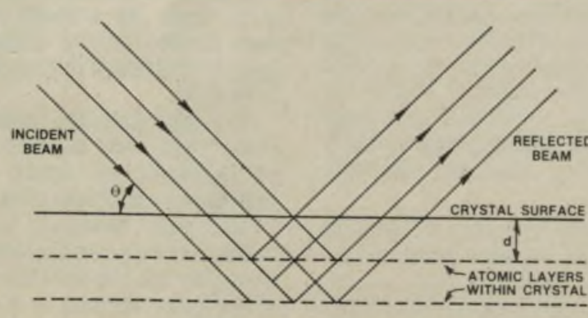


Fig. 2

X-ray spectroscopy

output of the detector is fed to a strip chart recorder, the record will be as shown in Fig. 4. Each peak represents a single wavelength present in the fluorescent radiation from the sample, and the heights of the various peaks indicate the concentration of elements in the sample.

X-ray detectors

The range of x-ray wavelengths that needs to be covered by a modern wavelength dispersive spectrometer is very wide and it is difficult to construct a single detector which is capable of covering the whole range. It is therefore common practice to use two separate detectors in tandem. The first detector is a flow proportional counter, capable of detecting the longer wavelengths only. This counter is transparent to all shorter wavelengths and it is possible to place a scintillation counter behind it which is able to detect these shorter wavelengths.

The flow proportional counter is used to measure the radiation from the lighter chemical elements, and this radiation has such a low penetrating power that it is unable to pass through air. For the measurement of these light elements it is therefore necessary to place the whole of the spectrometer, including the flow counter, inside a vacuum chamber.

This counter is similar in construction to the more familiar Geiger counter, as shown in Fig. 5. The body of the counter is made of metal and has two windows located on its front and back. These windows are covered with a very thin sheet of Mylar plastic. A very fine tungsten wire is stretched tightly along the axis of the counter and is electrically insulated from the body. The counter is filled with a mixture of argon and methane gas and a potential of 1500-2000V is applied to the central wire. The counter is then connected to an amplifier as shown in the simplified diagram in Fig. 6.

In order to detect the very long wavelengths the Mylar window has to be extremely thin, otherwise these low energy x-ray quanta would never reach the interior of the counter. These thin windows are not completely gas proof and gas has to be supplied continuously to the counter to make up for these losses.

When an x-ray quantum of suitable energy enters the counter it has a high probability of colliding with a gas molecule. When this happens the energy of the quantum is used up in forming ionised gas atoms within the counter.

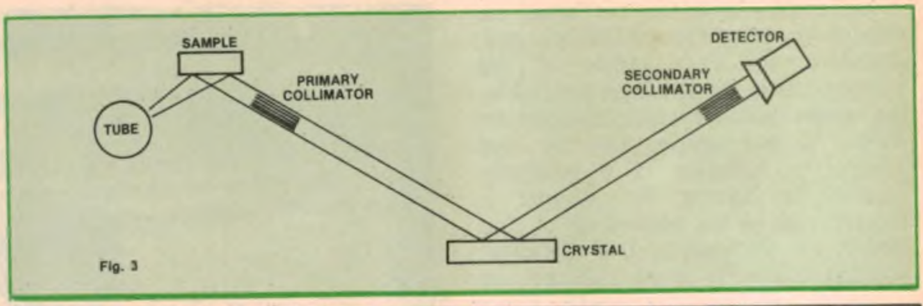


Fig. 3

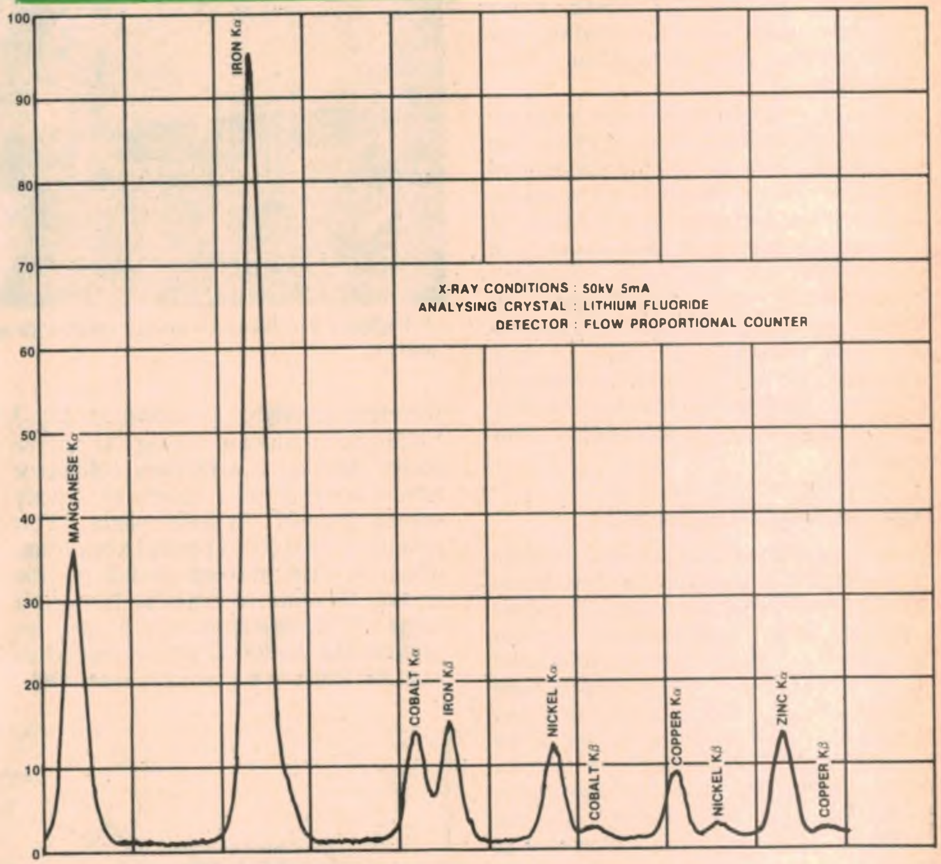


Fig. 4 shows the record from the strip chart recorder.

The number of ions produced is directly proportional to the energy of the incoming quantum. Because they are electrically charged, these ions immediately migrate towards either the body of the counter or to the central wire, depending on whether they carry positive or negative charges.

As these ions move they pick up speed and eventually have enough energy to ionise other gas atoms as they collide with them. As a result the number of ions formed by the original collision is greatly multiplied due to these secondary collisions.

Provided that the counter is operated under the correct conditions, the number of negative ions which arrive at the central wire is proportional to the energy of the x-ray quantum. Since all of the collected charge on the central wire must flow through the load resistor, a negative going pulse appears at the input to the amplifier for every quantum of radiation absorbed by the counter.

Scintillation counter

Any radiation which is not absorbed by the flow proportional counter passes out through the rear window and enters the scintillation counter. This counter is designed to detect more energetic quanta than the flow counter and so does not require such a thin and frail window. In most cases the window is made of a thin layer of beryllium, and its main purpose is to admit x-rays while blocking visible light.

After passing through the window, the x-ray quanta enter a specially activated sodium iodide crystal. This crystal converts the energy of the incoming quanta into individual pulses of visible light, which are sensed by a photomultiplier tube. Amplification of the pulses occurs in the photomultiplier and, in a similar manner to the flow counter, the output pulses from the load resistor are proportional to the energy of the original quanta.

Practical use of the x-ray spectrometer

Fully automatic x-ray fluorescence spectrometers have been in use in industry for about 25 years and are now an indispensable tool particularly in the mining, metallurgical and cement industries. In many cases they have almost completely displaced the older classical methods of chemical analysis with a significant reduction in both labour costs and the time taken to complete the work.

Instruments available at the present time can handle elements from atomic number nine (fluorine) up to atomic number 92 (uranium) at concentrations ranging from less than one part per million right up to 100%. These instruments are fully automatic in operation with all operating parameters being adjusted by an internal programming unit as the analysis proceeds from the determination of one element to the next.

Before commencing an x-ray analysis it is usually necessary to carry out some form of sample preparation before the sample is presented to the instrument. In the case of a metallic sample this usually consists of a grinding or machining procedure in order to produce a flat surface which is free of any surface contamination which may have been present on the original sample.

In the case of mineral samples the situation is usually more complex since the sample may consist of several separate mineral species present as discrete particles. It is usually necessary to reduce these irregularities in the sample and this may be done either by very fine grinding or by fusing the sample with a material such as lithium borate. This destroys the original crystal structure of the material and converts it into an amorphous glass.

The melt is poured onto a cold surface to solidify and the resulting glass disc may then be loaded into the instrument. However, in some cases segregation of the various elements occurs during solidification and it is then necessary to grind the disc to a fine powder and form it into a briquette before the analysis can be carried out. In order to further reduce the effect of any non-uniformity in the sample, some instruments continuously rotate the sample during measurement.

Modern instruments usually provide some form of automatic sample handling. The prepared samples are loaded into specially designed trays and each tray carries a card to provide identification of the samples and the required analysis program for those particular samples. The tray is then loaded into the spectrometer and the analysis proceeds automatically without further intervention by the operator.

The degree of excitation of the various elements in the sample by the primary beam from the x-ray tube depends on the wavelengths present in the primary beam. The main factor controlling these wavelengths is the material from which the tube anode is made since the emitted radiation consists of the characteristic wavelengths of the anode material plus "white" radiation which is spread over a fairly wide range of wavelengths. The anode material is therefore chosen to provide the optimum excitation for the elements of interest in the sample.

A further point which must be considered is that a small amount of the primary radiation from the x-ray tube finds its way through to the detectors. Consequently, if say a chromium anode tube is used then a chromium peak will be present in the spectrum even if there is no chromium in the sample. However, it is possible to insert a suitable filter into the primary beam to remove the unwanted characteristic radiation and so enable measurements to be made of the same element as that used in the tube anode.

In cases where it is required to analyse for elements covering a wide wavelength range, it is not practical to use a single crystal for wavelength dispersion due to the limitations imposed by the Bragg equation:

$$n\lambda = 2d\sin\Theta$$

Since $\sin\Theta$ has a maximum value of 1.0 it is necessary to use a crystal which has a "d" spacing of not less than half of the wavelength to be measured if first order reflection ($n = 1$) is to be used. Most instruments therefore are fitted with more than one crystal arranged in a suitable turret which allows them to be brought into use automatically as required during the course of the analysis.

The measurement is carried out by sending the pulses leaving the pulse height analyser directly to a pulse counting system. Counts are accumulated either for a fixed time or the time taken to accumulate a fixed number of counts is measured. A further option in some instruments is to make a direct measurement of the ratio of the count rates obtained from the unknown sample and from a previously analysed reference sample.

Signal processing

The output of both types of counter contains a certain amount of unwanted electronic noise in addition to the required pulses. Under normal conditions the noise pulses have lower peak amplitudes than the real signal and so can be removed by passing the output through a discriminator circuit which allows only those pulses greater than a pre-selected amplitude to pass.

A second problem which must be overcome, particularly with the lighter chemical elements, is that two or more wavelengths may be found at the same angle of the analysing crystal. This occurs when the term n in the Bragg equation has a value of 2 or 3 in place of the usual value of 1. Under these conditions the corresponding wavelength is one half or one third of the required value. However since both types of counter produce output pulses which are proportional to the energy of the incoming quanta, the pulses arising from these so-called second or third order reflections are two or three times as large as the required pulses.

In order to overcome this problem the simple discriminator is replaced by a full pulse height analyser. This unit will pass only those pulses which fall in a particular range of pulse heights. As a result it is able to reject both low level noise pulses and pulses due to higher order reflections, and only pulses from the required element will appear at its output.

Since the pulse heights increase in a regular manner from the lighter to the

The sample changer provides fast automatic loading of samples into the spectrometer.

X-ray spectroscopy

A mixture of analytical and reference samples can be analysed in a preset sequence.

heavier elements it is necessary to alter the settings of the pulse height analyser for each new element which is to be measured. These changes are usually made automatically by the instrument on the basis of a preset program.

Pulse counting

The pulses leaving either the discriminator or the pulse height analyser may be handled in two different ways. In the first method the pulse stream is sent to a pulse rate metering circuit which produces a DC signal whose amplitude is proportional to the rate at which pulses are supplied to it.

If the analysing crystal and detector system is moved at a constant angular velocity and the output of the count rate meter circuit is fed to a strip chart recorder, a recording of the type shown in Fig. 4 will result. This allows identification to be made of the elements in the sample from the position of the individual peaks, and a rough estimate of their concentrations to be made from the height of the peaks.

However the instrument is more commonly used for routine chemical analysis where the elements present are known in advance and a precise estimate of their concentrations is required. In this case the analysing crystal and detector system is moved directly to the angles corresponding to the elements to be measured and held at each of these angles while a measurement is made.

The measurement is carried out by feeding the pulses from either the discriminator or the pulse height

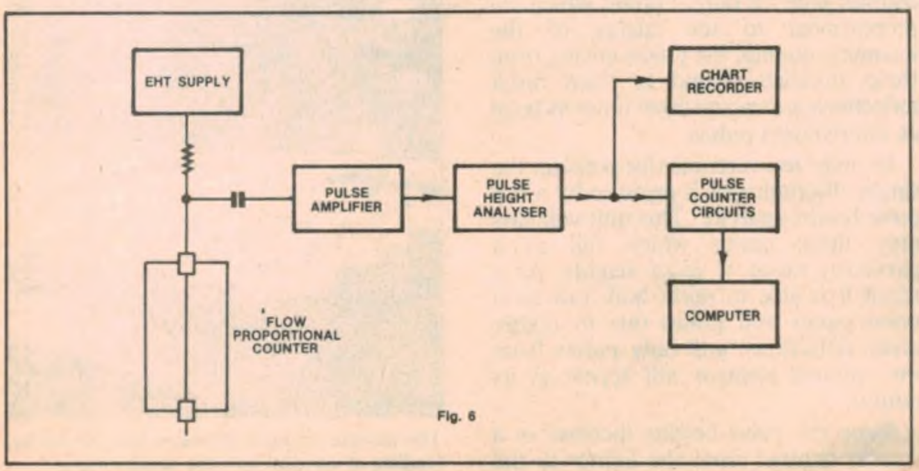


Fig. 6

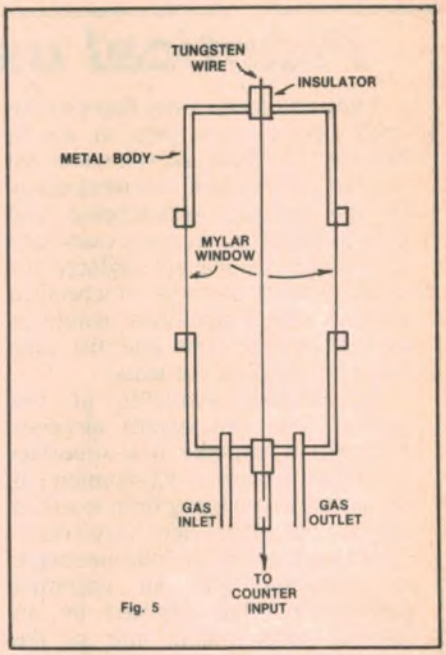


Fig. 5

analyser directly to a pulse counter. The pulses may either be counted for a fixed time or until the sample has received a fixed dose of x-rays. If the second method is used a small separate system is used to produce a stream of pulses whose rate is proportional to the output of the x-ray tube. This pulse stream is fed to a separate (reference) counter.

Both counters are set to zero at the start of the measurement and both are then allowed to run until the reference counter reaches a pre-selected number. At this time the analytical counter is automatically stopped and the accumulated total is printed out. This method is relatively insensitive to variations in the output of the x-ray tube and produces the most precise results. On the other hand, if counting is carried out for a fixed time, a very high stability in the x-ray source is required if reproducible results are to be obtained.

Final processing

In most cases results obtained from the instrument are not able to be used directly due to several interfering factors which are always present. The most serious of these effects is the fact that every element in the sample interferes to a greater or lesser extent with the measurement of every other element. This interference is of a complex nature due mainly to absorption by the interfering element of both the exciting beam of x-rays and of the fluorescent radiation which is generated in the sample.

These interferences can be corrected by means of a computer which is an integral part of the instrument. All the required settings for the operations are carried out automatically.

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74LS298 1.20
74LS299 3.90
74LS320 3.95
74LS321 3.95
74LS322 6.75
74LS323 6.50
74LS324 2.20
74LS326 2.20
74LS327 2.20
74LS352 2.20
74LS353 2.20
74LS354 3.95
74LS365 1.00
74LS366 1.00
74LS367 .60
74LS368 1.00
74LS373 1.90
74LS374 1.90
74LS375 1.00
74LS377 3.15
74LS378 1.20
74LS379 1.90
74LS386 1.00
74LS390 1.80
74LS393 1.80
74LS395 2.00
74LS396 2.50
74LS398 3.00
74LS399 1.90
74LS424 5.50
74LS440 5.50
74LS441 5.50
74LS442 5.50
74LS443 5.50
74LS444 5.50
74LS445 2.20
74LS446 5.50
74LS447 1.90
74LS448 5.50
74LS449 5.50
74LS490 3.20
74LS540 5.50
74LS541 3.95
74LS621 2.75
74LS622 2.75
74LS623 5.95
74LS629 5.95
74LS640 3.95
74LS641 3.95
74LS642 2.75
74LS643 2.75
74LS644 2.75
74LS645 2.75
74LS668 1.75
74LS669 1.75
74LS670 2.75
74LS673 12.55
74LS674 12.55
74LS681 3.95
74LS682 3.95
74LS693 3.95
74LS696 3.85
74LS699 3.95

CDP
CDP1802 10.50
CDP1864 17.50

CPU
6502 13.00
6502A 14.00
6504 13.00
6520 5.50
6507 13.00
6520 5.50
6521 5.90
6522 13.00
6522A 13.00
6532 14.00
6545 19.50
6551 12.90
2650 21.00
2651 23.00
6800 6.00
6802 7.00
6808 12.50
6809 10.00
6810 3.50
68B10 7.50
6820 5.50
6821 5.50
68B21 7.50
6840 12.50
6845 12.50
6847 13.50
6850 7.90
68B50 10.00
6860 19.50
6875 15.00
Z80CPU 5.00
Z80ACPU 6.00
Z80BCPU 12.00
Z80PIO 4.50
Z80APIO 6.50
Z80CTC 5.50
Z80ACTC 6.50
Z80DMA 16.00
Z80ADMA 19.00
Z80AS10 15.00
Z80S10 13.00
AD570 69.50
AD590 9.50
AD7524 17.50
AY-3-8910 14.50
AY-3-2513 14.50
MSM5832 16.50

MM58174 19.50
MM5303 7.50
MM5309 14.50
MM5369 4.95
LH0002 9.50
LH0042CH 9.50
LH0070 9.50
LH0071 9.50
TL061 1.50
TL062 2.90
TL064 4.90
TL071 1.20
TL072 2.90
TL073 3.20
TL074 4.90
TL081 1.90
TL082 2.50
TL083 2.90
TL084 3.45
TL494 4.90
TCA220 9.50
TCA280 1.50
TDA1024 2.80
TA7205P 3.90
TEA1002 17.50
UAA170 5.95
UAA180 3.75
LM10CH 7.50
LM301 .50
LM301H 1.50
LM302H 6.50
LM305H 1.50
LM307CN 1.00
LM308 1.00
LM308H 1.80
LM309K 1.90
LM310N 3.20
LM310H 3.20
LM311 1.00
LM311H 1.80
LM317T 2.50
LM317K 4.50
LM318 4.90
LM324 1.00
LM325 4.50
LM326 4.50
LM329DZ .90
LM344Z 1.90
LM335Z 2.20
LM336 2.5V 2.95
LM338K 12.50
LM339 1.20
LM348 1.80
LM349 1.60
LM350K 10.50
LM351N 1.00
LM353 2.50
LM356N 2.40
LM357 2.40
LM358 1.40
LM361 3.50
LM377 3.50
LM378 3.95
LM380 8 PIN 1.80
LM380 14 PIN 1.90
LM381 3.50
LM382 3.50
LM383 3.90
LM384 3.50
LM386 1.95
LM387A 3.95
LM387 2.00
LM390 2.95
LM391 2.90
LM393 1.00
LM395T 9.95
LM396K 22.50
LF398 5.90
NE544 6.50
NE555 .40
NE556 1.20
NE558 2.60
NE560 4.60
NE567 2.00
NE570 5.90
NE571 5.90
NE592 6.90
NE594 5.95
LM709-14 1.50
UA710CN 1.00
LM711 1.20
LM723 .75
LM723CH 1.50
LM725 4.75
LM739 2.75
741 .40
UA747 1.30
UA748 1.00
MC1310 9.50
MC1312 7.95
MC1314 7.95
MC1315 8.95
MC1327 7.95
MC1350 1.95
MC1408L8 7.50
MC1437 1.95
MC1445 5.95
MC1456 1.95
MC1458 1.20
MC1466L 14.50
MC1469R 6.90
MC1488 1.20
MC1489 1.20
MC1494 8.40
MC1495 8.90
MC1496 2.50
LM1596 3.00
LM1812 10.50
LM1830 3.90
LM2907 3.90
LM2917 8 PIN 4.90
LM2917 14 PIN 4.90
MN3001 17.50
CA3028 2.00
CA3046 1.90
CA3056 6.50
CA3059 5.95
CA3080 1.90
CA3086 1.90
CA3100E 7.95
CA3130E 2.20
CA3130T 2.95
CA3140E 2.20
CA3140T 2.95
CA3240E 11.95
CA3401 1.00
CA3900 1.75
CA3905 1.75
CA3909 2.95
LM3911 2.95
LM3914 5.90
LM3915 5.90
LM3916 5.90
LM3999Z 2.60
RL4136 1.95
RC4145 20.90
RC4194 3.90
MC5369 4.95

SC152D 6.90
C103YY .90
C103B .90
C106B .90
C122D 2.50
C122E 2.95
C260D 8.50
C280E 9.90
2N2646 1.20
2N2647 2.50
2N6027 .90

TRANS.
AC125 1.20
AC126 1.20
AC127 1.20
AC128 1.20
AC187 1.50
AC188 1.50
AD149 3.40
AD161 2.90
AD162 2.90
AF118 2.90
AF126 2.90
AF127 1.50
BC107 .50
BC108 .50
BC159 .50
BC177 .60
BC178 .60
BC179 .60
BC182L .40
BC212 .30
BC318 .30
BC320 .40
BC327 .30
BC328 .30
BC337 .40
BC338 .40
BC546 .40
BC547 .20
BC548 .20
BC549 .20
BC550 .40
BC556 .40
BC557 .20
BC558 .20
BC559 .20
BC639 .50
BC640 .50
BCY70 1.90
BCY71 1.90
BD135 1.00
BD136 .90
BD137 .90
BD138 .90
BD139 1.80
BD140 .90
BD201 .90
BD232 .90
BD233 .90
BD235 .90
BD236 .90
BD237 .90
BD238 .90
BD262 1.20
BD263 1.20
BD437 1.50
BD488 1.50
BD648 1.50
BD677 1.80
BD681 2.00
BD682 2.00
BDV64B 3.90
BDV65B 3.90
BDX63 6.50
Y96 (BUX 80) 4.90
BDY97 (BUX 80)
BF115 1.20
BF167 1.20
BF173 1.20
BF177 1.20
BF180 1.20
BF182 .90
BF183 .60
BF184 .60
BF198 .60
BF199 .60
BF200 1.20
BF245 1.20
BF337 1.50
BF338 1.90
BF458 1.00
BF459 1.00
BF469 1.20
BF470 1.20
BF494 .90
BF495 .60
BFW10 1.50
BFW11 1.50
BFW16 1.50
BFY50 1.20
BFY90 1.90
BU126 2.50
BU208 4.90
BU326 3.90
BUX80 4.90
MFE131 2.90
MFE3001 9.90
MFE3003 6.95
MJ413 5.90
MJ802 7.50
MJ901 4.95
MJ1001 3.90
MJ11011 9.90
MJ11015 14.50
MJ11016 14.50
MJ15003 6.50
MJ15004 6.50
MJ15024 10.00
MJ2501 3.90
MJ2955 1.50
MJ3001 8.00
MJ4032 12.50
MJ4502 6.90
MJE340 1.50
MJE371 2.90
MJE521 2.50
MJE700 3.90
MJE800 2.90
MJE2801 3.95
MJE2955 4.90
MJE3055 3.90
MJE13005 3.90
MJE13007 7.90
MJE13009 12.50
MPF121 .90
MPF131 2.50
MPSA05 1.00
MPSA06 1.00
MPSA10 1.00
MPSA12 1.00
MPSA13 1.00
MPSA14 1.00
MPSA20 1.00
MPSA42 1.00
MPSA43 1.20
MPSA55 1.00
MPSA56 1.00
MPSA63 1.00
MPSA65 1.00
MPSA92 1.00
MPSA93 1.20
MPF102 .90
MPF103 .90
MPF105 .90
MPF106 .90
MPF109 .90
MPSL01 1.50
MPSL51 1.50
MPSU02 1.75
MPSU52 1.90
MPSU56 1.75
MP131 1.75

SCR & TRIACS
SC141D 1.90
SC141E 1.95
SC142E 2.95
SC146D 3.90
SC150D 4.95
SC151D 2.95

MRF455 37.00
MRF475 7.70
MRF603 19.50
MRF641 49.00
MRF646 53.00
MRF901 3.75
MPF131 1.90
TIP31A .70
TIP31B .70
TIP31C .75
TIP32A .70
TIP32B .70
TIP32C .75
TIP41C 1.50
TIP42A 1.40
TIP42C 1.50
TIP49 1.90
TIP53 2.50
TIP111 1.50
TIP112 1.50
TIP116 1.50
TIP117 1.50
TIP120 1.50
TIP122 1.50
TIP125 1.50
TIP127 1.50
TIP145 3.40
TIP2955 1.50
TIP3055 1.50
2N301 4.00
2N697 1.00
2N918 1.00
2N1304 1.00
2N1613 1.20
2N2102 1.90
2N2219 .90
2N2222A 1.00
2N2369 1.00
2N2484 1.00
2N2646 1.20
2N2647 2.50
2N2894 1.00
2N2904 1.10
2N2905 1.10
2N2906 1.10
2N2907 1.10
2N3019 1.90
2N3053 .90
2N3054 1.90
2N3055 1.00
2N3096 1.20
2N3109 1.90
2N3251 1.90
2N3302 1.90
2N3440 1.80
2N3441 2.90
2N3442 3.50
2N3563 .30
2N3564 .30
2N3565 .30
2N3566 .30
2N3567 .30
2N3568 .30
2N3569 .30
2N3638 .30
2N3640 .30
2N3641 .30
2N3642 .30
2N3643 .30
2N3644 .30
2N3645 .30
2N3646 .30
2N3702 1.20
2N3704 1.10
2N3739 4.50
2N3771 5.50
2N3772 5.70
2N3773 5.90
2N3792 6.00
2N3819 1.50
2N3866 2.95
2N3904 1.00
2N3906 1.00
2N4030 1.00
2N4032 2.20
2N4033 2.20
2N4036 2.20
2N4121 1.50
2N4123 1.00
2N4236 1.90
2N4237 1.90
2N4248 .40
2N4249 .40
2N4250 .40
2N4258 .50
2N4355 .50
2N4356 .50
2N4360 1.00
2N4401 .30
2N4402 .30
2N4403 .30
2N4416 1.90
2N4427 2.90
2N4919 2.90
2N5088 1.00
2N5089 1.00
2N5139 1.20
2N5179 1.20
2N5190 2.50
2N5191 3.30
2N5192 2.40
2N5193 2.50
2N5194 2.95
2N5195 3.30
2N5210 1.50
2N5245 1.50
2N5303 8.50
2N5401 1.50
2N5457 1.00
2N5458 .90
2N5459 .90
2N5461 .90
2N5462 .90
2N5484 .90
2N5485 .90
2N5486 .90
2N5589 14.50
2N5590 16.50
2N5591 18.50
2N5641 18.50
2N5658 2.50
2N5770 .90
2N5777 1.50
2N5830 .30
2N5831 .30
2N5873 1.40
2N5874 1.70
2N5944 15.50
2N5945 18.50
2N5946 19.50
2N5961 1.90
2N6027 1.00
2N6049 1.90
2N6080 18.50
2N6083 21.90
2N6084 32.50
2N6124 1.90
2N6130 1.90
2N6133 1.90
2N6256 14.50
2N6259 13.50
2N6274 29.50
2N6378 4.90
2N6425 4.50
2N6578 4.90
3N201 1.50
2SA683 1.50
2SC2028 3.95
2SC2029 3.95
2SC2166 4.95
2SC1730 1.95
2SC1969 6.30
2SC1973 3.95

VN88AF 3.95
2SC372 1.95
2SC495 2.95
2SC710D 1.95
2SC73 1.95
2SC900F 1.95
2SC945A 1.95
2SC1014 2.50
2SC1017 4.95
2SC1018 4.95
2SC1061 2.95
2SC1173 2.95
2SC1226 2.95
2SC1306 6.30
2SC1419 2.95
2SC1449 1.95
2SC1674 1.95
2SC1307 6.90
2SD288 3.95
2SD325 2.95
2SD525 3.95
2SK45 3.95
2SJ48 6.00
2SJ56 12.50
2SK134 6.00
2SK176 12.50
1N4001 .10
1N4002 .15
1N4007 .20
1N5400 .40
1N5404 .30
1N5408 .40
OA47 .80
OA90 .50
OA95 .50
5082-2800 2.95
5082-2811 4.95
HLMP6620 5.95

BRIDGES
1.5 AMP
W005 .50
W02 .40
W04 .50
6AMP
BPC602 2.90
KBPC604 3.50
KBPC608 4.50
10AMP
KBPC10005 3.90
KBPC1002 4.20
KBPC1004 4.90
35AMP
KBPC3502 5.90
KBPC35014
MD A3504 6.90
KBPC3510
MDA 3510 9.90

74
7400 .35
7401 .45
7402 .45
7403 .45
7404 .60
7405 .80
7406 .80
7407 .80
7408 .60
7409 .80
7410 .60
7411 .70
7412 .70
7413 .70
7414 .80
7415 .70
7416 .80
7417 .80
7420 .60
7421 .60
7422 .80
7423 .70
7425 .90
7426 .70
7427 .80
7428 .60
7430 .70
7432 .70
7433 .70
7437 .80
7438 .90
7439 .90
7440 .70
7442 .90
7443 1.60
7444 1.50
7445 1.00
7446 1.20
7447 1.50
7449 1.20
7450 .90
7451 .90
7452 .80
7453 .70
7454 .90
7460 .70
7461 .90
7462 1.00
7463 1.20
7464 .90
7472 .90
7473 .70
7474 .70
7475 .80
7476 .80
7477 1.20
7478 1.20
7480 1.20
7482 1.80
7483 1.10
7485 1.00
7486 .80
7489 3.90
7490 1.00
7491 1.00
7492 1.00
7493 1.00
7495 1.00
7496 1.50
7497 2.30
74100 1.65
74107 1.00
74109 .90
74110 1.50
74111 1.50
74112 1.50
74113 1.50
74114 1.50
74116 1.95
74120 1.90
74121 .90
74122 .90
74123 .90
74125 1.00
74126 1.00
74132 1.00
74136 1.00
74138 1.80
74139 1.50
74141 1.50
74142 1.45
74143 1.45
74144 3.90
74145 1.45
74147 1.95
74148 2.00
74150 1.50
74151 1.00
74154 1.75
74155 1.20
74156 1.70
74157 1.00
74158 1.00
74160 1.00
74161 1.00
74162 1.00
74163 1.40
74164 1.00
74165 1.00
74166 1.70
74167 2.20
74174 1.45
74175 1.20
74176 1.40
74177 1.40
74178 2.15
74179 2.15
74180 1.20
74182 1.20
74184 1.20
74190 1.00
74191 1.45
74192 1.65
74193 .80
74194 1.10
74195 1.00
74196 1.00
74197 1.10
74198 1.10
74199 2.90
74221 1.90
74367 1.50
74368 1.50
74373 2.25
74374 2.25
74375 1.75
74377 2.45
74390 1.95
75107 2.50
75110 2.50
75150 2.50
75154 2.50
75450 1.50
75451 .90
75452 .90
75453 .90
75461 1.50
75462 1.50
75471 3.00
75472 3.00
75491 2.00
75492 2.00
75493 3.00
8121 5.00
8123 4.00
8130 6.50
8131 5.95
8136 6.95
8303 5.50
8304 6.95
82S23 5.95
82S123 6.95
8311 5.95
8641 5.95
8820 6.95
8830 6.95
8831 6.95
8833 6.95
8834 6.95
8835 5.95
1488 1.00
1489 1.00
81LS95 3.75
81LS96 3.75
81LS97 3.75
81LS98 3.75
8T26 3.00
8T28 3.00
8T30 3.00
8T96 1.80
8T97 1.80
8T13 2.95
8T14 2.95
8080 8.00
8085 9.50
8086 59.00
8088 29.00
8155 6.50
8156 11.50
8185 37.50
8202 52.50
8203 69.50
8212 2.90
8214 4.90
8224 3.50
8226 4.90
8228 5.50
8231 199.00
8232 199.00
8237 39.00
8238 9.50
8243 8.50
8251 6.90
8253 7.50
8255 5.50
8257 16.50
8259 6.50
8271 89.00
8272 33.00
8273 65.00
8275 38.50
8276 28.50
8279 8.50
8282 6.50
8283 6.50
8284 8.50
8286 6.50
8287 6.50
8289 73.00
8291 43.00
8292 34.50
8293 10 26.50
8741 55.00
8748 65.00
8749 58.50
8755 33.50
8035 6.90
8039 7.90

74HC
74HC00 .60
74HC02 .60
74HC04 .60
74HC08 .60
74HC11 .60
74HC14 1.40
74HC27 .60
74HC30 .60
74HC32 .60
74HC74 1.10
74HC76 1.10
74HC85 1.40
74HC86 .60
74HC123 1.40
74HC138 1.40
74HC139 1.40
74HC157 1.40
74HC165 2.50
74HC174 1.40
74HC221 3.60
74HC240 2.50
74HC244 2.50
74HC367 1.40
74HC373 2.90

FD1771 19.00
FD1791 (8876) 39.00
FD1793 (8877) 39.00
FD1795 39.00
FD1797 39.00
WD1691 29.50
WD2143 14.50
WD1931 22.50
WD1933 34.00
WD1983 14.75
WD1993 59.00
WD2123 26.50
WD8250 16.50
TR1602 (S1883) 8.50
TR1863 8.90
COM8116 24.00
BR1941 23.00
CRT8002A 59.90

74F SERIES
74F00 .79
74F02 .79
74F04 .92
74F08 .79
74F10 .79
74F11 .79
74F20 .79
74F32 .79
74F64 .79
74F74 .89
74F86 1.19
74F109 .99
74F138 1.79
74F139 1.79
74F151 1.79
74F153 1.79
74F157 1.79
74F158 1.79
74F175 2.78
74F181 5.98
74F182 2.73
74F189 7.44
74F190 4.86
74F191 4.86
74F194 2.41
74F241 3.72
74F243 4.34
74F244 3.72
74F251 1.93
74F253 1.93
74F257 1.93
74F258 1.93
74F350 4.34
74F352 1.93
74F353 1.93
74F373 4.84
74F374 4.84
74F399 2.78
74F521 4.22
74F533 4.84
74F534 4.84

MEMORY
2101 6.90
2102 2.50
2112 7.90
2114 2.95
2716 6.90
2708 8.90
2732 7.00
2764 12.00
27128 29.00
4116 3.95
4164 8.00
6116 8.00
6264 59.00
58725 (6116) 7.00
2101 (5101)
(8101) 7.90
5101 7.90
8101 7.90
2532 12.50

OPTO
4N25 1.20
4N26 1.20
4N27 1.20
4N28 1.20
4N29 1.50
4N30 1.60
4N32 1.50
4N33 1.50
4N35 1.50
4N37 1.50
MCT6 2.50
MCT66 6.90
MCT2 1.50
1LD74 5.90
1LQ74 6.50
FND500 2.00
FND507 2.00
TIL31A 2.95
TIL81A 2.95
TIL306 14.50
MAN72 (DL702) 3.50
MAN74 (DL704) 3.50
BPW50 2.25
HP5082-2811 4.95
HLMP 6620
3.95 LEDS
3mm RED .25
2mm YELL .30
3mm GRN .30
5mm RED .15
5mm YELL .30
5mm GRN .30
5mm ORG .30
RED RECT .30
GRN RECT .30
YEL RECT .30
RED CHROME BEZEL 1.20
YELLOW CHME BEZEL 1.20
GRN CHRME BEZEL 1.20

VOLTAGE REGS
7805C .80
7805KC 2.50
7812UC 1.20
7812KC 2.50
7815UC 1.20
7815KC 2.50
7818UC 1.20
7818KC 2.50
7824UC 1.20
7824KC 2.50
7905UC 1.90
7905KC 3.00
7912UC 1.90
7912KC 2.50
7915UC 1.90
7915KC 3.00
7918UC 1.90
7924UC 1.90
78L05 .50
78L12 .50
78L15 .75
78L18 .75
78L24 .75
79L05 1.20
79L12 1.20
79L18 1.20
79L24 1.20
LM309K (7805KC) 1.90
LM317T 2.50
LM317K 4.50
LM317HV 9.50
LM323K 7.50
LM337T 2.90
LM338K 10.50
LM350T 6.50
LM350K 8.50
LM395K 22.50
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4023 .75
4024 1.20
4025 .60
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4097 6.50
4098 2.40
4099 3.90
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4560 3.75
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We've got the kits at

LATEST KITS!

MULTI SECTOR ALARM STATION

Protect your home from intruders with this up-to-the-minute burgular alarm system, its easy to build, costs less than equivalent commercial units, and features eight seperate inputs, individual sector control, battery back up and self-test facility.

Specifications:
- Eight sectors with LED status indication.
- Two delayed entry sectors.
- Variable exit, entry and alarm time settings: entry delay variable between 10 and 75 seconds; exit delay variable between 5 and 45 seconds; alarm time variable between 1 and 15 minutes.
- Resistive loop sensing: suits both normally open and normally closed alarm sensors.
- Battery back-up with in-built charger circuit.
- Built-in siren driver.

Complete kit including deluxe prepunched metal work and electronics for only...

Cat. K85900 $119

LOW BATTERY VOLTAGE INDICATOR

Knowing your batteries are about to give up on you could save many an embarrassing situation. This simple low cost project will give your early warning of power failure, and makes a handy beginner's project.
(ETI 280, March '85)

Cat. K42800 $7.95

PARALLEL PRINTER SWITCH

Tired of plug swapping when ever you want to change from one printer to another? This low-cost project should suit you down to the ground. It lets you have two Centronics-type printers connected up permanently, so that you can select one or the other at the flick of a switch.
(ETI 666, Feb. '85)

Cat. 46660 $69.95

STEREO ENHANCER

The best thing about stereo is that it sounds good! The greatest stereo hi-fi system loses its magnificence if the effect is so narrow you can't hear it. This project lets you cheat on being cheated and creates an 'enhanced stereo effect' with a small unit which attaches to your amp.
(ETI 1405, ETI, MAR '85)

Cat. K54050 $79.50

MICROBEE ENHANCER 1

This brand new, totally amazing expansion unit for the Microbee is a must for all Microbee owners/users!

Most expansion units up to this time offered at best only one or other features; and this made it impossible to run, say, complex sound effects mingled with speech. The Enhancer 1 will do all this and much more as well. It is quite amazing how much has been shoe-horned into this compact unit. The Enhancer 1's many powerful features inlcude:
- Two ATARI/COMMODORE/COLECO/SEARS type joystick inputs
- Two TRS COLOR COMPUTER type joystick inputs
- Allows the connection of Touch Pads, Paddles, Proportional Joysticks, Trakballs, Mice, temperature sensors, lights level sensors, transducers, etc. etc!!
- A 4 voice music/sound effects sythesizer
- A real time clock
- Unlimited vocabulary speech synthesizer (option)
- Parallel printer interface (option)
- A built-in speaker with volume control
- Listings of all necesary routines for use
- An impressive demonstration program package
- Compatible to all Microbees
- All units carry a 90 day warranty and servicing is also available
- Digital recording and playback of speech and sound
- An 8 channel analog to digital converter with variable voltage or variable resistance type analog inputs and also user selectable resolution from 1 to 9 bits
- A digital to analog converter with selctable resolution from 1-8 bits
- Allows automatic data acquisition and logging
- 5 digital input lines, 4 digital ouput lines
- A voice input channel
- A 40 pin experimenter socket with all 8 analog inputs, 5 digital inputs, 4 digital ouputs, 3.58 MHz buffered clock, sound output (so that you can play the sound effects through your HI FI), 3 high resolution voltage comparators DAC output etc.

The amazing Microbee Enhancer is available exclusively from Rod Irving Electronics

Cat. $149

TALKING ELECTRONICS KITS!

HEADLIGHT REMINDERS Cat. K80022	$12.90
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LOGIC DESIGNER (with PC) Cat. K80027	$20.90
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KEN'S DUAL PSU. Cat. K80011	$11.80
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STEREO VU METER (with PC) Cat. K80053	$14.00
TOUCH PUZZLE Cat. K80054	$6.25
TRAIN THROTTLE MK11 Cat. K80055	$4.30
TREMOLO Cat. K80056	$3.80
TEC 1A Cat. K80057	$95.00
STAGE-1 KIT Cat. K80058	$89.95

SERIES 5000

PRICES SLASHED!

By directly importing and a more technically orientated organisation, ROD IRVING ELECTRONICS can bring you these products at lower prices than their competitors. Enjoy the many other advantages of RIE Series 5000 kits such as "Super Finish" front panels at no extra cost, top quality components supplied throughout. Over 1,000 Sold.

For those who haven't that time and want a quality hi-fi, we also sell the Series 5000 kits Assembled and Tested.

OUR PRICE $289!

POWER AMPLIFIER

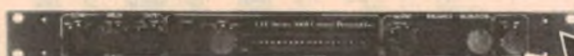
WHY YOU SHOULD BUY A "ROD IRVING ELECTRONICS" SERIES 5000 POWER AMPLIFIER.

★ 1% Metal Film resistors are used where possible.
★ Aluminium case as per the original article.
★ All components are top quality.
★ Over 1000 of these kits now sold.
★ Super Finish front panel supplied at no extra cost.

Please note that the "Superb Quality" Heatsink for the Power Amplifier was designed and developed by ROD IRVING ELECTRONICS and is being supplied to other kit suppliers.

SPECIFICATIONS: 150 W RMS into 4 ohms
PPOWER OUTPUT: 100 W RMS into 8 ohms (±55 V SUPPLY)
FREQUENCY RESPONSE: 8 Hz to 20 Hz +0 -0.4 dB 2.8 Hz to 65 KHz +0 -3 dB NOTE: These figures are determined solely by passive filters.
INPUT SENSITIVITY: 1 V RMS for 100 W output
HUM: 100 dB below full output (flat)
NOISE: 116 dB below full output (flat 20 KHz bandwidth)
2nd HARMONIC DISTORTION: <0.001% at 1 KHz (0.0007% on Prototypes) at 100 W output using a ±56 V SUPPLY rated at 4A continues <0.003% at 10 KHz and 100 W.
3rd HARMONIC DISTORTION: <0.0003% for all frequencies less than 10 KHz and all powers below clipping.
TOTAL HARMONIC DISTORTION: Determined by 2nd Harmonic Distortion (see above)
INTERMODULATION DISTORTION: 0.003% at 100 W (50 Hz and 7 KHz mixed 4:1)
STABILITY: Unconditional

Cat. K44771. **Assembled and Tested $499**



OUR PRICE $249!

PREAMPLIFIER

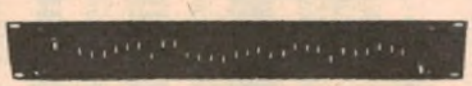
THE ADVANTAGES OF BUYING A "ROD IRVING ELECTRONICS" SERIES 5000 PREAMPLIFIER KIT ARE:

★ 1% Metal Film Resistors are supplied.
★ 14 Metres of Low Capacitance Shielded Cable are supplied (a bit extra in case of mistakes).
★ English "Lorlin" switches are supplied (no substitutes here).
★ Specially imported black anodised aluminium knobs.

Available Assembled and Tested. (We believe that dollar for dollar there is not a commercial unit available that sounds as good.)

SPECIFICATIONS:
FREQUENCY RESPONSE: High-level input: 15 Hz-130 KHz +0 -1 dB Low-Level input - conforms to RIAA equalisation ±0.2 dB
DISTORTION: 1 KHz <0.003% on all inputs (limit of resolution on measuring equipment due to noise limitation)
S/N NOISE: High-Level input, master full, with respect to 300 mV input signal at full output (1.2V) >92 dB flat >100 dB A-weighted. MM input, master full, with respect to full output (1.2V) at 5 mV input 50 ohms source resistance connected: >86 dB flat 92 dB A-weighted MC input, master full, with respect to full output (1.2V) and 200 uV input signal: >71 dB flat >75 dB A-weighted.

Cat. K44791. **Assembled and Tested $599**



THIRD OCTAVE GRAPHIC EQUALIZER

SPECIFICATIONS:
BANDS: 28 Bands from 31.5 Hz to 16 KHz.
NOISE: <0.008 mV, sliders at 0, gain at 0 (-102 dB0).
20 KHz BANDWIDTH DISTORTION: 0.007% at 300 mV signal, sliders at 0, gain at 0; maximum 0.01%, sliders at minimum.
FREQUENCY RESPONSE: 12 Hz-105 KHz, +0, −1 dB, all controls flat.
BOOST AND CUT: 14 dB.

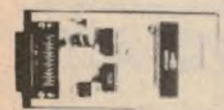
Cat. K44590

1 Unit... **$199**
2 Units... **$379**

POST & PACKING: $10 per SERIES 5000 KIT.

Rod Irving Electronics!

HEADPHONE AMPLIFIER
PRACTICE WITHOUT ANNOYING THE FAMILY!
If you play any type of electronic instrument,this headphone amplifier will surely interest you. It will let you practice for hours without upsetting the household or you can use it to monitor your own instrument in the midst of a rowdy jam session. (EA Feb. 84) 83MA11
Cat. K83011 **$28.00**



MICROBEE SERIAL-TO-PARALLEL INTERFACE
Most microcomputers worth owning have an "RS232 connector, or port, through which serial communications (input/output) is conducted. It is a convention that, for listing on a printer, the BASIC LLIST or LPRINT command assumes a printer is connected to the RS232 port. Problem is, serial interface printers are more expensive than parallel Centronics interface printers. Save money by building this interface. (ETI Jan. 84) ETI 675
Cat. K46750 **$59.00**

LOW OHMS METER
How many times have you cursed your Multimeter when you had to measure a low-value resistance? Well with the "Low Ohms Meter" you can solve those old problems and in fact measure resistance from 100 Ohms down to 0.005 Ohms.
(ETI Nov. 81) ETI 158
Cat. K41580 **$34.50**

PHONE MINDER
Dubbed the Phone Minder, this handy gadget functions as both a bell extender and paging unit, or it can perform either function separately. (EA Feb. 84) 84TP2
Cat. K84021 **$24.00**

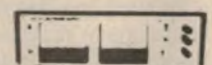
SOUND SIMULATOR FOR MODEL TRAINS
Fancy a diesel sound simulator for your model train layout? This circuit mounts inside the train for added realism and even varies its speed according to the throttle setting.
(EA Nov. 84)
Cat. K84110 **$18.00**

DIRECTIONAL DOOR MINDER
Most electronic door minders function by having a beam of light shinning across doorway interrupted, but are incapable of detecting whether the light beam is broken by a person entering or leaving the room. this project overcomes that problem with the aid of digital logic.
(ETI Nov. 84) ETI 278
Cat. K42780 **$29.95**

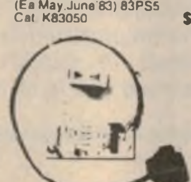
LAB SUPPLY
Fully variable 0-40V current limited 0-5A supply with both voltage and current metering (two ranges: 0-0.5A/0-5A). This employs a conventional series-pass regulator, not a switchmode type with its attendant problems, but dissipation is reduced by unique relay switching system switching between taps on the transformer secondary.
(ETI May 83) ETI 163
Cat. K41630 **$175.00**

CAR IGNITION KILLER
Most car burgular alarms are easily circumvented, but not this cunning "Ignition Killer". This sneaky antitheft device uses a 555 timer to place an intermittent short circuit across the points. Until disabled by its hidden switch the circuit effectively makes the car undriveable — a sure deterent to thieves! (EA Feb. 84) 84AU1
Cat. K84010 **$16.95**
(Our kit includes the box!)

ELECTRIC FENCE
Mains or battery powered, this electric fence controller is both inexpensive and versatile. Based on an automotive ignition coil, it should prove an adequeate deterrent to all manner of livestock. Additionally, its operation comforms to the relevant clauses of Australian Stnd 3129. (EA Sept. 82) 82EF9
Cat. K82092 **$19.50**

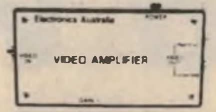


50V 5A LABORATORY POWER SUPPLY
New switchmode supply can deliver anywhere from three to 50V DC and currents of 5A at 35V or lower. Highly efficient design.
(Ea May June 83) 83PS5
Cat. K83050 **$149**



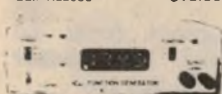
RADIOTELETYPE CONVERTER FOR THE MICROBEE
Have your computer print the latest news from the international shortwave news service. Just hook up this project between your short wave receivers audio output and the MicroBee parallel port. A simple bit of software does the decoding. Can be hooked up to other computers too. (ETI Apr. 83)
Cat. **$20.00**

ELECTRIC DUMMY LOAD
With this unit you can test power supplies at currents up to 15 Amps and voltage up to 60 Volts. It can "sink" up to 200 Watts on a static test and you can modulate the load to perform dynamic tests.
(ETI Oct. 80) ETI 147
Cat. K41470 **$109**

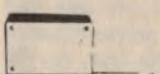


VIDEO AMPLIFIER
Bothered by smeary colours, signal beats and RF interference on your computer display? Throw away that cheap and nasty RF modulator and use a direct video connection instead, it's much better! The Video Amplifier features adjustable gain and provides both normal and inverted outputs. Power is derived from a 12V DC plugback supply.
(EA Aug. 83) 83VA8
Cat. K83081 **$15.00**

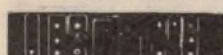
TRANSISTOR TESTER
1000's SOLD
Have you ever desoldered a suspect transistor, only to find that it checks OK? Trouble-shooting exercises are often hindered by this type of false alarm, but many of them could be avoided with an "in-circuit" component tester, such as the EA Handy Tester. (EA Sept. 83) 83TT8
Cat. K83080 **$15.00**



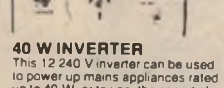
FUNCTION GENERATOR
This Function Generator with digital readout produces Sine, Triangle and Square waves over a frequency range from below 20Hz to above 160Hz with low distortion and good envelope stability. It has an inbuilt four-digit frequency counter for ease and accuracy of frequency setting.
(EA April 82, 82AO3A/B)
Cat. K82040
Cat. K82041 **$87.50**



TEMP PROBE
Can measure temperature from -50-to 150-c. It simply plugs into your multimeter - great for digital multimeters. Accuracy of 0.1-c resolution of 0.1-c
(ETI June 83) ETI 153
Cat. K41530 **$24.50**



150W BASS AMP
This guitar amp for impeccable bass players features many facilities found on expensive commercial ones. It delivers 150 watts into 4-ohms, has a 1-band graphic limiter, line out and bi-amp facilities.
(ETI Aug. 84) ETI 1410
Cat. K54100 **$299**



40 W INVERTER
This 12 240 V inverter can be used to power up mains appliances rated up to 40 W or to vary the speed of a turntable. As a bonus, it will also work backwards as a trickle charger to top up the battery when the power is on. (EA May 82) 82IV5
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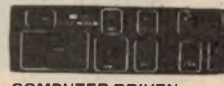

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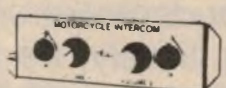

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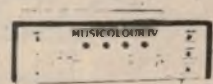

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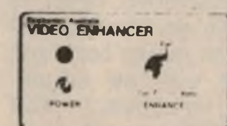

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Baffles, boffles, boxes and vents

by NEVILLE WILLIAMS

While expressing appreciation for articles on current hifi technology, a reader from Parkdale in Victoria has entered a strong plea for a plain language discussion of loudspeakers and enclosures, old and new. Surely, he says, a modern fully sealed enclosure must "strangle" the loudspeaker? And whatever happened to that very sensible concept, the "boffle" box? We do our best to oblige.

In putting his request, correspondent (A.B.) adds: "I guess that my interest owes more to mechanical than to electrical engineering. What I am trying to sort out is the effect of various types of enclosure on the basic pumping action of a loudspeaker."

We'll refer to that concept later, but let's start at the beginning:

When an electrical drive signal is applied to a dynamic (ie, moving coil) loudspeaker, the cone moves back and forth in accordance with the instantaneous polarity, frequency and amplitude of the signal. As the cone moves forward, it creates a layer of compressed air at the front, and rarified air at the back; as it moves backward, the reverse applies.

The effect of such pressure pulses on the surrounding air can be compared to what happens when something disturbs the water in a still pond: waves can be observed radiating outwards from the source, effectively dispersing and propagating the original energy over a wide area.

Variations in instantaneous pressure produced by a loudspeaker cone in an invisible medium (air) are likewise dispersed and propagated in the form of sound waves.

Directional Effects

The pond analogy applies best to frequencies in the middle of the audio spectrum — from a few hundred to a few thousand Hertz. Over this range, sound waves are propagated from an unmounted dynamic loudspeaker substantially through the full 360°.

Above about 4-5kHz, however, as the sonic wavelength diminishes and becomes smaller than the frontal dimensions of the cone, propagation from an ordinary dynamic loudspeaker becomes increasingly directional.

Depending, in part, on the size and shape of the cone, sound propagation to the sides diminishes, while that to the rear is shadowed, anyway, by the housing and magnet structure. What remains is predominantly a "beam" of high frequencies typically 20-40° wide along the frontal axis of the cone.

At frequencies below about 600Hz the situation is different again. With the cone moving in a given direction for a progressively longer period during each half-cycle, air under pressure on the one side of the cone has time to flow around the edge of the housing to relieve the partial vacuum on the other side.

Instead of propagating a pattern of low frequency sound waves into the surrounding atmosphere, much of the system energy is wasted in simply pushing air back and forth around the edge of the housing.

Fig.1 depicts the sound propagation pattern of a typical full-range dynamic loudspeaker (unmounted) with the highest frequencies projected as a beam, the median frequencies widely dispersed, and the lowest frequencies confined mainly to the immediate vicinity of the cone.

Clearly, if the reproduction is to sound reasonably balanced, it is essential to achieve better propagation at the bass end. This is mainly what the article is all about: **"Baffles, boffles, boxes and vents"** — and their influence on low frequency response.

Bass Roll-off

In their loudspeaker literature, Philips (and others) describe the direct front-to-back path for bass energy as an "acoustic short-circuit". It becomes evident, they say, at frequencies below that at which the distance from front to back of the cone approximates one half wavelength. (For an unmounted driver, I take it upon myself to suggest a mean distance between points at about half the driver

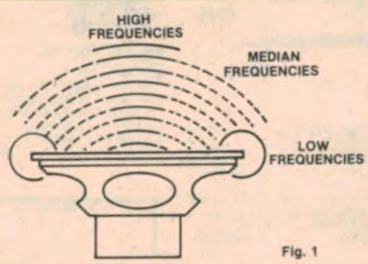

Fig.1: The sound propagation pattern for an unmounted full-range loudspeaker. Baffling is necessary to prevent low frequency energy from being merely pumped back and forth around the edge of the housing.

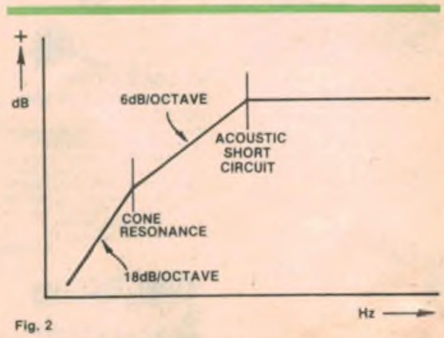

Fig.2: The low frequency response of an unmounted loudspeaker diminishes at about 6dB/octave in the region of acoustic short-circuit and by a further 12dB/octave below the cone resonance.

radius).

Below this region, the effective response falls at the nominal rate of 6dB/octave, down to the system resonance. Below that again, the slope steepens to 18dB/octave (Fig.2).

It follows that physically large loudspeakers with (normally) a lower cone resonance will exhibit better bass response, unmounted, than their smaller counterparts — something that most will have noticed.

In fact, examples exist in commercial hifi systems and electronic organs of loudspeakers which, for bass response, rely primarily on jumbo size (and sometimes oddly shaped) cones, with only a modest amount of additional cabinet work. But while they may provide an interesting talking point, they can offer, at best, only a partial solution to the basic problem.

Baffling Essential

In the late '20s, the potential for improved bass response was a major reason for the rapid adoption of dynamic loudspeakers. It was accepted, however, that they would need to be mounted on a "baffle" of some sort for the advantage to be realised.

It might take the form of a rigid panel, possibly resting on the floor and/or mounted across a corner, to increase its effective area. Alternatively, the need might be met by an open-back radio cabinet, preferably as large and substantial as possible.

Either way, the basic purpose was to increase the path length between the front and rear of the cone, thereby pushing the region of acoustic short-circuit and low frequency roll-off further down in the range.

However, aspirations at the time were not all that demanding — at least for the mass market. After the moving iron horn and cone loudspeakers of the '20s (Fig.3) any bass seemed like good bass! Besides, other factors had to be considered:

- Supply, reliability and price in a booming, highly competitive market.
- Sensitivity, too, was vital and, in keenly priced, mass-produced models, that meant using a lightweight cone and a relatively short voice coil in a narrow magnetic gap.
- To maintain the voice coil central in the gap, and to keep cone excursions within acceptable limits, suspension systems had to be relatively stiff. As a result, the majority of such loudspeakers ended up with a prominent (high Q) cone resonance, commonly above 70Hz for 30cm models and higher again for their smaller counterparts.

When mounted in typical console radio cabinets, it was not unusual for the low frequency response to meet up with the cone resonance, which would then be heard loud and clear, resulting in the infamous "one-note bass" of the early '30s (Fig.4).

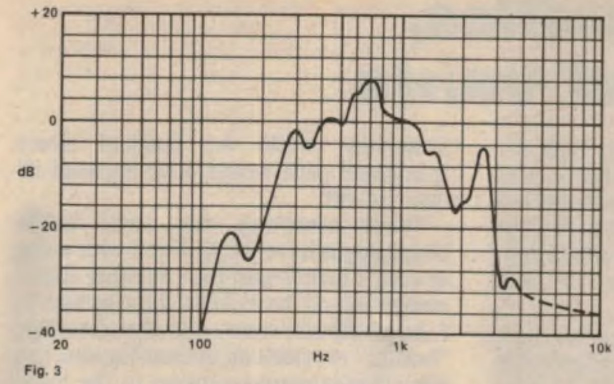

Fig.3: The frequency response curve of a typical old-time horn loudspeaker — bad enough, without even considering the distortion! It is of little wonder that dynamic loudspeakers took over so rapidly.

To curb it, designers came to rely on negative feedback in the amplifier to lower the impedance of pentode output stages and to provide a measure of electrical damping on the coil/cone system.

While budget-priced "radio" loudspeakers, with suitable circuitry, may provide acceptable sound for general listening, their potential for use in a high quality sound system is strictly limited, despite claims to the contrary over the years.

In any case, what might have rated as excellent in the days of indifferent signal sources could sound very ordinary in this, the digital era.

Hifi Loudspeakers

With rare exceptions, the starting point for a good loudspeaker system needs to be a high quality driver (or drivers) of which examples have been available since I first entered the industry in the early '30s.

I still look back with a certain anguish to the big full-range American Magnavox and Jensen models that I had to fit to other people's systems but could not afford myself! These were followed by a variety of British and European models, including big-name brands like Goodmans, Wharfedale, Celestion and Philips.

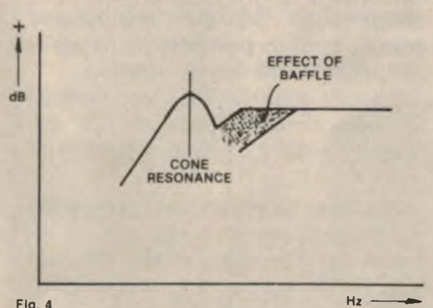

Fig.4: Fitting a loudspeaker to a baffle pushes the 6dB/octave roll-off further down in the range. The cone resonance can become very prominent, as a result, if it is not sufficiently damped by the associated amplifier.

Best described as "general purpose" hifi loudspeakers, they were generously proportioned (30-38cm diameter) with specially moulded (often curvilinear) cones, long travel voice coils and suspension, and a large magnet structure to ensure high sensitivity and good electrical damping with (commonly) power triode output stages. Their bass resonance was down around 45Hz but so well damped and so broad that it was usually difficult to pick by ear.

They certainly sounded impressive in a deluxe console or, less commonly, on a large suitably styled baffle made from heavy timber or, in the Wharfedale manner, from plywood layers filled with dry sand.

Extended Bass

But still not satisfied, individual enthusiasts and a generation of dedicated English hifi manufacturers aspired to a still further downward extension of the bass response, requiring the means to more effectively contain or control back radiation from the cone.

One logical — but not very practical — answer was to create an "infinite" baffle by mounting the loudspeaker: (1) in a dividing wall; (2) in the door of a capacious cupboard; (3) in the opening of a disused chimney, or (4) through the ceiling.

Apart from structural implications, however, other matters had to be considered like noise from the rear of the loudspeaker, unequal air pressure on the respective sides of the cone — and hungry rodents!

To quote Gilbert Briggs of Wharfedale: "Moral: don't use the mouse's living room as a speaker enclosure!"

So the tantilising problem remained: to devise an enclosure that would be self-contained, of practical dimensions and construction, and able to contain or control low frequency radiation from the rear of the cone; this — to use A.B.'s term — without "strangling" the loudspeaker!

Baffles, boffles, boxes and vents

(What should be added was that, for the most part, the effort was concentrated around general purpose hifi loudspeakers which, as a class, did not lend themselves to being crammed into "practical" sized enclosures of any description!)

The obvious starting point was a rigid, completely sealed box, still misguidedly described by some as an "infinite" baffle. While it may indeed have "contained" back radiation from the cone, it was (and still is) anything but "infinite" in its effect on cone behaviour.

In particular, the body of air trapped behind the cone, alternatively compressed and rarified by cone movement, acts as a supplementary spring, tending to restore the cone to its median position. It has the effect of raising both the frequency and the "Q" of the cone resonance, being particularly apparent with large loudspeakers in unduly small enclosures.

In the mono era, some enthusiasts nevertheless found it practicable to accommodate a "general purpose" hifi loudspeaker in a single large enclosure — 250 litres (9 cu ft) or more — tolerating a modest 5-10Hz rise in the bass resonance and restraining the "Q", if necessary, by partially filling or padding the enclosure.

Smaller Boxes?

But, especially with the arrival of stereo, 250-litre enclosures were out of the question for most enthusiasts. Nor did they relish the idea of small sealed enclosures, with their potentially traumatic effect on the resonance of typical loudspeakers, padding and filling notwithstanding.

The "boffle" box, mentioned by correspondent A.B., represented one of many attempts to get around the dilemma. I forget the finer details but we actually had a pair of them bracketed to the wall of the EA lab at one stage, for on-the-spot audio testing.

As I recall, they were about 45-50cm cubes, open at the back. But, behind the 30cm loudspeakers, was a succession of caneite panels and spacers, with a circular hole in each panel, progressively smaller towards the back.

The idea was that the panels would intercept and absorb middle and high frequency radiation from the rear of the cone and thus minimise standing waves in the box. This they probably did but, at the vital lower frequencies, their contribution would have been something of a gamble.

Air partly trapped behind the cone could still have affected its resonant frequency, while the residual direct front/back path would have imposed its own roll-off.

While accepting that some boffle boxes might have worked well with some drivers, I feel certain that, in other cases, results would have been very ordinary. Like jumbo size cones, mentioned earlier, "boffles" provided an interesting idea but not a fundamental solution to the basic problem.

Among other approaches, popular at the time, was the acoustic labyrinth — an enclosure with internal partitions which formed a convolute path for the back radiation to a separate outlet port.

The object was to achieve an approximate half-cycle phase delay through the labyrinth at selected low frequencies, such that output from the port would reinforce direct radiation from the cone in the normal roll-off region.

Unfortunately, a suitably long acoustic path of sufficient cross-section to work well with a large loudspeaker can itself be quite large. If shortened, it will reinforce the wrong frequencies. If narrowed, or filled with fibrous material, it may raise the resonant frequency of the cone and achieve little else.

Much the same remarks apply to folded horn enclosures. If well executed (as by Paul Klipsch in the '40s) they can be very good, even if rather large and expensive. But, if scaled down in an effort to conserve space and cost, they become eminently forgettable!

Forgettable, too are many other examples of the enclosure maker's art from the immediate pre-and post-war period, based on earlier work, hunches, ovservation, enthusiasm — and an imperfect understanding of the principles involved! Prominent in this group is an array of smallish, highly "doctored" vented systems, yet to be discussed.

Most such creations are the product of an era in which those involved started out with a particular loudspeaker (or system) thereafter attempting, by empirical methods, to produce an enclosure to suit it. The inevitable result has been misinformation and confusion.

The Modern Approach

The present-day approach to hifi loudspeaker and enclosure design is reminiscent of the old adage: "If you can't beat 'em, join 'em!".

Instead of acquiring independently an ostensibly high performance loudspeaker (or system) and then trying — possibly against the odds — to devise an enclosure to go with it, the loudspeaker (or bass driver) and enclosure are chosen and/or designed, from the outset, to complement each other.

The concept is not new but, over the past 20-odd years, mathematical analysis and computer programs have emphasised its advantages, transforming what was once a rather tedious and empirical procedure into an exact science.

For a given loudspeaker, it is now possible to predict system performance for a range of enclosure dimensions. Or, given certain enclosure specifications, a design can be derived for a complementary driver. Yet again, for a certain performance target, the options for both driver and enclosure can be explored to discover the most practical combination — before any hardware is produced.

Computer aided design has focused mainly on fully sealed and on reflex (ie, vented) systems, both of which combine relative ease of construction with a wide range of options in terms of size, cost and performance.

Both can be presented as simple, rectangular boxes housing either a single full-range loudspeaker or a complete multi-way system with a dedicated bass driver. Alternatively, they can be constructed in a variety of shapes, provided the correct volume is retained.

Sealed Systems

In the case of fully sealed systems, the basic concept is to plan for a loudspeaker (or a bass driver) with a deliberately soft

Linear Phase Loudspeakers

In these systems, the treble, mid and low frequency drivers are mounted on the front panel in such a way as to equalise, as far as possible, the distance from each cone to a listener seated in the optimum listening area. The purpose is to maintain the correct phase relationship between the frequency components of the reproduced sound, both to preserve its integrity and to optimise stereo imaging.

Special attention may also be paid to the dividing network in the system, with the same objective in view.

The measures can be shown on instruments to have an effect on phase and waveshape but whether the difference is significant subjectively is open to argument.

Either way, linear phase design does not modify the need to pay full attention to basic requirements for proper bass response.

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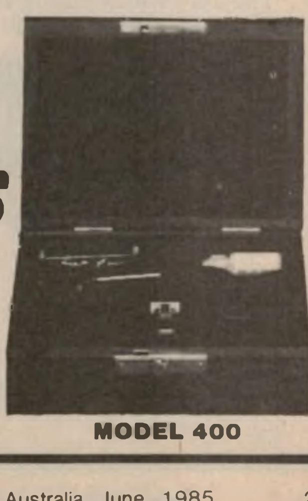

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Baffles, boffles, boxes and vents

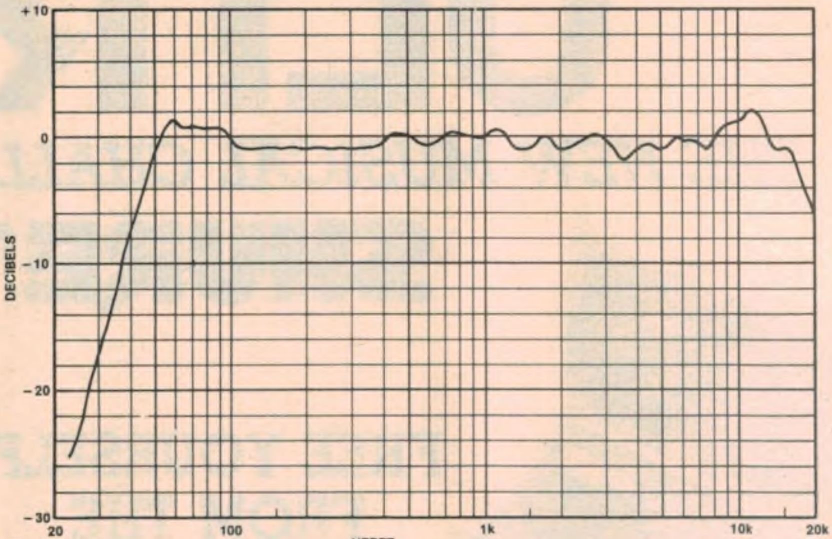

Fig. 5

Fig.5: The frequency response curve of a full-scale domestic loudspeaker system using Philips drivers and a Philips designed sealed enclosure. It could readily cope with low-end bass boost.

(compliant) suspension and a deliberately low cone resonance, typically below 30Hz.

Such a driver would be liable to damage by excessive cone excursion, if used on a flat baffle, in an open-back cabinet or an over-large sealed enclosure. But, by mounting it in a suitably small enclosure, the "stiffness" of the entrapped air supplements that of the mechanical suspension, affording greater protection from overdrive and raising the resonance to a still low but convenient frequency.

Instead of the enclosure "strangling" the loudspeaker, as was formerly the case, it becomes an essential part of the suspension. As well, it completely "contains" the back radiation, thereby solving the basic problem.

By way of example, a large, 3-way loudspeaker system marketed by Philips for commercial or home construction, includes a 30cm bass driver having a cone resonance, unmounted, of 20Hz. Installed in the recommended fully sealed 100-litre (3.6 cu ft) enclosure, the bass resonance rises to about 50Hz, giving full output at that frequency and a useful response extending to below 30Hz (Fig.5). Rated power handling capacity for the system is 100W.

At a more modest level, commercial sealed enclosures range downward in size to small "bookshelf" dimensions, often with a surprising performance for their size. They use proportionately smaller drivers, with a long travel voice coil to permit high output, relying heavily on the entrapped air to cushion the cone against excessive travel.

However, small wide-range fully sealed systems are, by nature, comparatively insensitive, requiring more drive than their larger counterparts to produce an adequate level of sound in the listening room. Fortunately, this seldom poses a problem with modern solid state amplifiers.

One other point warrants repetition from page 100 of the February issue: If a sealed enclosure has been optimally designed to complement a particular driver, it is unwise to arbitrarily increase the enclosure volume with the idea of gaining extra bass response. The resonance of the system may indeed be moved to a lower frequency but the "Q" of the system could also be lowered (Fig. 6), causing the response curve to droop, with a marginal loss, rather than a gain in useful response.

Reflex Enclosures

Reflex (or vented) enclosures are a derivative of the historic Helmholtz

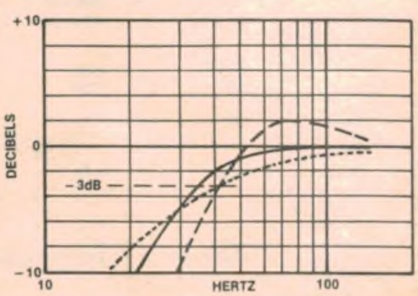

Fig. 6

Fig.6: The solid curve shows the bass response of a critically designed sealed enclosure. A too-small enclosure produces an undesirable peak (dashed) but too large causes the curve to droop (dotted).

Multidirectional Loudspeakers

Conventional stereo loudspeakers project sound towards the listener and are frequently judged on their ability to create a sharp stereo image.

Multidirectional loudspeakers, on the other hand, are designed to project middle and high frequencies in a variety of directions, often deliberately bouncing the sound off adjacent and rear walls.

The claim is that it is subjectively more natural, pleasant and relaxing to be surrounded by sound than to have it "squirted" at the listener from two sonically obvious sources.

It is largely a matter of individual preference but one thing is certain: an array of small loudspeakers to disperse middle and high frequencies does not obviate the need for adequate provision for the bass end.

resonator, involving an otherwise airtight cabinet, with a vent or tubular port, plus a mounting hole for a loudspeaker.

The volume of the enclosure and the dimensions of the vent are normally chosen such that a mutual acoustic resonance occurs at a frequency approximating the bass resonance of the loudspeaker. In this region, energy from the rear of the cone emerges from the vent, shifted sufficiently in phase to reinforce direct radiation from the front of the cone.

Effectively, the reflex system achieves a similar end result to the acoustic labyrinth — without the partitions. And, because it uses rather than suppresses energy from the rear of the cone, if offers somewhat greater acoustic efficiency than the fully sealed system, particularly in the bass region.

One of the all-time champions of the method, Gilbert Briggs of Wharfedale, had this to say:

"From the point of view of size, cost and ease of construction, the vented enclosure seems to pay the highest dividends in terms of bass output, provided vent resonances below about 50Hz are adhered to. A higher resonance frequency may be obnoxious."

The vented system worked well for Briggs because, in his day, Wharfedale was mainly concerned with large loudspeakers in large enclosures and resonances generally in the under-50Hz region. What he and his contemporaries didn't fully realise was that then-current design guidelines did not take into account factors that were vital to compact systems.

So, when compact reflex systems began to appear on the market, the bass characteristics of some were indeed sufficiently "obnoxious" to earn them a reputation as boom boxes!

In an attempt to curb objectionable resonance effects, designers resorted to a variety of measures, including internal partitions or curtains, padding, filling and acoustic filters across the vent. Sometimes they helped; sometimes they didn't.

It was left to an Australian engineer, Neville Thiele, and others, to perform a detailed mathematical analysis of the reflex system. It has since been translated into computer programs, making it possible to predict accurately the performance of various driver/enclosure/vent combinations and to give the "thumbs down" to basically unsuitable drivers or to impractical specifications.

The work has also rendered obsolete most articles on the subject from the '50s and '60s, along with ideas for "doctoring" systems that were probably ill-conceived in the first place!

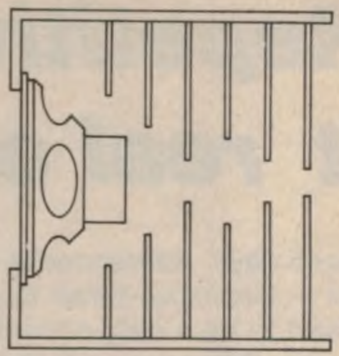

Fig.7: the "boffle" box used a succession of canite panels and spacers, with a circular hole in each panel, progressively smaller towards the back. The panels were designed to minimise standing waves in the box.

But, equally, it has made it possible for companies with engineering know-how to design and/or manufacture a range of vented systems based on proven technology rather than "guesstimation".

The one lament is probably that modern reflex enclosure design can not be reduced to a few simple tables and graphs, for use by non-technical hobbyists. If you want to build a reflex system, base it on a proven design from a reliable source.

How do reflex and fully sealed systems compare in terms of performance? In general, reflex systems should have the advantage in terms of efficiency, particularly over the bass region, but they are probably less practical for very small enclosures. Both have strong support, however, and our advice is simply to invest in the system which seems best to meet your needs, be it sealed or vented!

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Repetitive Strain Injury: is it real or imaginary?

These days, references in the media to RSI — Repetitive Strain Injury — seem almost to be a daily occurrence. For some people, RSI supposedly spells the end of a promising career; to others, the whole idea is a load of hogwash. Who's right and who's wrong or does the truth lie somewhere in between.

FORUM

Conducted by Neville Williams

When concern about possible computer operator ailments first surfaced some years ago, RSI had not been dignified by a special name. It was just one aspect of broadly based and rather emotional staff opposition to the introduction of computer keyboard technology into the workplace.

Some saw the technology as a threat to their existing personal expertise; others were more concerned with its likely impact on job opportunities generally. Still others were ready enough to accept advanced technology — provided they could negotiate an award to cover new skills, new hazards, and anything else they could dream up!

Some indulged in rather free-wheeling speculation about the possible ill effects of spending long hours in front of a display screen. Might not the TV-style scanned image cause eyestrain and/or produce mental tension of an obscure kind?

Again, something as highly visual and electronic as a display screen must surely generate rays of a sort and these might have an effect on anything from libido to genes!

More practically, there were claims that the kind of environment that had sufficed for typists and stenographers for decades was totally unsuitable for electronic keyboard operators. Room layout, lighting and posture all needed to be re-thought before the new equipment was introduced!

On the other side of the table, computer manufacturers, computer vendors and prospective purchasers were busily working out appropriate rebuttals.

In all this, fact was often so obscured by fiction and by industrial politics that I, along with a lot of others in the technical fraternity, tended to treat much of the debate with the proverbial "grain of salt".

Then, in a stroke of pure genius, someone invented a collective term — complete with initials—for the potential physiological effects of working for long periods at a computer style keyboard; they christened it RSI, short for Repetitive Strain Injury.

In very short order, keyboard operators across the country were claiming that they had had to give up work because of RSI, or were currently suffering from its effects, or were being exposed to its ravages.

It was reminiscent of the one-time debate surrounding those vague, alleged visitations from outer space. Initially, people merely professed to having seen a disparate array of mysterious lights, flying saucers, and unearthly aircraft manned by little green men. But, almost overnight, all such phenomena were dignified and unified by a new, collective name: UFOs or Unidentified Flying Objects!

But, as with "UFOs", the term RSI also provided a convenient focus for the sceptics. There were plenty of them, but it would be difficult to imagine one more outspoken than Dr Denis P. Mackey, of Lindisfarne, Tasmania, author of a letter to the Editor, published in the Sydney Morning Herald on February 21, last. Under the title "RSI a joke", he says:

"A form of mass hysteria is moving through the Australian Public Service in the guise of repetitive strain injury (RSI).

"This 'disease' was invented two years ago as a bit of a joke so that work shy people could have an excuse for a 'sickie'. RSI represented no more than sore muscles or joints following repetitive use or overuse, as any tired housewife can confirm.

"RSI was invented as a diagnostic entity to support a hoax. All the aches and pains of everyday life have been translated into RSI and floated to a gullible community as a workers' compensation claim, to see which sector will take the bait."

From the standpoint of the medical profession, Dr Mackey admits to a certain amusement, as public servants "line up by the droves to claim compensation for their overworked muscles." He concludes:

"It must be embarrassing for the Commonwealth Health Department, which controls all medical statistics, to observe that there are more cases of this disease in its own ranks that in any other Government department."

While few sceptics have expressed themselves quite as forcibly as Dr Mackey, there has certainly been widespread reservation about this ostensibly "new", potentially crippling disease. What about all the woman who worked for years in traditional typing pools? Why hadn't they become victims of RSI?

Perhaps many did, without some cumulative work-related disability ever having been diagnosed — or accepted — as such.

The same question could doubtless be pursued about women machinists in clothing factories or other process workers doing tedious repetitive handwork, often under makeshift conditions.

Accepted wisdom is to point out that typists, for example, normally break their keyboard routine at frequent intervals to handle paper and documents, thereby changing posture and bringing other muscles into play. This may not happen to anything like the same extent with, say, a word processor, where the activity involves fewer muscles for longer periods — possibly resulting in RSI.

A very old problem:

As it turned out, Dr Mackey's letter to the Sydney Morning Herald prompted three letters from other readers, all coincidentally having to do with old-time Morse Code operators.

Referring to RSI (and more particularly to Tenosynovitis or Carpal tunnel syndrome), J. W. Dargan of

Greenwich, NSW (Mar 4, '85) pointed out that the basic problem surfaced at least 50 years ago in connection with a primitive forerunner of modern "electric" communication devices: the Morse Code key. I quote:

"The same over-use of movements of small amplitude and low force by the tips of the fingers resulted in pain and rigidity of the wrist, which in turn destroyed the flexibility necessary for forming Morse signals at high speed. In those days it didn't have a medical name, and was known graphically as 'glass arm'!"

When that happened, according to the writer, the operator had no alternative but to learn to send with the other hand and, failing that, with the palm or even the wrist. Then unable, any longer, to send code, the operator simply lost his job, with little or no thought of sick pay or compensation.

By way of further comment (SMH March 8, '85) Mr Alf Baker confirmed the difficulties faced by old-time Morse Code operators, who were vital to Railway Department communications in country areas, before the installation of telephones. The glass arm problem was alleviated by development of the "pendograph", which allowed the operator to send code messages by using the thumb and forefinger in a lateral movement.

In the same issue, Dr M. Raphael of Mosman, NSW, also refers to the problems of Morse Code operators early in the century but says that over-use syndromes have been reported under various names in many industries over at least 300 years!

Morse Code operators, he said, ultimately had their shifts reduced. It seems only logical that, in addition to ergonomically designed work stations, present-day employees should receive proper consideration in regard to shifts, rest pauses, exercises, etc, in order to forestall trouble of a similar nature.

(In fact, this practice is now mandatory in some computer intensive government departments.)

Distortion on orchestral strings

I would like to comment on your article "Why the distortion on orchestral strings?" in the February issue of "Electronics Australia". It has been a pet study (or hate) of mine over many years.

First let me say that the distortion is on the master tapes but becomes more apparent through each processing stage. (You can certainly hear it if you play back the master lacquer.)

But, significantly, it is often discernable also at the original performance. By way of illustration, let me recount something that happened to me in the days of mono reproduction.

At the time, I used to hold musical evenings in my home where a number of guests would come and simply sit in silence, listening to the reproduced music. One such guest was a prominent artist in Melbourne, who learned his craft painting model and stage scenery at La Scala in Milan, often to the sound of great orchestras rehearsing in the background.

At one of our evenings, he noticed "fizz" on the strings and described it as distortion, ostensibly in the recording. Later, we happened to attend an opera together and, during the performance, he became quite agitated. I learned later that he was trying to tell me how he had become aware of the very same "distortion" at this live performance. So it is a fact.

Now for my theory: You have noted, as I have, that it only occurs with some sound sources: vocal, strings — and some brass, you will find.

Further observation seems to indicate that it only occurs where the artist has to select the pitch of the instrument while playing — no definite finger hole. Flutes in unison do not seem to exhibit the effect.

It appears to me that, in sounding the required notes, individual members of the group are all ever so slightly "off key" and that this causes a large conglomeration of harmonics. The louder the playing (or singing) the more noticeable the effect.

One might reasonably argue that, if enough harmonics are generated, the wave envelope would start to "square off".

So we have a problem to start with — it sounds distorted "live" — but this is progressively compounded by the difficulty which the unnaturally complicated waveform presents to the microphones and to the rest of the system, both recording and playback. Phase problems with multiple microphones certainly do not help!

Yes, I have heard the effect on some compact discs. And, yes, the skill of the musicians is important. For example: try as I may, I could not hear it during a performance by the Israel Orchestra during their last visit here.

To sum up:

(1) "Distortion" is frequently present in the live performance.

(2) It happens only with choral groups and some instruments and depends to a degree on the skill of the performers.

(3) It becomes more noticeable with each recording stage, particularly if great care is not taken with levels and any application of treble boost.

Harry Mauger
(Mordialloc, Vic).

Musicians as well!

More or less coincident with the foregoing debate in the Sydney Morning Herald, a news item in the Sydney Daily Telegraph quoted a report from Victoria, to do with professional musicians. The curiously worded introduction made it sound as if RSI was really an infectious disease, to be passed on and caught like the flu:

"The disease that was once thought only to inflict keyboard operators in the typing pool is also sweeping through symphony orchestras."

The item goes on to say that Mr Hunter Fry, the scientific convenor of the Victorian Arts Medical Society, has surveyed six symphony orchestras during the past year, on the lookout for signs of RSI amongst the players.

Reportedly, he found evidence of the problem in 50% of the players. About 7% were ranked as having a "Grade Five" condition, suggesting that they would not be able to continue playing for much longer.

The report put the blame for RSI on bad posture and constant practice, and foreshadowed the time when orchestra members might "down tools" every half hour for an RSI break!

When I read that, I immediately rang Julian Russell, well known for his record reviews in this magazine. In his younger days, Julian was a professional concert and orchestral pianist, and later a conductor. He has been in and around orchestras and musicians, worldwide, for most of his long life.

What were his reactions to the Victorian report?

In effect, they were substantially parallel to those of Dr Mackey, as quoted earlier, but expressed in somewhat less polite terms!

Any good teacher, he said, would place strong emphasis on posture and a professional musician who chose to ignore such advice would be likely to suffer the consequences in the way of plain, old-fashioned aches and pains.

Said Julian: unlike electronic keyboard operators, musicians do not, for the most part, just use their fingers. There is, or can be, considerable incidental

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Forum — continued

movement of other muscles.

As a professional pianist, he would customarily have spent many hours each day practicing, followed by an evening performance, and he never experienced any suggestion of so-called repetitive strain injury. Nor, could he remember other musicians complaining about it.

"It's the same old syndrome. Invent a new ailment and there's an immediate rush of people claiming to have it!"

In retrospect, I guess I should have asked Julian whether he could remember musicians being troubled by rheumatism or arthritis — or, at least, by complaints so described. RSI by any other name hurts just the same!

To this point I have deliberately kept my options open — but I haven't quite finished. The fact is that I had a personal reason for raising the matter in the first place.

My own experience

As a professional technical writer I, too, worked for decades in front of a typewriter, without any notable complications, apart from quite predictable fatigue. In retirement, however, I have effectively pensioned off the aging Adler and, nowadays, write virtually everything on a word processor.

As often happens in a domestic situation, the new equipment was shuffled around a good deal, until it finally ended up on a separate small table — appropriately tidy and set up ready for immediate use.

Some time later, I became aware of mild but niggling arm and shoulder pain which, on the wrong side of retirement, can give some cause for concern. But then I noticed that the pains became most apparent after some hours at the word processor. Why so, after years in front of a typewriter keyboard?

I was using the processor because it encouraged longer periods of concentration, with fewer distractions, resulting in much higher productivity. But, in so doing, it largely obviated the need for physical movement, other than to do with the keyboard.

Then I realised that, during those longer periods of concentration, my elbows were thrust quite heavily into the padded arms of the office style chair, with a significant amount of body weight literally hanging from my shoulders. No wonder the arm and shoulder muscles were protesting. It seemed very much a matter of posture.

A call to a doctor friend proved most enlightening. He is associated, by the way, with a large company which operates a great many keyboards.

"Do you recognise the symptoms?

"I certainly do. They're classical. Where do you have the processor?

"On an ordinary small table.

"It'll be too high. The keyboard should be down near your knees, not up near your chest! Cut a few inches off the legs!

"What about the arms on the chair?

"Put them right down, if you can, or take them right off!

"Anything else?

"Yes. Set the screen at a comfortable viewing height and make sure that it's not reflecting glare from windows or lights.

"Thanks for your observations. I think I might say something about this in the magazine.

"By all means do. Impress on your computer-nut readers the vital importance of posture and lighting when spending long periods at a keyboard. If they don't, they could run into aches and pains — no matter by what name you call them!"

Frankly, that sounds to me like good advice, particularly for private users, isolated from imposed work practice discipline.

By its very nature, a computer style keyboard encourages prolonged concentration, particularly in the role of a word processor. There is little need for incidental body movement: No need to reach for new sheets of paper or to arrange completed sheets as the job progresses. No need to search for a rubber or correction fluid, or to get up and walk away in disgust when something has to be re-typed or re-arranged.

You just tap a few extra keys and carry right on!

The combination of that kind of concentration with poor posture and/or poor lighting can cause exactly the kind of aches, pains and eyestrain that one would expect. Whether tenosynovitis or carpal tunnel syndrome lurks just around the corner is not quite so clear but at least we should take note of problems that are immediately obvious.

Distortion on strings

In February last, I raised the matter of the "edginess" or "zizz" that often characterises the sound of massed strings or massed voices. It is commonly blamed on the recording and replay equipment but I suggested that, if you listen carefully, it can often be discerned at a live performance.

Could it be that the sheer complexity of harmonics from multiple sound sources, all slightly and randomly off tune, is interpreted by the ear as noise and therefore as "distortion"?

Some may have regarded it as a rather "way out" suggestion and I was naturally most interested to receive a letter of support from a long-time friend, Harry Mauger (pronounced 'major'). Before his retirement, Harry was chief recording engineer for Astor Records in Melbourne and he speaks from a wealth of practical experience.

I suggest you read his letter on the preceding page and compare his observations with the original article in February.

"So next time you go to a concert, don't just sit there enjoying the music. Keep an ear out for the "distortion"!

SORRY, Mr KODAK!

The inadvertent omission of a few words from a paragraph in "Forum" (March '85, page 30) completely changed its sense, to the disadvantage of Kodachrome film. The actual printout from the Author's word processor reads as follows:

But, closer to home, when comparing notes with a photographer friend, I had a look at a collection of 35mm slides which I had either taken personally or bought during the EA-organised "Technitour" to Osaka for EXPO '70. My own Kodachrome slides were still in good shape but many of the bought slides had taken on hues ranging from a prevailing blue, through, reddish-purple to a faded all-over orange — in the latter case, a complete write-off.

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This sort of performance would be raved about by other manufacturers and their P.R. personnel as state of the art performance."

Louis Challis. "Electronics Today International". May 1985.

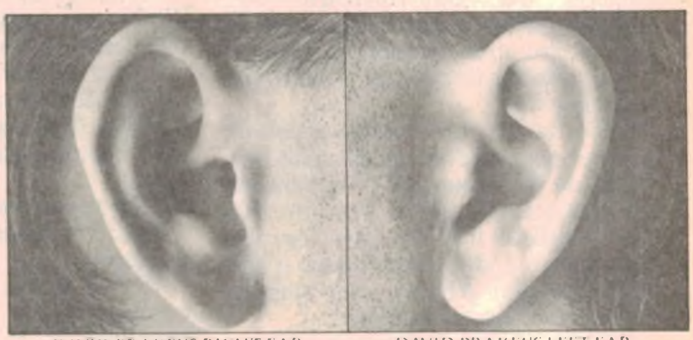
STAN CURTIS' RIGHT EAR. STAN CURTIS' LEFT EAR.

"By contrast, the Marantz player produced a sound which was smoother, not so forward or bright, and infinitely more musically convincing.

Many recordings played on the Marantz exhibited that very important characteristic of a good reproducing system – the sound didn't obviously emanate from two loudspeakers.

Obviously at this level we are not talking about a standard of reproduction that was poor, but of a difference in absolute performance which made the Marantz preferable."

Stan Curtis. "Hi-Fi for Pleasure."



DAVID PRAKEL'S RIGHT EAR. DAVID PRAKEL'S LEFT EAR.

"I have been surprised by the quite audible difference between CD players and have already stated a preference for the sound of the Marantz machine in terms of its handling of "ambience" and its sheer unfatiguing listenability.

Other players I've heard in direct comparisons have shown a bright veiling effect with more up-front presentation and a fatiguing quality.

...ars as good experts?

How much of this is down to the quality of the analogue audio circuitry in the players in question, and how much to the 14 versus 16 bit systems, I'd hate to guess."

David Prakel. "Hi-Fi Answers," U.K.

"Ironically, after all the opulent, lavish and wholly enjoyable CD launches of the past four years, it was in these very low key surroundings that I can truly say I first heard the potential of this system.

To my ears and those of our Technical Editor, Dave Berriman, it was the most convincing and encouraging demonstration to date. But why should little Marantz get it right where the others have failed? It certainly encouraged many who had come to despair of CD ever attaining the heights claimed for it."

David Prakel. "Practical Hi-Fi," U.K.

MARTIN COLLOMS' RIGHT EAR. MARTIN COLLOMS' LEFT EAR.

"Marantz U.K. managed to lend me a CD player for just a few hours.

To my ears and in my system the CD player provided a standard of home replay as good as I have ever used.

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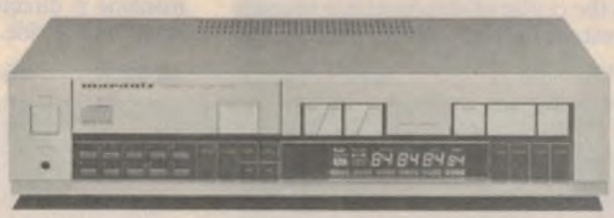
This is a very good sign, a feature familiar to me from my collection of copy master tapes. Moreover, in certain respects, the sample programme bettered my master tapes.

Judging from the advance sample, the Marantz CD has a very bright future."

Martin Colloms. "Hi-Fi for Pleasure," U.K.



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Mitsubishi DP-205 compact disc player

One of the less familiar names in the hifi market is Mitsubishi. They have been building fine audio equipment for many years and they have a compact disc player, the DP-205. This is a full-featured machine which has infrared remote control.

While Mitsubishi has been producing hifi equipment for quite a few years now, they have not had a high profile on the Australian market. Maybe this will change with the release of their compact disc player.

The Mitsubishi DP-205 is a fairly large machine for a CD player although it has a low profile. It has a conventional front-drawer disc loading system and is finished in the most popular hifi colour: black. Dimensions of the unit are 424mm wide, 300mm deep and 79mm high. Weight of the unit is 5.4kg.

The front panel presentaion of the DP-205 consists mostly of tinted perspex which has been screen-printed in white for the control legends. Happily, all the control labelling is easily readable, even in relatively dim lighting.

In the centre of the panel is a vacuum fluorescent display which indicates all the disc track, index and time information. The visibility of this display is good, both under dim and bright room lighting.

The DP-205 has an unusual array of pushbutton controls on the front panel which do not immediately strike a familiar chord with the user. But it also has an infrared (IR) control and it seems fairly clear that the makers intend the machine to be controlled with this rather than via the front panel buttons.

The IR control has the usual Play, Pause, Stop, Fast Forward and Reverse buttons, plus others for repeat, Open/Close, Display, Program, and forward and reverse skipping by track or index selection. The IR control has an effective range of between three and four metres, depending on whether the machine is directly in front of the user, or off to the side.

On the far righthand side of the front panel of the machine is the headphone socket and accompanying volume control. This is a natty little knob which is normally flush with the front panel and which, when slightly depressed, springs out by a centimetre or so, to allow the user to adjust it.

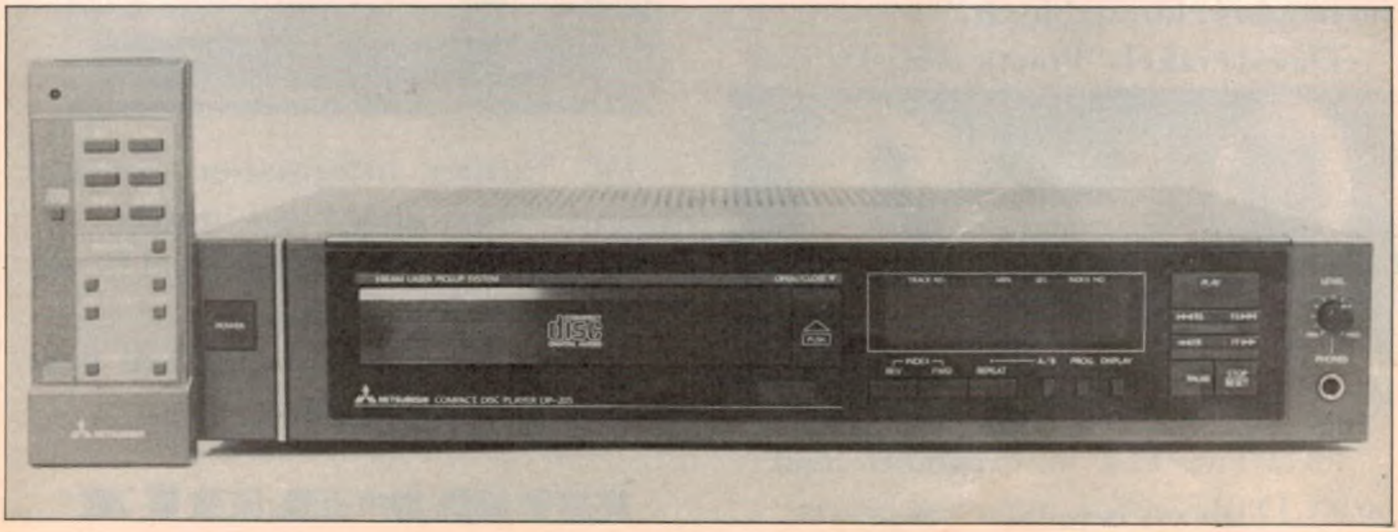
Removing the cover of the unit reveals a spacious chassis with a surprisingly large disc mechanism. The laser pickup is also a fairly large assembly which linearly traverses the underside of the disc.

On the righthand side of the chassis are two large printed circuit boards which are stacked face to face. Access to the lower board is gained simply by unlatching two nylon clips on the upper board and rotating it over to one side. Our photo shows the copper side of the top board so that the only components visible are two resistors tacked across some IC pins and a 60-pin surface-mounting integrated circuit.

Japanese products are appearing with more and more surface-mounting components these days. Beside the one just mentioned there is another mounted on the other printed board which has no less than 70 pins at about 0.7mm spacing.

In other respects the internal details of

The Mitsubishi DP-205 is supplied complete with an infrared remote control. The unit is large for a CD player.



the DP-205 are more or less standard and require little further comment.

The rear panel of the unit is bare except for a pair of gold-plated RCA sockets. The unit is double-insulated and is fitted with a sheathed two-core mains flex and standard Australian 2-pin mains plug.

As with most other compact disc machines, the Mitsubishi DP-205 has transport screws which must be removed before it can be put into use. Just why these are necessary is beyond this reviewer, as the act of screwing the transport suspension down removes any possibility of lessening the shock damage to the laser pickup.

When power is applied, the only sign that the unit is alive is the tiny "colon" indication on the fluorescent display. If it wasn't for this, the machine would look completely inert.

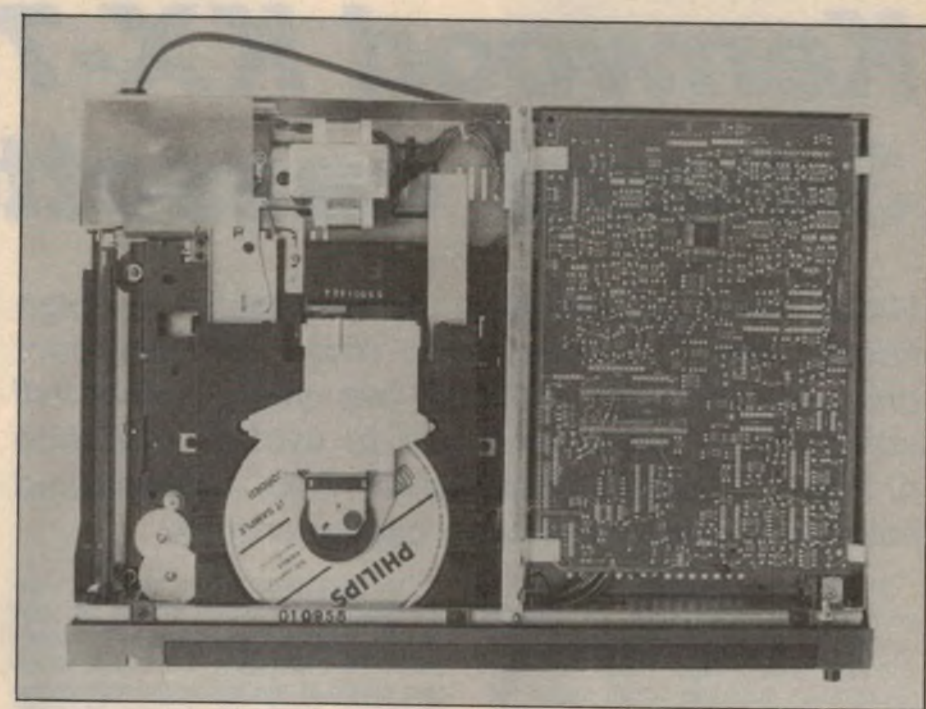
From there on, the machine is fairly standard in its operation although it is more convenient to use the remote control than the front panel buttons.

Loading a disc causes "Disc" to be displayed, plus the number of tracks and the total playing time. Pushing the Play button then causes the machine to start and to display the elapsed time. It is possible to program the unit to play the tracks in random order and to repeat musical phrases, complete tracks or the whole disc. Learning how to do all this is not easy, however, as the controls are not self-explanatory and the 8-page manual is not at all clear.

As with most Japanese machines, the DP-205 uses conventional 16-bit digital-to-analog conversion and sampling at 44.1kHz.

Performance

As usual, we put the Mitsubishi through the full battery of tests to assess its performance. Frequency response was very flat, being at 0dB from 20Hz all the way up to 15kHz. At 18kHz, it was 0.2dB down and 0.4dB down at 20kHz. The level discrepancy between channels, more usually expressed as "channel balance", was exactly 0.5dB over the whole range, with the right channel being the lower in level.



The DP-205 features two PCBs stacked face to face and a surprisingly large disc mechanism. Two surface mounting components are used in the design.

Separation between channels was good, at close to 90dB over the whole range of frequencies. When you compare the figures for separation between channels for CD players and other hifi equipment, it is astounding just how good they are.

Figures for harmonic distortion were also very good, at typically between .004 and .005%, rising to just over .01% at 20kHz. Intermodulation at 0dB for a 400Hz + 7kHz signal was .007%.

Results for the linearity tests were also good, showing an error of 1dB (only 0.5dB in the right channel) at the —80dB level and 4dB error at the —90dB level.

Signal to noise ratio figures were —97.5dB with emphasis and —94dB without emphasis. Both results are good.

Where the machine was not so good was in its tracking and error correction. On the Philips No 4A defect disc, the DP-205 would not track the 800μm dot (which simulates quite a large defect) and at other times on the same disc there was a regular "ticking" noise, indicating that the error correction was in the muting mode. And on our badly scratched sample disc, which is something of a torture test for CD players, there were some tracks the machine could not play at all.

As far as susceptibility to shock and vibration was concerned, the DP-205 was also not quite up to the standard we have come to expect from CD players in general. In normal circumstances though this should not be a big problem since it is not customary to jolt the player while it is working.

In all other respects, the Mitsubishi turns in a fine performance and should give many years of listener satisfaction. Naturally, it sounds superb.

Recommended retail price of the Mitsubishi DP-205 is $859.00, including the infrared remote control. For further information on the Mitsubishi range of products contact the Australian distributors, AWA-Thorn Consumer Products Pty Ltd, 348 Victoria Road, Rydalmere, NSW 2116 or interstate branches. (L.D.S.)

Specifications

Sampling frequency	44.1kHz
Digital-to-analog conv	16-bit linear
Frequency response	5 — 20,000Hz ±0.5dB
Dynamic range	Better than 94dB
Harmonic distortion	0.003% (at 1kHz, 0dB)
Channel separation	Better than 94dB (at 1kHz)
Wow and flutter	Below measurable limits
Line output level	2V (0dB, into 50kΩ load)
Headphone output level	22mW (0dB, into 8Ω load)
Power consumption	19W
Weight	5.4kg
Dimensions	424 x 79 x 300mm (W x H X D)

Kenwood KX-780 3-head cassette deck

While most of the new developments in high fidelity seem to have taken place with compact disc players over the last two years, other hifi components have continued to evolve. Evidence of this is the new Kenwood KX-780, a three-head microprocessor controlled cassette deck.

The first cassette decks to employ a microprocessor used them to provide optimum bias and equalisation for different types of tape. These were top-of-the-range machines which aimed for the very best of performance, more or less regardless of cost.

By contrast, this new medium range machine from Kenwood employs a microprocessor to control the mechanical functions of the deck, plus some of the fancy user features. In total, the microprocessor provides the electronic tape counter, transport control, line muting (depending on the mode of operation) and such features as re-record/standby, fast forward and reverse skip plus memory rewind and replay.

If all these features were to be provided using conventional circuitry and mechanics, the resulting machine would be a great deal more complex and more costly.

The microprocessor is not used to optimise bias. Kenwood have provided a manual bias control which, provided the user settles on just a few tape types, can give very good results.

One good point about having a user-adjustable bias control is that the bias can be optimised according to the user's particular preference. A criticism which was aimed at the earlier microprocessor machines mentioned above is that the machines seemed to be programmed to optimise bias at the expense of distortion. In other words, they have a good frequency response but quite high harmonic distortion, especially at the higher signal levels. The user had no option but to live with this compromise for there was no way of overriding the machine's internal program.

From our point of view then, the concept of a user-adjustable bias control is better than having the microprocessor do it.

The Kenwood KX-780 is quite an imposing machine to look at, both as far as its overall dimensions are concerned and its general style. It does not have a large array of user controls but those it has have been arranged and labelled so as to give it a "technical look". This is not meant as a criticism as such, as we quite liked the looks of the unit. At any rate it makes a change from the antiseptic styling of some European hifi equipment which seems to go too far in the opposite direction.

Overall dimensions of the KX-780 are 440mm wide, 111mm high and 322mm deep. Weight is 4.8kg.

Features

The KX-780's cassette compartment has a large, clear plastic door which is very gently released by the Eject button. This is accomplished by a minature version of a pneumatic door closer.

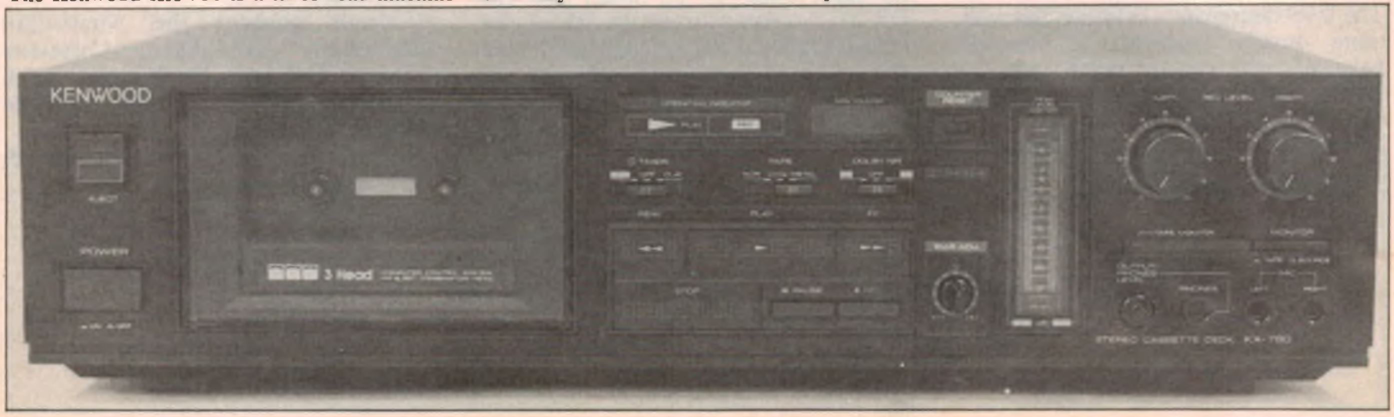
The unit has three heads and is compatible with all three tape types including metal tape.

In the centre of the front panel are the transport control buttons. They are not buttons actually, more like a "bent membrane". They have very little travel and operate as if they each have a microswitch behind them. Above these are three slide switches which select timer operation, tape type and noise reduction: Dolby B or C. To the right of these is the counter reset, and below it, the bias control knob. To the right again is the large vertical signal level meter panel which employs red LEDs.

At the far righthand side are the recording level controls, monitor switch, microphone sockets, headphone socket and combined headphone/line output level control.

The rear panel is bare except for the RCA input and output sockets and the two pin socket for the AC mains power input. The machine appears to be

The Kenwood KX-780 is a three-head machine with Dolby B and C noise reduction systems.



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- Dolby B & C noise reduction effects can be monitored whilst recording by the operator, via discrete circuitry.
- Microprocessor control facilities include a 100 count automatic REW or FF, play, rewind-play, re-record standby, counter zero stop and auto-recording mute zero signal 4 record spacer.
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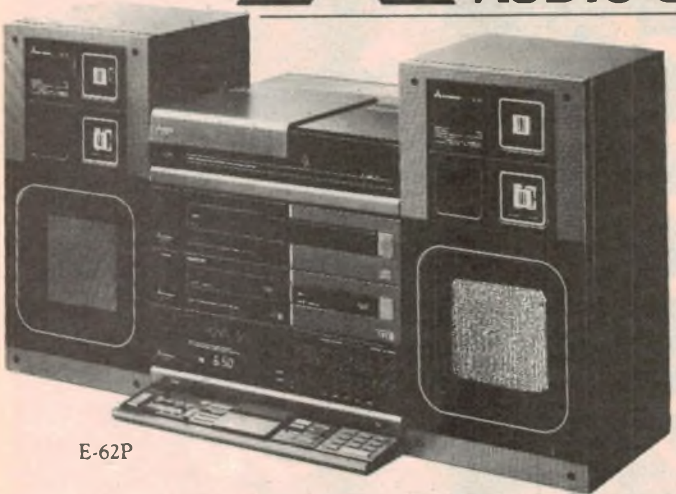

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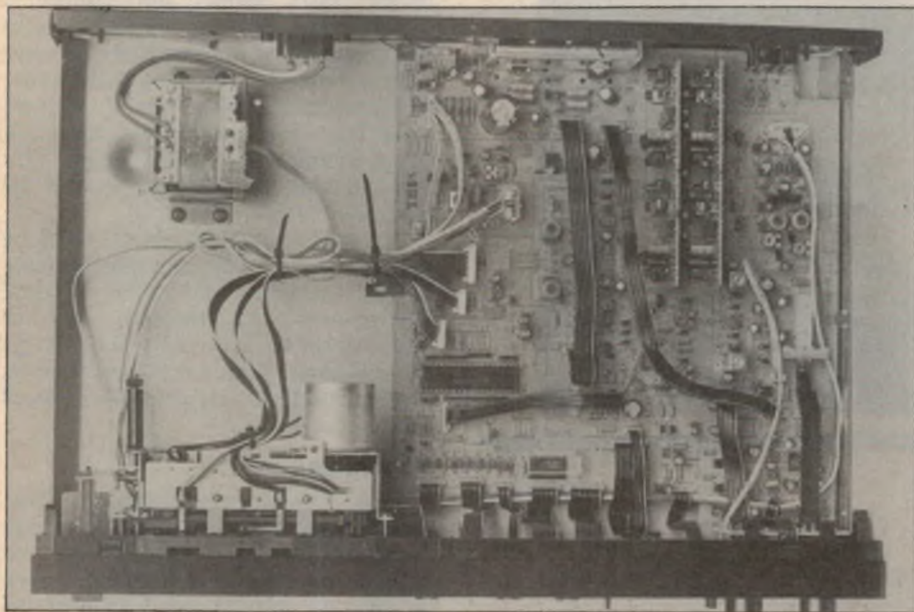

The large integrated circuit on the PC board is the microprocessor which provides many of the user functions.

double-insulated but lays no claim to being so.

Chassis features

The transport mechanism of the KX-780 is powered by a single motor, with two solenoids employed for changing the transport mode. The record and play heads are separate but occupy the volume of the normal record/play head in a conventional two-head machine. A single capstan is employed and it has a reasonably large flywheel.

More than half the chassis area is occupied by the main printed circuit board which carries the microprocessor control circuitry and the audio circuitry. The microprocessor is a 40-pin device with internal ROM (read only memory) and inbuilt oscillator.

Four Dolby processor ICs are used, for B and C noise reduction. There is also a largish vertical board, for the circuitry associated with front panel controls, the tape counter and the LED signal level meters.

Another point of interest is the relatively large number of ribbon cables employed in the unit. These are mostly soldered into place rather than using sockets. It appears the entire electronics component of the deck is manufactured as one large PC board and then sections are snapped off (with cables in place) to provide all the ancillary boards.

At the rear of the chassis, all on its ownsome, is the transformer which is fitted with a copper strap (for hum leakage). This transformer is energised while ever the unit is connected to the mains, and the power switch operates in the secondary winding. This is a common enough practice with synthesised FM/AM stereo tuners but is unusual in cassette decks. The reason for doing it in this machine is to enable a somewhat simpler power switch than is usual. In double-insulated equipment it is usual to have a well insulated push-on/push-off switch mounted toward the rear of the chassis, near the power transformer, and actuated by a long plastic rod. In the KX-780, this has been dispensed with in favour of a switch with lower ratings, mounted off the front panel.

Performance

Testing any cassette deck is not easy these days as there are three types of tape to contend with, ferric, chrome and metal, and on this deck there is the added complication of having two noise reduction systems to contend with. Add in bias adjustments and you have an almost infinite number of variables. To make some sense of this we decided to do the tests of the selected tape types with three different bias levels: minimum, normal (halfway setting) and maximum.

As might have been expected, the differences wrought by the changes in bias level were mainly apparent at frequencies above 15kHz with the major difference being the corner frequency, beyond which the response took a sudden plunge. Distortion figures were

continued on page 126

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PART 1

Rally Computer

Rallying is a popular motor sport in Australia. This easy-to-build Rally Computer features three separate distance counters, 10-metre resolution and a quartz clock. The clock and counters can be independently set to count up or down and an alarm sounds when any count reaches zero.

by JOHN CLARKE

Since publication of the EA Car Computer in July, August and September 1982, we have had many requests for a rally computer. As rally enthusiasts have discovered, commercial rally computers are quite expensive. This unit provides similar features to a well-known commercial unit, but can be built for a fraction of the cost.

Rally events are a gruelling test of driving and navigation abilities. Success relies heavily on teamwork and on having the right equipment. A suitably prepared vehicle is a good starting point but accurate navigation is also a vital ingredient.

By using this Rally Computer, the navigator can very effectively locate various points along the rally course. Three independent up/down counters provide the vital distance information with 10-metre resolution, while a 12-hour clock enables checkpoint times to be measured to the nearest second.

Alternatively, the clock can be used as a stopwatch or as a down counter which can start from any time up to 19 hours 59 minutes and 59 seconds.

All information is displayed on a bright 5-digit LED readout. Naturally, the computer will retain all data when switched off after the rally event so that important information can be recalled. This is also an important feature for overnight stops or if the car is temporarily disabled during the event.

All the above features are packed into a unit that's very easy to use. After all, what good is a rally computer that's too complicated to use when you're sideways in the dirt at 120km/h?

Presentation

The Rally Computer is built into two plastic cases which are connected together by a multiway cable. One case contains most of the electronic circuitry and is mounted out-of-sight, either under the dashboard or under one of the front seats. The second case is the control unit and is mounted on the dashboard. This unit contains the LED display and the control switches.

To measure the distance travelled by the vehicle, a magnet and coil assembly is used to monitor driveshaft rotation. Alternatively, the magnets may be mounted on an undriven wheel. In this way, distance measurement inaccuracies due to wheelspin and slides are reduced to a minimum.

Functions

Three Road functions and one Time function are available on the Rally Computer and are selected by the function switches located directly below the display. A LED above each of the ROAD 1, ROAD 2, ROAD 3 and TIME switches indicates which function is currently displayed.

All of the Road counters have 10-metre resolution on the final digit and will display up to 1999.99km before automatically returning to zero. As already mentioned, they operate independently of each other and can be set to count either up or down. Alternatively, a counter may be placed on Hold, in which case no further distance counting occurs.

This independent operation makes the unit extremely versatile. For example, one counter may be on hold while another counts up and the third counts down.

Similarly, the Time function can be set to count either up or down, or set to Hold. An alarm sounds when the count reaches zero for any of the Road or Time functions. All these features may seem complicated but you soon become familiar with them after a short period.

Controls

To the right of the display and function switches are the various control switches; DIMming, END, ENTER, CLeaR/1, HOLD, SET, –, + and CALibration.

Note that all the switches, with the exception of DIM, END and ENTER, are also marked with a number from 0 to 9. These are used in conjunction with the ENTER switch to program the function counters and CALibration memory.

When the ENTER switch is pressed, the accompanying LED lights to indicate that the other switches are now numeral switches. The display is then cleared ready for entering numbers into the function or CALibration memories. As each numeral switch is pressed, the number is entered on the display. After completion of the entry, the END key is pressed to store the entered number into the selected function. At the same time, all switches are returned to their normal functions.

The SET switch controls the HOLD, CLR/1, − and + switches. When pressed, the SET LED lights to indicate this mode of control. For example, let's say that we want to clear the contents of the ROAD 2 counter. The switch sequence is ROAD 2, SET, CLR/1. At the completion of the sequence, the display will show 0.00 and the SET LED will extinguish.

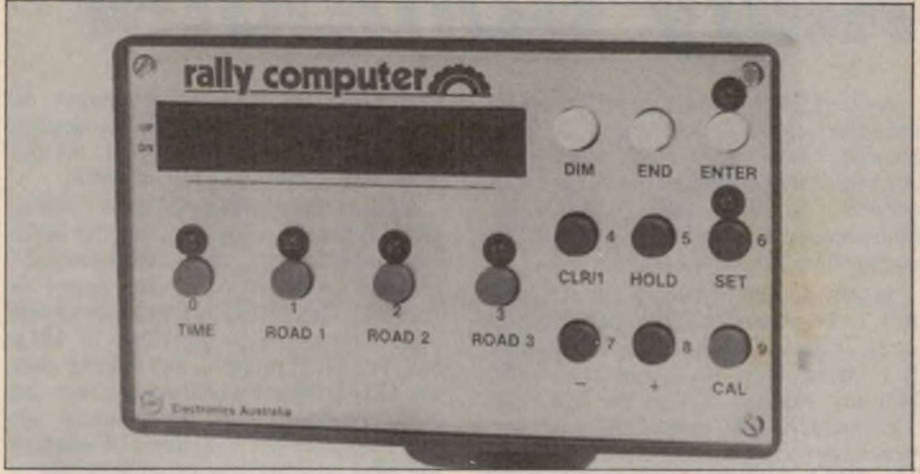
The CLR/1 switch can also be used to zero the ROAD 1 counter when the SET LED is off. This allows the rally navigator to quickly clear this counter without using the SET control switch. To further aid the navigator, CLR/1 also has a remote hand-held switch facility.

To alter the + (up), − (down) or HOLD status of a function, just press the SET switch and one of these switches. Once again the SET LED will extinguish when the alteration is completed. The left hand digit of the display will indicate a "+" for an up counting function, a "−" for a down counting function and a combined "+" and "−" for a HOLD.

The process of altering the function status by using the extra SET switch ensures that the functions are not altered inadvertently during the gruelling mental strain of rally navigation. You must use the SET switch before the status is altered. To escape from SET without altering the function status just press END.

The CALibration switch provides access to the distance calibration number. This number represents the distance travelled by the vehicle between each pulse from the distance sensor. We'll tell you more about this feature in the second article next month.

The final switch on the front panel is the DIMming switch. Its function is self-evident — it simply allows the user to switch between two levels of display brightness. The bright setting is suitable for daylight use and the dim setting is designed for night-time driving.



The control unit is designed for dashboard mounting and is easy to operate.

The circuit

A microprocessor takes care of most of the complex functions of the Rally Computer. This is basically an integrated circuit which can be programmed to manipulate data and control or respond to external hardware in the manner requested by the program.

In this case, the microprocessor controls the display and responds to the switch and distance sensor inputs. It also carries out the addition and subtraction functions and performs the various other duties as required.

Refer now to the circuit. IC1 is the microprocessor which is a Motorola 6802 8-bit CPU. It can perform all the instructions of the well-known 6800 microprocessor and contains 128 bytes of RAM which can be used for data storage when running a program. The first 32 bytes is separately powered, to enable important information to be retained when power to the remainder of the CPU is switched off.

A 3.58MHz crystal supplies a stable clock reference for the CPU and this is divided internally by four to give an 895kHz clock (or E) pulse on pin 37. Note that there is a trimmer capacitor on pin 39 of the crystal oscillator input to IC1. This allows the crystal oscillator frequency to be precisely adjusted for accurate time keeping on the Rally Computer clock.

IC2 is a Peripheral Interface Adaptor (PIA) and is used to control all the external hardware under the direction of the CPU. It comprises two 8-bit ports (PA0 to PA7 and PB0 to PB7) which can be programmed as inputs or outputs. Two extra control lines on each of these ports, CA1 and CA2 and CB1 and CB2 respectively, are also available. The CA1 and CB1 lines are inputs, while CA2 and CB2 can be programmed as either inputs or outputs.

PA0 to PA7 are used to drive the display segments via 7404 TTL inverters (IC9 and IC10) and 33Ω current limiting resistors. The inverters buffer the outputs of the PIA "A" port and provide the high current necessary for driving the display LEDs.

PB2 to PB7 are used to drive the display digit transistors (Q3 — Q8), while PB0 and PB1 scan the front panel switches. PB0 and PB1 are thus programmed as inputs while PB2 to PB7 are outputs. Inverters IC8a-f buffer the PB2-7 lines while the 390Ω resistors limit the transistor base currents.

The display consists of six common anode display digits. The most significant digit is actually an overflow digit and displays +, −, 1 and decimal point. The remainder of the displays are standard 7-segment types with decimal point. The separate LEDs which indicate the four functions, the SET and ENTER modes connect to unused segments on the display.

Note that the cathodes of each display are connected to the corresponding cathodes of the adjacent displays, while the display anodes connect to their respective digit driver transistors. This form of connection allows the display to be multiplex driven.

With multiplexing, only one digit is on at any given time. In this design, the PIA "A" lines drive the display cathodes while the PIA "B" lines switch the displays in sequence. Because the digits are switched at a 1kHz rate, the eye perceives a continuous flicker-free display.

The switches are scanned in matrix form via the multiplexed PIA "B" lines. If a switch is closed, a high will be read by either the PB0 or PB1 input. The program then decodes which switch has been pressed and acts accordingly by displaying the necessary function, modifying the function status or entering a number.

IC3 is a 2K byte Electrically Programmable Read Only Memory (EPROM) which holds the Rally Computer program. This is a non-volatile memory, which means that the memory will remain stored even with the power off.

Rally Computer

A common 8-bit data bus (D0 — D7) interconnects IC1, IC2 and IC3. This provides two way read and write communication between the devices. An address bus from A0 to A10 also interconnects IC1 and IC3 and is used to access the EPROM locations.

Simple address decoding for IC2 and IC3 is performed by the two NAND gates, IC6c and IC6d. IC3 is accessed by IC1 when both A14 and the Valid Memory Address (VMA) line are high. This switches the output of IC6d low which, in turn, forces G-bar of IC3 low. The VMA indicates a valid address on the bus. The EPROM locations are from hexadecimal memory address 6000 to 67FF.

All the registers of the PIA (IC2) are accessible by high/low combinations of RS0 and RS1 (pins 35 and 36), which are connected to A0 and A1 respectively. The Chip-select lines — CS0, CS1 and CS2-bar — are connected to G-bar of IC3, Vcc and the output of IC6c respectively. When A15 and the VMA go high, CS2-bar goes low and, provided IC3 is not selected with a high A14, IC2 is selected. IC2 is accessed using addresses from hexadecimal 8004 to 8007.

Interrupts

Three levels of programming are used in the Rally Computer. These are the RESET, Non Maskable Interrupt (NMI) and the Interrupt Request (IRQ). The initiation of these programs is determined by the voltage levels, or edge triggering in the case of NMI, on the respective pins of IC1 (40, 4 and 6).

Each of these programs has a priority level. When first switched on, the Rally Computer runs the "background" program initiated by the power-on RESET. This program continues to run until interrupted by NMI-bar or IRQ-bar. The NMI program has priority over the IRQ program which means that the NMI program runs immediately the NMI-bar goes low, regardless of whether the IRQ program was running or not.

The NMI program is used to control the display multiplexing and to update the data on the display. The multiplexing rate is set by Schmitt trigger oscillator IC5c, which is gated via NAND gate IC6b. As a result, the NMI-bar interrupt is disabled until CB2 of IC2 goes high. This occurs during the RESET program and after the PIA has been initialised.

The IRQ performs two functions and is interrupted when either a time pulse or distance pulse occurs. So that the processor can determine which of the two inputs actually caused the interrupt (after all the processor only has one IRQ-bar pin), it is necessary to send these signals via the PIA. The PIA sets flag bits within the registers which correspond to the input that caused the interrupt. The hardware outputs of IC2 — IRQA-bar and IRQB-bar — then interrupt the IRQ-bar of IC1.

Whenever negative edges occur at CA1 or CB1, IRQ-bar of IC1 goes low to serve the interrupt. The IRQ-bar line will then only go high after all the interrupt flags within the PIA registers are cleared.

The time interrupt is derived from division of the 895kHz E clock signal from IC1. IC6a inverts the E clock signal and applies it to the input of IC7 which is designed to divide a standard 3.58MHz crystal oscillator signal down to 60Hz. However, since the E clock is actually one quarter the crystal frequency, the output from IC7 is only 15Hz. This signal is connected to CA1 of the PIA.

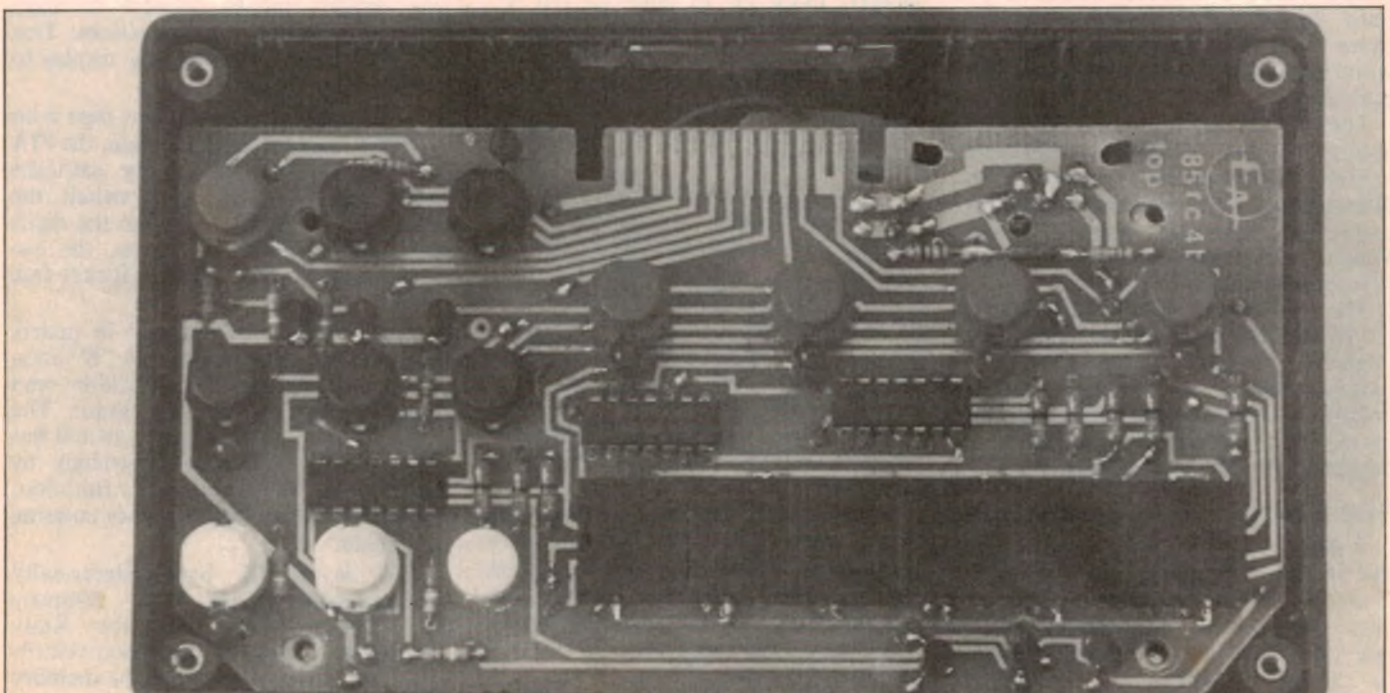
Whenever there is a time IRQ, the clock function program of the Rally Computer is accessed. This means that the clock alters by one second every fifteenth pulse.

The distance interrupt input is CB1 of the PIA. This collects its pulses from the distance sensor via IC5b and transistor Q2.

An induced voltage is developed in the distance sensor coil each time the rotating magnet assembly passes the coil. This signal is rectified by diode D4, filtered and amplified by Q2. Finally, the distance signal is squared up using Schmitt trigger inverter IC5b.

Each time there is a distance IRQ, the distance function of the Rally Computer is accessed. It checks whether the distance counter is to be incremented, decremented or left unchanged and acts accordingly.

Whenever one of the distance counters or the clock counts down to zero, the CA2 output of IC2 goes momentarily low and triggers a 555 timer, IC11. This timer provides a high



View inside the control unit showing how the LEDs and pushbutton switches are mounted (construction details next month).

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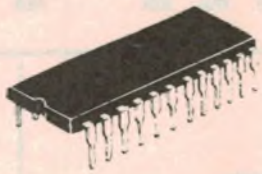

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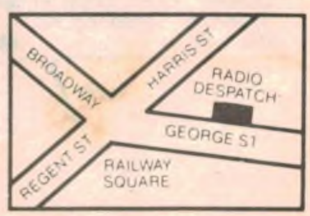
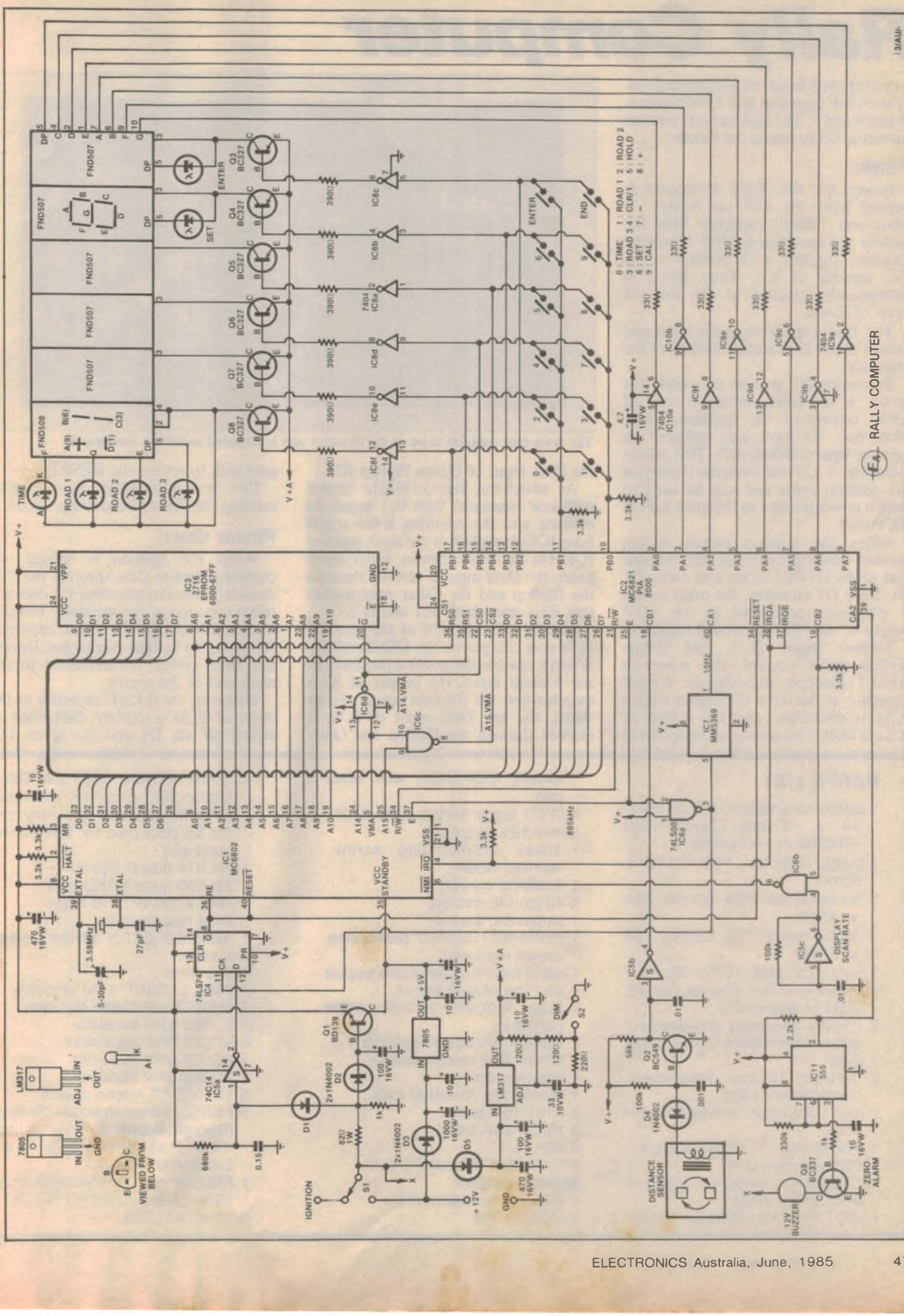



RALLY COMPUTER
0 : TIME
1 : ROAD 1
2 : ROAD 2
3 : ROAD 3
4 : CLR/1
5 : HOLD
6 : SET
7 : −
8 : +
9 : CAL
DISTANCE SENSOR
12V BUZZER
ZERO ALARM
DISPLAY SCAN RATE
IGNITION
VIEWED FROM BELOW

Rally Computer

output at pin 3 for about 3 seconds, as set by the 10μF capacitor and 330kΩ resistor at pins 6 and 7. The high output turns on transistor Q9 to sound the buzzer.

Power

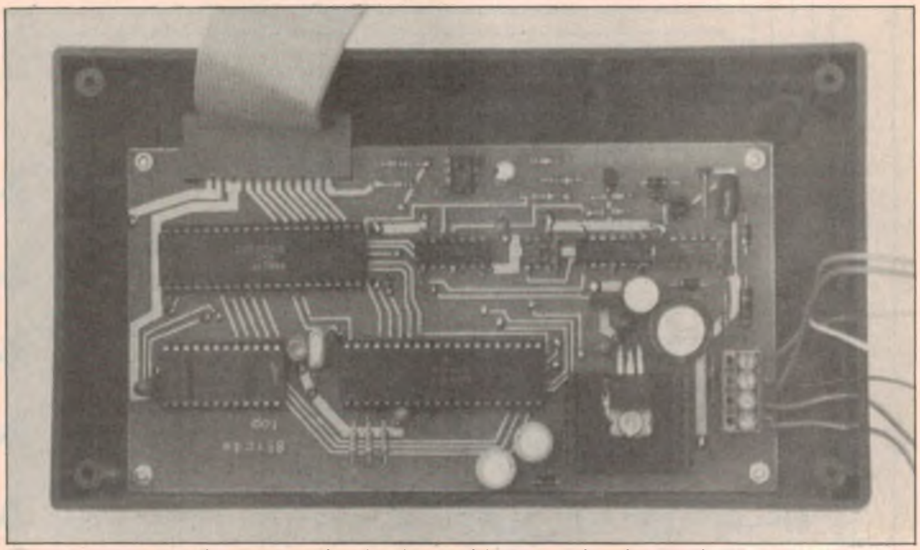
Power for the Rally Computer is derived from the 12V car battery. A diode and 1000μF capacitor filter the battery voltage while a 7805 3-terminal regulator supplies +5V directly to the Vcc standby of IC1. Thus, power is permanently supplied to the first 32 bytes of RAM.

The 10μF capacitors at the input and output of the 7805 ensure stability of the regulator.

Transistor Q1 is used to switch the power to the main circuit on and off under control of the ignition switch. Note that we have also included an ignition bypass switch (S1). This selects either the +12V rail from the battery or the ignition input and can be used to switch power directly to the main part of the circuit.

When the ignition switch is on, current flows through the 82Ω resistor and series 1N4002 diode and turns Q1 on. Since Q1 saturates, the main circuit is effectively connected to the +5V output of the 7805 3-terminal regulator.

Schmitt trigger IC5a and D-type flipflop IC5a control the power-on RESET function. Initially, the 0.15μF capacitor at the input of Schmitt trigger IC5a is discharged and the output of IC5a is high. This output is connected to the Data input of D-type flipflop IC4.



The main case contains most of the circuitry and is mounted under the dashboard.

At switch-on, the 3.58MHz crystal oscillator associated with IC1 begins to oscillate and the resulting E-bar signal from IC6a is applied to the clock input of IC4. On the first positive E-bar clock pulse, the Data input is clocked through the flipflop and the Q-bar output goes low. This resets both IC1 and IC2.

The 0.15μF capacitor at the input of IC5a now charges via the 680kΩ resistor. When it reaches the positive threshold of the Schmitt input, the output of IC5a switches low. On the next positive E-bar signal, the low Data input of IC4a is clocked through the flipflop and Q-bar goes high to release the RESET.

The microprocessor now begins running the Rally Computer program.

Power down

When the ignition is turned off, current ceases to flow through the 82Ω resistor. However, transistor Q1 does not cease conduction immediately. Instead, it remains on while the 100μF capacitor connected to its base discharges. During this time, power is maintained to the main part of the circuit.

However, the 0.15μF capacitor at the input of IC5a is rapidly discharged at switch off via D1 and the series 1kΩ

PARTS LIST

- 1 plastic console box, 161 × 96 × 39 × 57mm (Jaycar Cat HB-6203 or equivalent)
- 1 plastic utility box, 195 × 113 × 60mm
- 1 double sided PCB, 85rc4a, 164 × 87mm
- 1 double sided PCB, 85rc4b, 154 × 82mm
- 1 Scotchcal label, 157 × 92mm
- 1 distance sensor (Jaycar Cat XC 2034 or equivalent)
- 2 26-way insulation displacement edge connectors, Amphenol 225F
- 2 metres 26-way insulation displacement cable
- 1 mini U heatsink, Altronics Cat H 0502
- 1 Thermalloy TO-220 heatsink, 6038 or equivalent
- 12 Isostat key switches, 5 red, 5 black and 2 white
- 1 SPDT alternate action pushbutton switch, C&K 8161, with white cap
- 1 SPDT toggle switch, C&K 7101
- 1 mini 12V buzzer
- 1 4-way PC-mounting screw terminal block
- 1 3.58MHz crystal
- 2 40-pin DIL sockets
- 1 24-pin DIL socket
- 1 momentary contact pushbutton switch (optional)
- 1 panel mounting earphone socket and line plug (optional)
- 1 metre light duty twin flex cable (optional)
- 2 25mm 4BA tapped spacers
- 2 12mm 4BA tapped spacers
- 4 6mm spacers
- 4 15mm 4BA threaded rods
- 4 6mm 4BA bolts
- 4 12mm 4BA bolts
- 8 4BA nuts
- 2 6mm 6BA bolts and 2 nuts

Semiconductors

- 1 MC6802 microprocessor
- 1 MC6821 PIA
- 1 2716 EPROM with EA Rally Computer program (erased EPROMs can be programmed for $5 post paid by *Electronics Australia*)
- 1 74LS74 dual-D flipflop
- 1 74LS00 quad NAND gate
- 1 74C14 hex Schmitt trigger
- 3 7404 hex inverters
- 1 MM5369 EST/N divider, 60Hz version
- 1 555 timer
- 1 7805, LM340T +5V regulator
- 1 LM317T adjustable regulator
- 1 BD139 NPN transistor
- 6 BC327 PNP transistors
- 1 BC337 NPN transistor
- 1 BC549 NPN transistor
- 5 1N4002 1A silicon diodes
- 5 FND507 common anode displays (George Brown & Co Pty Ltd, 174 Parramatta Road, Camperdown 2050)
- 1 FND508 common anode display (George Brown & Co Pty Ltd)
- 6 3mm red LEDs

resistor to ground. This sets the output of IC5a high and thus Q-bar of IC4 goes low on the next positive E-bar clock pulse to again reset IC1.

This power down sequence ensures that memory in the first 32 bytes of RAM is not corrupted at this critical stage.

As well as controlling power to the main circuit, the ignition switch also switches power to the LM317 regulator which supplies the display driver transistors (Q3 — Q8).

A 1N4002 diode and 470μF capacitor filter the battery voltage to the input of the LM317, while the 100μF and 10μF capacitors at the input and output of the regulator ensure stability. The output voltage of the regulator is set by the 120Ω and 220Ω resistors connected between the output and adjust terminals and ground.

Since about 1.25V is applied between the OUT and ADJ terminals, around 10.5mA flows through the associated 120Ω resistor. This current also flows through the 120Ω and 220Ω resistors connected between ADJ and ground. With both these resistors in circuit, the ADJ terminal is jacked up by 3.4V above ground. This produces +4.65V at the output.

When the 220Ω resistor is shorted by the DIM switch, the output is about +2.5V. The DIM switch thus controls the voltage applied to the displays and consequently sets the display brightness.

That concludes the circuit description. Next month, we shall describe the construction and give the installation details.

Capacitors

1 1000μF/16VW PC electrolytic
2 470μF/16VW PC electrolytic
2 100μF/16VW PC electrolytic
1 33μF/16VW PC electrolytic
5 10μF/16VW PC electrolytic
1 4.7μF/16VW PC electrolytic
1 1μF/16VW PC electrolytic
1 0.15μF metallised polyester
2 .01μF metallised polyester
1 .001μF metallised polyester
1 27pF miniature ceramic
1 5.2-30pF D series Murata trimmer (green), Altronics Cat. R 4007

Resistors (¼W, 5%)

1 × 680kΩ, 1 × 330kΩ, 2 × 100kΩ, 1 × 56kΩ, 5 × 3.3kΩ, 1 × 2.2kΩ, 2 × 1kΩ, 6 × 390Ω, 1 × 220Ω, 2 × 120Ω, 1 × 82Ω 1W, 8 × 33Ω

Miscellaneous

Hook-up wire, solder, machine screws and nuts, washers, etc.

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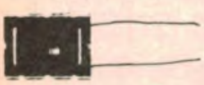

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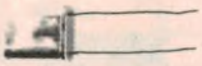

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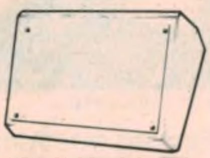

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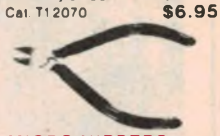

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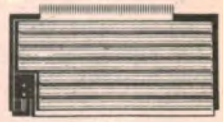

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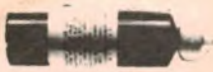

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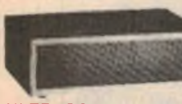

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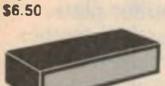

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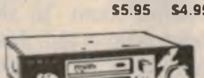

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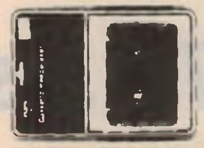

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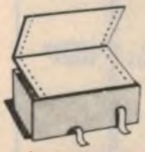

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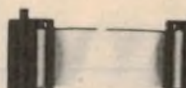

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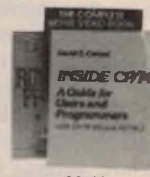

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The Serviceman

First aid for a motel TV system

One area of television in which day-to-day expertise appears to have lagged behind the available technology is that of antenna distribution systems as used in blocks of home units, motels, etc. The butchery approach by electricians attempting such installations is well known, but, even within the industry, where those concerned should know better, there appears to be a woeful amount of ignorance and a slap-happy approach.

These comments were prompted by a story from my colleague on the NSW south coast, involving the TV system in a local motel and the various problems which can occur in such a situation. For any reader likely to be similarly involved there are several lessons to be learned. This is the story as he told it to me.

The motel in this story is one of a large chain operated by the one company — a matter of some importance as far as administration is concerned — and, in its original form, had been built before there was any TV available in the area. As it stands today it consists of a central block, which is the original building, having 22 units, office, dining room, kitchen, manager's quarters, etc, laid out in a rectangular arrangement enclosing a courtyard or quadrangle.

About 50 metres from the central block, in different directions, are two additional blocks of 10 units each, referred to as the western block and the southern block. Both these blocks were added later, first one and then the other as business increased, and are connected to the central block by covered walkways.

A natural result of all these factors was that the TV distribution system had been installed after the central block had been built and whoever had done the job had run all the coax externally. I can't really blame him for this because it would have been a prohibitively expensive job to run it in the roof and wall in the conventional way. The roof is a low pitched style of corrugated fibro cement, and large sections of it would have had to be removed.

The two later blocks were a better proposition. The western block is well above ground level, providing easy access under the floor, while the southern block was apparently wired when it was built. This had been done with 300Ω ribbon for the early monochrome sets.

In fact, one of the first jobs I did for the motel, some 10 years ago when they first called me in, was to rewire this block with coax to accommodate colour sets. And that produced the first of many surprises. Apart from the need to change the cable there was the problem that there was little or no signal in several units, a condition which apparently had prevailed since the system was first installed.

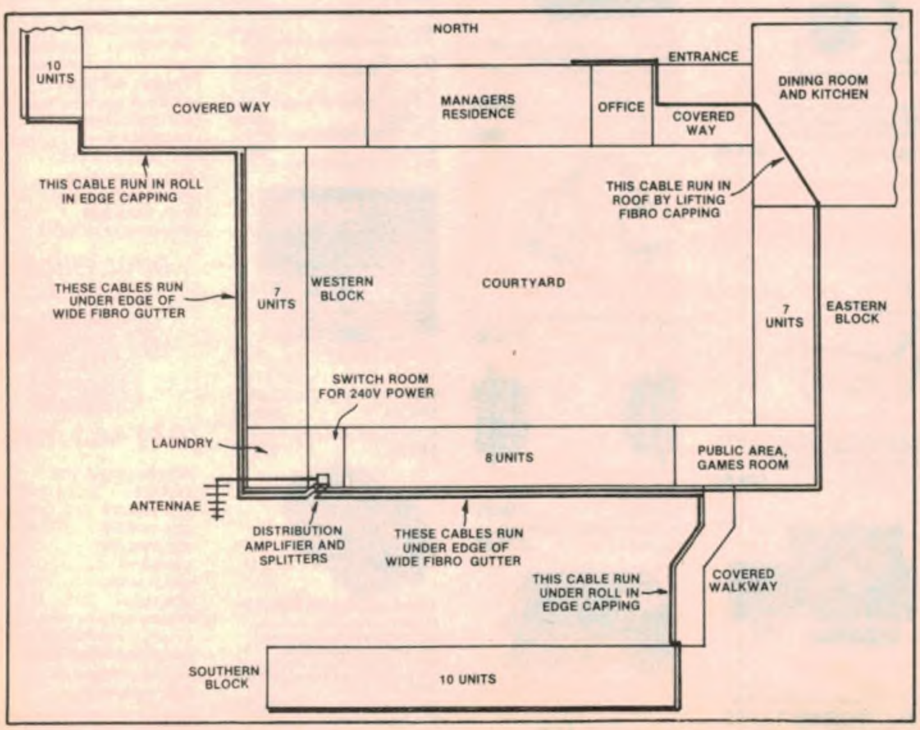
The reason wasn't hard to find. Removing the wall mounted outlet plates in the offending units revealed the simple fact that there was no ribbon behind them. In short, they had never been connected. Just why the contractor had done this, or why the management had allowed him to get away with it, is one of those mysteries lost in time.

In rewiring this block I was forced to run the cable along the front wall, just above path level, but below floor and entrance step level. It was then looped through the wall to each outlet plate.

As for the central block, the weather had taken its toll. Even at that time the outer covering of the coax was beginning to crack and break away, allowing moisture to enter and generally degrade performance. In one case, in order to cut down the length of cable with consequent losses, the coax had been run across the roof above the fibro.

But these weren't the only problems. Countless technicians, electricians, and do-it-yourself types had all had a go at the system over the years, with the result that it was now a real patch job. And, while I continued to do what I could to

Below: this diagram shows the path of the cable to each section of the motel.



keep the system working this was becoming more and more difficult and I kept advising those in charge that, sooner or later, the whole system would have to be overhauled and largely rewired.

But getting any action was difficult. The fact that it was only one unit in a large chain meant that decisions of this kind were outside the scope of the local manager, who could only make recommendations to head office. And, to make matters worse, the managers were changed from time to time. I would just get a manager on-side and convince him that the work needed to be done when he would be shifted somewhere else and I would have to start all over again with a new manager.

Ultimately, it was the system itself which forced the issue. It simply reached the stage where the performance was quite unacceptable and I was forced to adopt the attitude that it was just not possible to go on patching it any further. So the then manager was finally given the go-ahead to get a quote for a major re-wire job.

And so I set to work to assess what would be needed. In addition to the coax, the antenna system itself had also reached the end of its life, having succumbed to the salt atmosphere of the coastal district. The distribution amplifiers were also suspect. They had been mounted on the outside of the building, under the eaves, where they were exposed to the weather. Again, damp salt atmosphere had taken its toll.

A further complication involved the western block. At some time in its history some technician had decided to divorce this block from the rest of the system and provide it with its own antenna and distribution amplifier. This wasn't necessarily a bad concept, but the actual installation had fallen down on several points.

First, there is the matter of signal strength in this area. The only reliable signals are those on channels nine and 11 from translators near Moruya and, taking into account the strength of the translators, the distance involved, and the terrain, the level at the motel site is nothing spectacular. Adequate signals are available, but one has to search for them.

In this case the antenna the technician had chosen, and its position, had resulted in about 500μV of signal. In my experience, the minimum signal to aim for, whether for a single set, or to be fed to a distribution amplifier, is 1000μV (1mV) to ensure noise free pictures. Below this figure there is a serious risk of some noise which no amount of subsequent amplification will correct. On the contrary, the noise will be amplified along with the signal, and added to any noise generated in the amplifier.

But, even if this signal had been adequate, his subsequent treatment of it was not. He fed it into a small distribution amplifier having about 10dB gain; this to serve 10 sets. Now there is just no way that such a signal could do the job, as a few simple calculations would have revealed, had he bothered to make them.

Distribution systems

Which brings me to the point where it may help the reader if we look at the whole concept of distribution systems of this kind and the basis of their design and operation. The most basic requirement in any situation involving more than one set connected to one antenna — and of which most readers would be aware — is the need to isolate each set from its neighbours.

A major reason is the need to prevent any local oscillator re-radiation from any one set from interfering with any other set. It is also necessary to ensure that branch runs of cable are either (ideally) always terminated by a set or dummy load or, at least, adequately isolated from the rest of the system.

As many a do-it-yourselfer and electrician has discovered, an unterminated run of cable, connected to an existing antenna system, can play havoc with the signals. If the length of such a run should happen to equal an odd number of quarter wavelengths, at a particular channel frequency, it will act as a short circuit at that frequency, with disastrous results to the signal strength.

In practical terms there are two commonly used devices to provide the necessary isolation between sets; splitters and "T"s. Typical splitters split the signal equally either two ways or four ways, allowing this number of sets to operate from the one antenna. A two-way splitter will normally cause about 3.5dB loss in each outlet, at VHF, and a four-way unit about 7dB. They will provide between 25 and 30dB of isolation at VHF and slightly less at UHF.

They are intended mainly for domestic installations, or perhaps small showroom displays, and it goes without saying that the incoming signal must be strong enough to withstand the losses involved and still provide each set with an adequate signal. They can also be used in reverse as combiners; ie, to feed two antennas — VHF and UHV — to one set.

The "T" is a completely different device. As its name might imply, it is designed to provide a branch off a main run of cable, the main run being through the horizontal portion of the "T" and the branch via the vertical portion. Unlike the splitter, the losses via the two outlets

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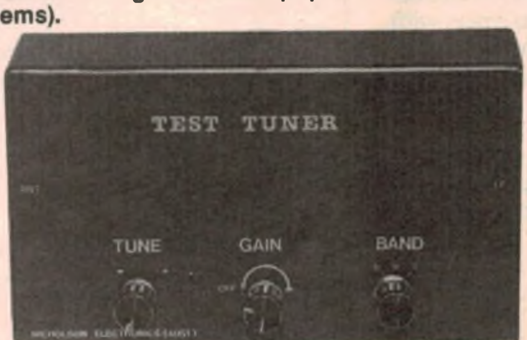

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are, quite deliberately, not equal. The "through loss" is kept as low as possible, while the "side loss", which is also the isolation figure, is kept as high as possible. Typical values would range from 0.2dB through loss for 30dB isolation, to 1.5dB for 12dB isolation.

As can be seen, the two losses are related; the higher the side loss, or isolation, the lower the through loss. Where a large number of "T"s are used in a long run it is customary to use high side loss units at the beginning of the run, to minimise the through losses and to avoid possible overload of the sets, and progressively lower side loss units towards the end of the run.

Fairly obviously the side losses have to be allowed for by providing a high level signal on the through run, taking into account the worst case situation at the end of the run where the combined through losses, plus cable losses, can be significant. Supplying the necessary signal level is the function of the distribution amplifier and its selection depends on the signal level into it from the antenna, and the calculated losses along the line to the last TV set.

So much for the potted theory. Harking back to the 500μV signal into the 10dB amplifier it is obvious that, with a minimum isolation figure of 20dB at the first "T", the signal to the set is going to be 10dB down on the antenna level, or about 160μV — a hopelessly inadequate level. The results were exactly as one would expect; tons of snow and frequent colour drop-out, particularly at the end of the line.

I suspect that this technician had fallen into a common trap which seems to have thrown a lot of technicians. The amplifier he used is described as a "high power" unit, a possibly confusing term but one which is intended to mean that they are capable of delivering a distortion-free high level output — as high as 1.5V in some models — suitable for driving very large systems with potentially high losses. This voltage output would be given in the specifications.

The confusion appears to arise because some technicians assume that the amplifier will deliver this level automatically whereas, of course, it will only do so if the input level is high enough. In the example given (10dB or three times voltage gain) the amplifier would need over 300mV input to deliver 1V out.

Such signal levels could be encountered in favourable city or suburban locations and such an output might be desirable for a very large installation; ie, several hundred outlets. Which is a far cry from the meagre 500μV available in this case. Looking at it another way, the person concerned appeared to be unable to differentiate between the unit's gain — perhaps because it is quoted in dB — and its maximum output level.

But this wasn't the only boo-boo this character had made. I subsequently retrieved this amplifier for use as part of the high gain amplifier system I had planned. In the process of pulling it out I removed the outlet plate in the first unit to make some checks and, while handling the connections, copped an almighty wallop.

A check with the meter revealed something like 120V of AC across the outlet, and a further check revealed that the three-pin plug on the amplifier power cord had been incorrectly wired. Don't ask me to go into detail; I was too shocked — in every sense of the word — to work out the exact mechanism by which I was able to measure 120V, a rather puzzling value in itself, across the outlet.

But it was one of those classic mixups of active, neutral and earth leads which so often prove fatal. Fairly obviously I was not in direct contact with the mains, but rather via some form of leakage path made possible by the wiring mixup. I simply reefed the wires out of the plug and re-wired it correctly.

The new system

This, then, was the set-up I encountered when I was given the go-ahead to rebuild the whole system, and I had to decide the best way to tackle it. I started out by assuming that I could get a 1mV signal using a suitable antenna in a practical location. This was a reasonable assumption, based on field strength measurements I had made during previous service calls, and was subsequently confirmed by more exact measurements.

Assuming this figure could be achieved, I made a few rough calculations and began to evolve a plan. The idea was to provide one distribution amplifier system having about 45dB gain — more about this in detail in a moment — and from this to split the signal into four legs, each leg supplying about one quarter of the total sets. More exactly, I planned to use two legs for the central block and one leg each for the western and southern blocks.

The actual amplifier system was to be made up from two amplifiers; a new 40dB unit and the 10dB unit originally used in the western block. The idea was to connect the two amplifiers in line, with a small attenuator, about 5dB, between them. Not only did I not really need the full extra 10dB, but I had to consider that the two amplifiers connected directly together might prove unstable or that the output of one might overload the other.

Output from the amplifier would then go to a two-way splitter, the outputs of which would then each go to two more two-way splitters, giving four outputs in all. (Yes, a single four-way splitter would have done the same job, but I had a small surplus of two-way units on hand.) Allowing a theoretical loss of 3.5dB for each splitter, the total loss to each leg would be at least 7dB. For safety I added a couple of dB to my calculations.

On this basis each line would be running at +36dB over 1mV at its beginning. From this must be subtracted cable losses and the runs to the western and southern blocks would each involve about 100m of cable to the first "T". Good quality cable has a loss of about 2dB per 30m, at 200MHz, so each of these runs would involve about 6dB loss. Thus we would have a 30dB signal at the first "T" and would have to select suitable "T" values to ensure adequate signal at the last set.

A good compromise seemed to be a mixture of 26dB isolation (0.3dB through loss) and 20dB isolation (0.5dB through loss) "T" units. In addition to the through losses there will be cable losses between each "T" and these could run to 0.5dB each, or a total loss of up to 1dB per "T". A typical arrangement would be to use 26dB isolation units for the first five "T"s and 20dB units for the remainder. This would provide a +4dB level at the first set, falling to +1dB at the last set.

Well that's the kind of rough estimate needed to determine if the whole concept is at least in the ball park. Some of the figures used are estimates, but have been slanted on the conservative side. In any case, published loss figures for components, cables, etc, should always be treated with some reserve, while even minor components, such as plugs and sockets, introduce some loss.

Practical requirements

So much for the theory. The first practical requirement was to find a better place to house the distribution amplifiers, splitters, etc, where they would be protected from the weather and reasonably close to the antenna. The switch room for distribution of 240V power seemed to be an ideal spot and prompted me to make my first field strength readings in this area.

Fortunately, luck seemed to smile on me. At a convenient corner of the building, close by the switch room, I was able to score a little over 1mV from a reasonably high gain antenna. So I went ahead and installed this part of the system; the antenna, distribution amplifiers, splitters, etc, and confirmed that I had the calculated signal on all four outlets. (For obvious reasons I planned to do as much work as possible before disturbing the existing system, and then to cut over in sections, as convenient.)

The next problem was how best to run the cables. The original wiring in the central block had been alongside the outside walls, about half a metre above ground level. While a convenient level as far as the outlets were concerned, I was looking for some way to run them that would not only conceal them, but also protect them from the weather and physical damage.

On the other hand, getting into the roof would prove far too expensive so I had to find some other solution. Again I had a lucky break. The gutters were of fibro cement supported on the facia board by metal hangers in the conventional way. However, at the back of the gutter the transition from vertical to horizontal was markedly rounded, while the metal hanger was a sharp angle.

The result was a large gap between the gutter and the bracket; quite large enough to take at least two cables. Granted, the job of feeding the cables through each hanger was a trifle tedious, but it made a first class job and was well worth the effort. I left a loop of cable at each intended "T" point, large enough to go under the facia board and permit mounting the "T" on the back of the facia, high up where it would be well protected from the weather.

But that was only part of the cable story. While the gutters solved the problem around the main block, I still had to get the cables to the southern and western blocks. The covered walkways provided the obvious path but, again, I was anxious to conceal and protect it as much as possible.

The walkway roofs were flat and of corrugated iron running lengthways. Both walkways had a slight natural slope and drainage was into an end gutter and, in one case, into a central box as well. The roofs were finished along each edge with rolled edge capping and I found it was fairly easy to remove the nails from the lower edge of this capping and then slip the cable up into the rolled section. It thus served as a very effective protective conduit and, although the job was a little tedious, the end result was well worthwhile.

Using these techniques I first ran two cables from the switch room along the southern side of the building to the corner, then along the western side. One of these was to serve the seven units on the western side, while the other was continued along the covered walkway to the western block, down the wall of this block under a convenient cover strip, and along the underside to serve the 10 units.

Then I ran two more cables along the southern side of the main block, in the opposite direction. One of these was then taken along the covered walkway, to serve the 10 units in the southern block. The other run was destined to serve the eight units on the southern side of the main block, the games room, seven units on the eastern side, the dining room, the office, and the manager's residence.

This was a long run, and certainly the most complex. It was plain sailing as far as the dining room but then, to get to the office and residence, it was necessary to go around the dining room, which would add some 60 metres to the cable path, or take a short cut across the roof.

This latter arrangement was what had been done before and there was a very strong temptation to do it again, provided I could find a way to get most of the cable out of the weather. In fact, I found a way. The manner in which the building had been constructed, at various stages, meant that the dining room roof had a valley in it between the end of the units and the beginning of the covered way to the office.

I was able to run the cable in the valley, then tuck it under the fibro sheets where they overhung the valley. This brought me to the pitched roof running the length of the northern side and the solution here was to remove the fibro ridge capping and lay the cable on top of the ridge pole. It was a tricky job in one sense because the fibro was old and brittle but, by carefully undoing the screws and exercising reasonable care, the whole job was completed without breaking one piece of fibro.

This brought me to the office and manager's residence and completed the main cable runs. At this stage I decided to concentrate on the western block which had been running on its own antenna, although it had been restricted to a few units ever since I had removed the amplifier. Fortunately, this was during a slack period.

Because the cable was to run under the floor, with only short runs up to the outlet plates, I elected to use what are called loop plates. These are actually a "T" network built on to an outlet plate and the cable is looped into the plate, hence the name. This means using more cable and, if running down from a ceiling, may be unacceptable if losses must be kept to a minimum. In this case the extra length was negligible.

That much done I fired the system up and checked the field strength at each outlet. Everything worked out at least as well as I had expected with well over a millivolt of signal at all outlets. So that was one block up and running.

Next in line was the southern block. As I mentioned at the beginning this had already been re-wired some years ago and, apart from some tidying up, mainly involving worn or damaged outlet plates, was ready to go. And, once again, I finished up with well over 1mV of signal at all outlets. So that was two sections on line.

So now I was ready to tackle the central block, in many ways the biggest part of the exercise. But at this point the manager intervened. It appeared that he had just been advised by head office that the whole of the block was to be given a major refurbish; new electrical fittings, and wiring where necessary, new bathroom fittings, plumbing, etc, painting, new furniture — in short, a major overhaul from the shell up.

In the circumstances, the manager felt that it would be pointless for me to wire cable into the units with the risk that, at best, it might be damaged or, at worst, ripped out. All of which seemed perfectly logical and I was happy enough to suspend operations. According to the manager, it was anticipated that it would take about six months, by the time everything was organised and the work completed.

So it was agreed that he would contact me when the job was done.

Well, that's my friend's story so far. I'm afraid we will have to leave it there for this month, due to space limitations. (The Editor gets awful twitchy if my copy runs over its allotted length.) I'll continue the story, and in many ways the best part of it, next month.

TETIA Fault of the Month

National TC2631

Symptoms: North-south barrel distortion. East-west correction works perfectly but set has no adjustments for N-S correction.

Cause: Fault is caused by drift in pincushion correction circuit values. Adjust by reducing value of R456 (560 ohm 1 watt). This circuit is almost the same as the Korting 5507 which has an adjuster at this location.

This information is supplied by courtesy of the Tasmanian branch of The Electronic Technicians' Institute of Australia. Contributions should be sent to J. Lawler, 16 Adina St, Geilston Bay, 7015.

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SPECIFICATIONS:
• **Input** Mic 1—0.5mV 600 Ohms Mic 2—0.5mV 600 Ohms Mic 2—0.5mV 600 Ohms (low imp.) 2.5mV 10K Ohms (low imp.) Phono 1 & 2 (Mag) 3mV 50K Ohms Phone 1 & 2 (Cry) 150mV 100K Ohms Tape/Tuner 1 & 2 150mV 100K Ohms • **Equaliser** 5 frequency bands—60Hz, 250Hz, 1KHz, 4KHz, 12KHz—Boost Cut range-plus or minus 12db @ Centre frequency. • **Output** 1.5V/0.775V (Selectable) • **Frequency Response** 20Hz to 20KHz plus or minus 1db • **Distortion** Less than 0.05% • **S/N Ratio** More than 50db

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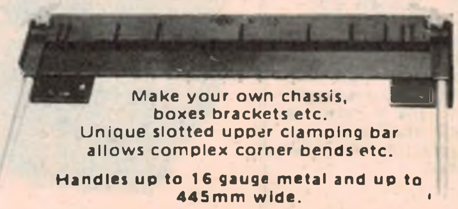

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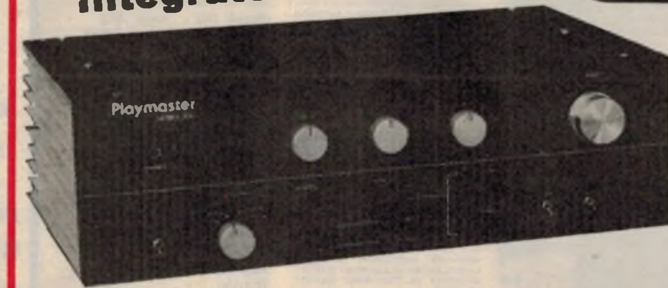

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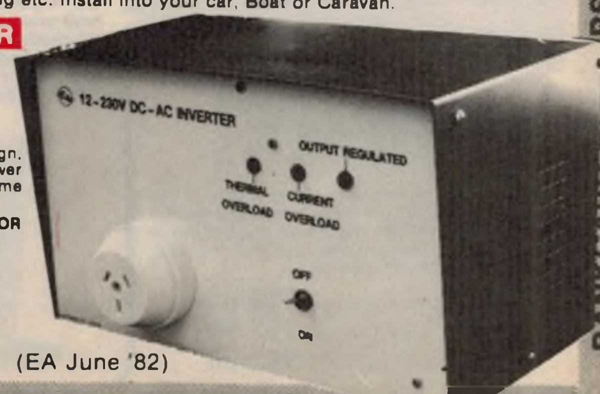

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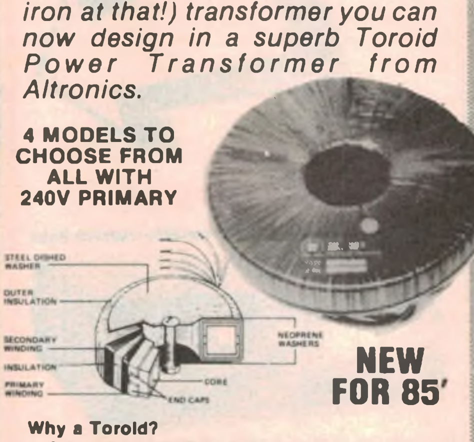

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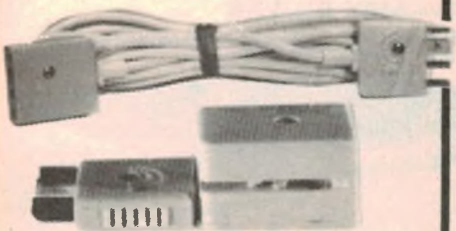

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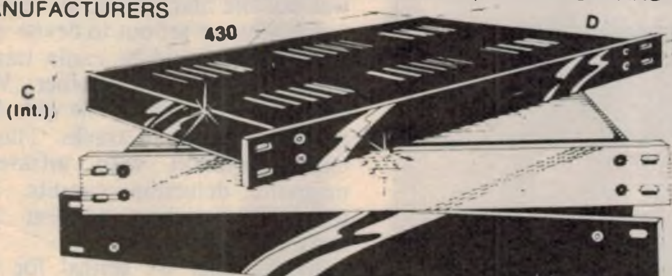

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Timer/lap counter for slot cars

Slot car enthusiasts know that electronic timing equipment adds considerably to the atmosphere of a "meet". With commercial timing gear expensive and scarce, we decided that there was a definite need for a "do-it-yourself" project. So here it is — the EA Slot Car Timer and Lap Counter.

by COLIN DAWSON

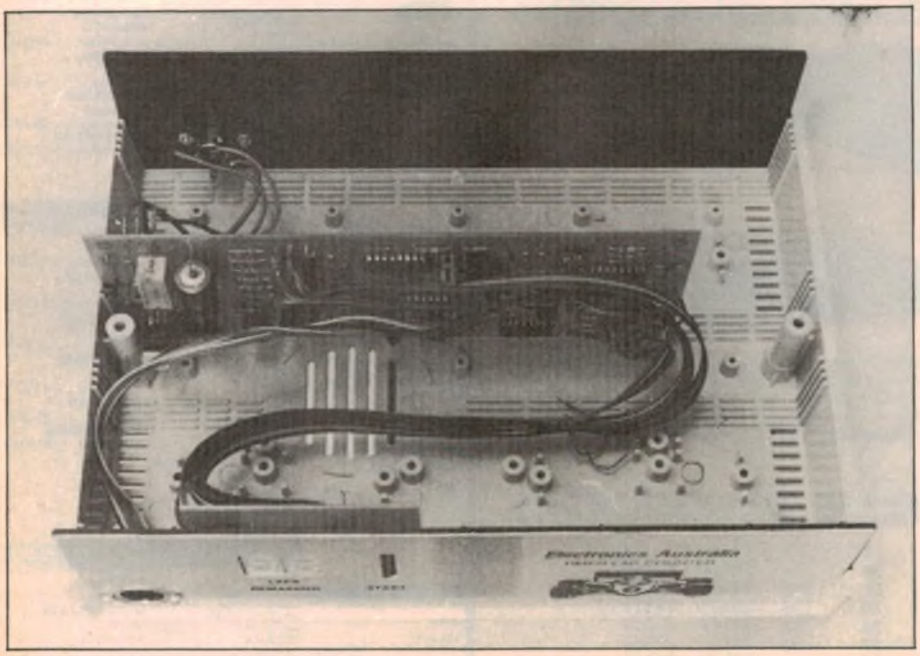
The completed project has every desirable feature: drag race style "Christmas tree" starting lights, a presettable lap counter (it counts down from the preset to zero) and, of course, an electronic stopwatch with .01s accuracy.

The Christmas tree lights consist of six LEDs in a column. When a start is initiated, the lights count down from the top with one LED at a time illuminated. When the bottom LED is illuminated, the competitor is free to start and the stopwatch begins timing. Should the competitor jump the start, the LEDs will stop counting down. A new start can only be initiated by resetting the circuit.

As with most forms of racing, the stopwatch is started simultaneously with the start signal, not when the competitor actually starts. Obviously, fast reflexes in starting are an advantage.

Each time the car crosses the start/finish line, the stopwatch display is frozen for about half of a second so that the progressive time can be read. When timing resumes, the total time including the 0.5s delay is included. The timer stops when the lap count is "00".

This view inside the prototype shows an early version of the PCB.



The lap counter can be preset to any number from one to 99. After resetting, the preset number is indicated. This decrements every time the car completes a lap.

To keep costs within reasonable bounds and simplify the construction, we have adapted a hand-held electronic stopwatch to take care of the timing. This can be used as a control unit and is linked to the main circuit by a 7-way rainbow cable. Resetting, as well as manual start/stop, can be performed by the stopwatch. In this case, only the start LEDs and lap counter display would need to be mounted in view of the competitors.

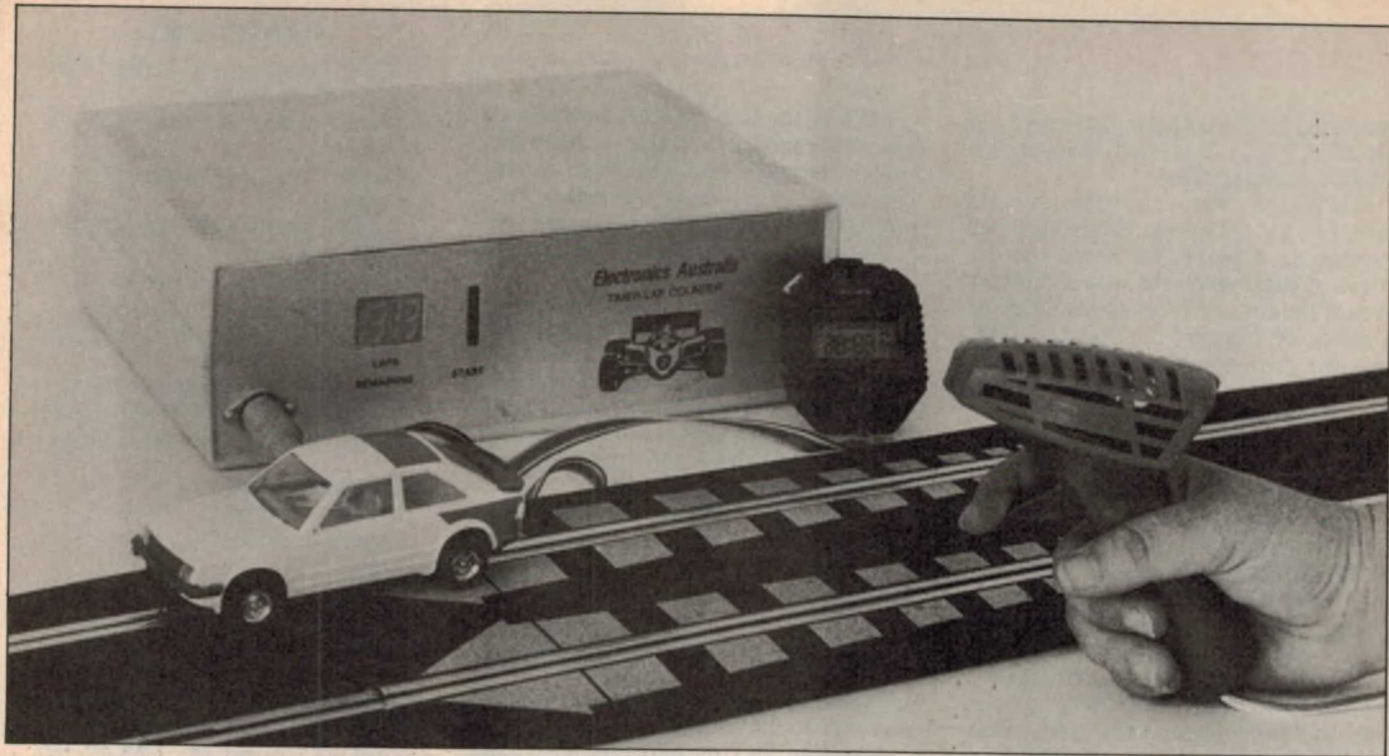
The basic circuit described here can monitor one track but, by duplicating the circuit, another track can be monitored. Only a single connection between boards need be made to synchronise them.

By far the most time consuming part of the design was the detection circuity, although this would not be immediately apparent from the circuit diagram. The pick-up, after all, is a simple track mounted contact. Unfortunately, this was not the first scheme we tried.

Initially, we set out to devise a pickup system that could be easily transferred from one track to another. We also wanted it to be compatible with different makes and sizes of tracks. This led to experimentation with infrared and magnetic detection circuits. Unfortunately, neither system proved sufficiently reliable.

In the end, we settled for a semi-mechanical detection system. The input circuitry relies on the brushes of the car shorting a wire contact to the positive rail of the track. For our prototype, only about 3mm of the wire is exposed. This protrudes through the joint between track segments and is isolated from the positive rail with insulation tape.

To date, this scheme has proven to be completely reliable. In view of its simplicity and ease of installation, we don't think the lack of portability is a serious limitation.



The unit features starting lights, a presettable lap counter and a modified stopwatch for timing.

From the electrical point of view, it would have been preferable to mount the contact on the negative rail of the track. This rail is permanently connected to the power supply, whereas the positive rail is intermittently disconnected through the hand controller. However, the construction of the track we used (Scalextric) was more suited to positive rail mounting of the contact.

Circuit description

It is essential to consider the circuit in terms of its various "blocks" to make any headway with the description. It will quickly become apparent, however, that the connections between blocks are manifold and devious!

Detection is performed by Q1, a BC337 NPN transistor. In addition to providing greater immunity to voltage spikes than an IC detector, the transistor can also be triggered from a lower voltage. This ensures reliable detection. Even if the car coasts across the finish line, the motor will generate sufficient voltage for triggering. In fact, pushing the car over the finish line by hand will trigger the detection circuitry.

IC1b and IC1c operate as a latch, with the latch condition maintained by D5. When Q1 turns on, the output of IC1c latches high and will remain so until reset by D2.

The start lights are controlled by IC2, a 4017 decade counter. When the Reset switch is pressed, IC2 returns to its "0" count (ie, pin 3 high). This turns on the first LED. When the Reset switch is released, IC2 begins counting "down" with each of the outputs from 1 to 5 going high in turn.

Clock signals for IC2 are generated by Schmitt trigger oscillator IC1d, which has a frequency of about 2Hz.

In order for IC2 to continue counting, its clock enable pin (13) must be low. There are two conditions which can defeat this condition: the "5" output of IC2 can go high, taking pin 13 high by means of D7; or the start pulse can be latched, taking pin 13 high by means of D6. In the latter case, IC2 will stop counting before the last LED has been illuminated. This corresponds to an illegal start.

Diodes D3 and D4 form an AND gate. When both pin 1 of IC2 and pin 2 of IC1a are high, the AND gate output is high. This corresponds to a car crossing the pickup after the count down sequence is completed. Since the car will be moving when it crosses the pick up, a brief pulse will be generated at the output of the AND gate.

View showing the stopwatch with the modified Reset switch and race in progress LED.

The pulses generated at the AND gate are used for both the lap count and stopwatch functions. Consider first the lap count circuit — its operation is rather more straightforward.

The lap count display has two digits, each driven by a 4511 decoder/driver IC. IC6 drives the least significant digit and IC8 the most significant. Each of these ICs has a 4-bit binary coded decimal input which is decoded and used to drive the respective displays.

The input code is generated by two 4029 presettable counter ICs. In this case, the preset number is the number of laps to be raced. This is set by two small screwdriver adjustable binary coded decimal switches. These two switches can either be mounted on the PCB and left at some setting or mounted on the front panel so that they can be easily adjusted. When the preset enable pin (1) is taken high, the output code is the same as the preset input code. This number is latched so that it continues to be displayed after the preset enable goes low.

Clock pulses are fed into the clock input (pin 15) of IC7 which drives IC6 and the least significant digit. Because the 4029s have been configured to count down in this circuit (pin 10 tied low), IC7 decrements each time a pulse is

Timer/lap counter

generated by the detector. The carry-out pin of IC7 (pin 7) is used to clock IC9 (most significant digit).

Normally, the counters would continue to decrement after they had reached 0. Clearly, we want the lap count to cease when the race is finished, even if the car continues to circulate. As a means of stopping the count at "00", the two carry-out pins of the counters are ANDed and used to enable clocking via the enable pin.

The carry out pins are normally high, going low only when the minimum count (for decrement mode) has been reached. The carry out pins of IC7 and IC9 are fed to a common point through D17 and D18 respectively. This point goes low only when the "00" count is reached and is fed back to the clock input of IC7 (pin 15) through D15.

Since the clock signals are fed to IC7 via a 100kΩ resistor, the ANDed carry outs can easily prevent any clock pulses from registering at pin 15 once both carry outs go low.

The clock pulses for IC7 are not taken directly from the input AND. Instead, the input pulses are processed in IC5 before being supplied to the rest of the circuit. The stopwatch part of the circuit will need to be considered in conjunction with IC5.

The stopwatch

The actual stopwatch used in our prototype came from Dick Smith Electronics, but it appears to be very similar to other types. It has three button switches — the middle switch selects the mode, the right hand switch is Stop/Start for the stopwatch mode, and the left hand switch is Reset for the stopwatch. These buttons also perform other tasks which are irrelevant to this circuit (eg, time and calendar setting).

Pressing the Reset button before the timer has been stopped gives a lap time. This causes the display to freeze. When it resumes the correct elapsed time is indicated. To operate the stopwatch as required by this circuit, the sequence must be: Start, Reset, another Reset 0.5s later (the display freeze time), Stop, and then finally the Reset to 0 pulse. All of these pulses must originate from the track mounted detector.

The stopwatch is connected to the main circuit via a 7-way rainbow cable. This permits the Stop and Reset to be controlled externally. Since the stopwatch has only a single battery as its power supply, the +12V rail of the main circuit can not be used for the control pulses. To overcome this problem a 4016 quad bilateral switch (IC4) is included in the circuit.

Each of the four switches function as low power solid state relays — when the control terminal is taken high, a low resistance path exists between two input/output terminals. There are no polarity requirements for the input/output signal.

In this circuit, 12V control signals are used to control the 1.5V switch voltage of the stopwatch. The Stop button of the stopwatch can be left in place — there is no problem if it is wired in parallel with IC4c. In fact, this will allow starting and stopping of the stopwatch to be performed manually if desired.

The Reset switch of the stopwatch must, however, be rewired. It is essential that both the main circuit and the stopwatch receive reset pulses at the same time. The simplest method of achieving this is to fit a new switch and run two wires to the main circuit. When the main circuit is reset, a reset pulse is also sent to the stopwatch via IC4d.

Note that the control pin for IC4d (pin 5) is connected via a 10kΩ resistor to diodes D10 and 11. These two diodes form an OR gate for the "1" and "8" outputs of IC5 (a 4017 decade counter). The 10kΩ resistor ensures that the OR output can easily be defeated by other control functions.

IC5 is reset each time a pulse is delivered from the track pickup. After each reset, it cycles through to the "9" count and, because the "9" output (pin 11) is connected to the clock enable (pin 13), waits until another reset pulse is delivered. While cycling, both the "1" and "8" outputs (pins 2 and 9) will momentarily go high, providing two pulses at the OR gate output.

The duration of each pulse is one clock cycle. In this case the clock (IC1f) operates at about 12Hz. The two OR pulses are separated by seven clock pulses which is about 0.5s.

The "9" output of IC5 (pin 11) is also connected to the reset pin (15) via D12. At the end of the cycle, the "9" output will be high and D12 reverse biased. In this state, a reset pulse fed to pin 15 will reset IC5.

As soon as the reset is effective, the "9" output goes low. D12 is now forward biased and pulls pin 15 low, thus preventing any further reset pulses from resetting IC5. This prevents multiple counting due to contact bounce at the pickup — only the first pulse registers. Any other pulses occurring before IC5 finishes counting (just over 0.5s) will be ignored.

The clock signal for the lap counting circuit is taken from the "1" output of IC5. This is connected via a 100kΩ resistor to the clock input (pin 15) of IC7.

PARTS LIST

- 1 LCD stopwatch (DSE Cat. Y-1041 or similar)
- 1 PCB, code 85ms6a, 205 × 75mm
- 1 PCB, code 85ms6b, 70 × 75mm
- 1 plastic instrument case, 260 × 190 × 80mm
- 1 7-pin DIN plug and socket
- 1 3-pin DIN plug and socket
- 1 SPST momentary contact pushbutton switch
- 2 rotary BCD decade switches
- 3 metres of 8-way rainbow cable
- 1 metre of 2-core shielded cable

Semiconductors

- 16 1N914 diodes
- 1 1N4001 diode
- 6 red LEDs
- 1 green LED
- 7 BC337 NPN transistors
- 1 7812 12V regulator
- 2 7-segment common cathode displays (Stanley NKR163, Fairchild FND500 etc)
- 1 74C14 or 40106 CMOS hex Schmitt inverter
- 2 4017 decade counters
- 1 4093 Schmitt input quad NAND gate
- 1 4016 quad bilateral switch
- 2 4029 presettable up/down counters
- 2 4511 BCD to 7-segment decoder/drivers

Capacitors

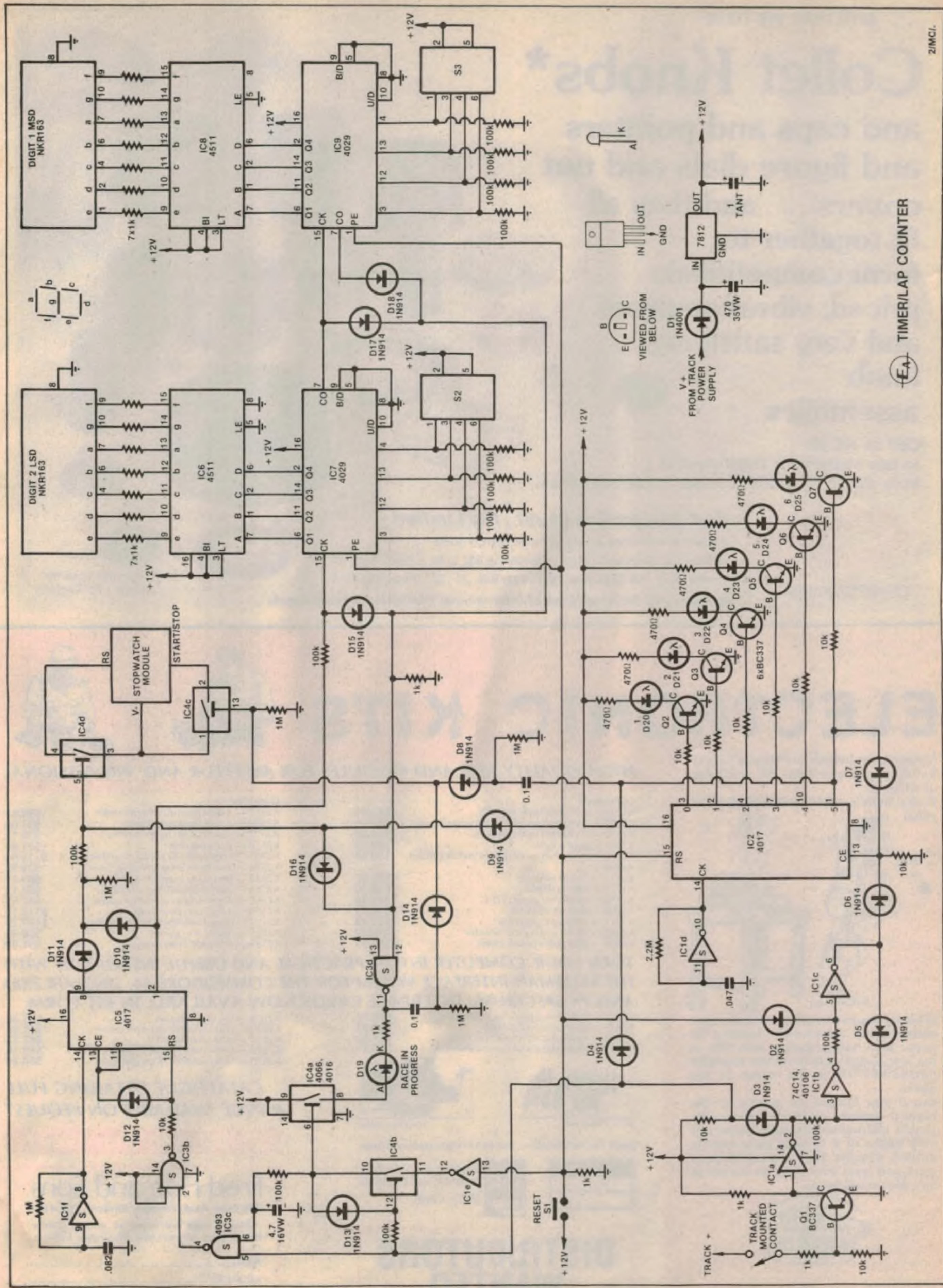
- 1 470μF 35VW PC electrolytic
- 1 4.7μF 15VW PC electrolytic
- 1 1μF 15V tantalum
- 2 0.1μF metallized polyester (greencap)
- 1 .082μF greencap
- 1 .047μF greencap

Resistors (0.25W, 5%)
1 × 2.2MΩ, 5 × 1MΩ, 14 × 100kΩ, 10 × 10kΩ, 19 × 1kΩ, 6 × 470Ω.

Miscellaneous
Machine screws and nuts, 6mm spacers (optional), hookup wire etc.

Whilst the reset pulses for IC5 are obviously derived from the pickup, they are not in fact coupled in directly. The first reset pulse must be ignored — we do not want the lap count to decrement as the car crosses the start line for the first time. Thus, we need a circuit that ignores the first pulse but registers all subsequent pulses.

This circuit is provided by IC1e, IC4b, IC3c and IC3b. IC4b (a CMOS switch) latches the first pulse, with pin 10 going high and the latch condition maintained



TIMER/LAP COUNTER
DIGIT 1 MSD NKR163
DIGIT 2 LSD NKR163
STOPWATCH MODULE
START/STOP
RACE IN PROGRESS
RESET S1
TRACK MOUNTED CONTACT
TRACK +
V+ FROM TRACK POWER SUPPLY
VIEWED FROM BELOW
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74C14, 40106

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Timer/lap counter

by D13. This logic level is fed to pin 6 of NAND gate IC3c, but only after a delay of about 0.5s as set by the associated RC delay network (100kΩ and 4.7μF).

In order for IC3c to deliver a pulse, both of its inputs must go high. Pin 5 goes high whenever the detector delivers a pulse but pin 6, as we have just seen, does not go high until 0.5s after the first pulse. By this means, the first detector pulse is ignored while all subsequent pulses are gated through to the output (pin 4).

IC3b inverts the output of IC3c to obtain the correct logic sense for resetting IC5.

To reset the pulse discrimination circuitry, pin 11 of IC4b must be pulsed low. This pulse is derived by using IC1e to invert the positive going pulse from the Reset switch.

One last characteristic of the stopwatch Reset circuit should be mentioned. In the event of any resetting pulses being supplied by IC4d after a Stop pulse has been delivered by IC4c, the stopwatch would immediately reset to 0. This may not be desirable — a car may perform a victory lap after the race and this should not reset the timer.

For this reason, D16 is connected between the lap counter AND circuit (D17 and D18) and the control pin of IC4d (pin 5). When the AND output is low (both counters at 0), D16 is forward biased and blocks any further reset pulses to pin 5.

Let's briefly sum up the functions described thus far. First, a starting cue is provided by a column of six LEDS. When the last of these is illuminated, the competitor is free to start.

When the car crosses the starting line for the first time, a pulse is generated and a latch is toggled. If this occurs before the last LED illuminates, the start is aborted (ie, the LEDs stop). If the start is legal, the start pulse toggles another latch which, after a 0.5s time delay, toggles a third latch which enables the lap counting circuitry.

Each subsequent pulse is converted to a double pulse (IC5) and interfaced to the Reset control of the stopwatch. When the lap count reaches 0, both lap counting and lap timing are inhibited.

Stop/start control

Let's move on now and discuss the Stop/Start control for the stopwatch. Fortunately, both the stop and start pulses are generated by relatively simple means.

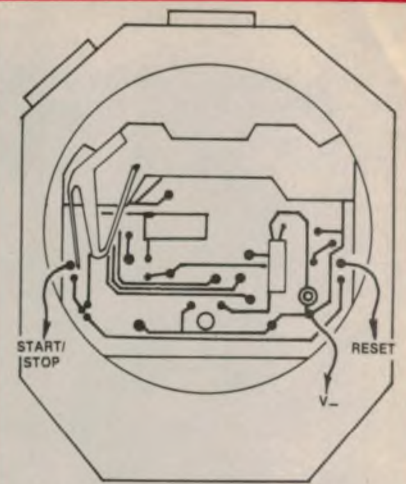
The start pulse is delivered when the "5" (final) count of IC2 is reached. This positive transition is differentiated by a 0.1μF capacitor and 100kΩ resistor. It is then coupled to the control pin (pin 13) of IC4c via diode D8.

A stop pulse is provided when the ANDed carry out of the 4029 counters changes state. At the completion of the race, this output goes low and is inverted by IC3d. The resulting positive going stop pulse is again differentiated and coupled to pin 13 of IC4c via D14.

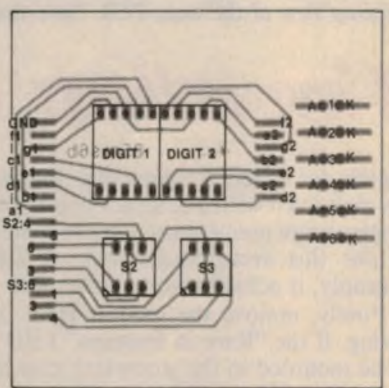
D8 and D14 serve to isolate the stop and start circuits from each other.

In addition to providing the stop pulse, IC3d also drives the cathode of LED D19. The anode of D19 is driven through an inverter (IC4a) from the pulse discriminator latch (IC4b). In this way, the LED is illuminated whenever there is a race in progress. It comes on after the car crosses the start line (not when the timer starts) and is extinguished when the lap count reaches 0.

Power for the circuit is derived from the track power supply and regulated to +12V using a 7812 3-terminal regulator.



This diagram shows the wiring connections to the stopwatch module. Additional leads are run to the LED and Reset switch.



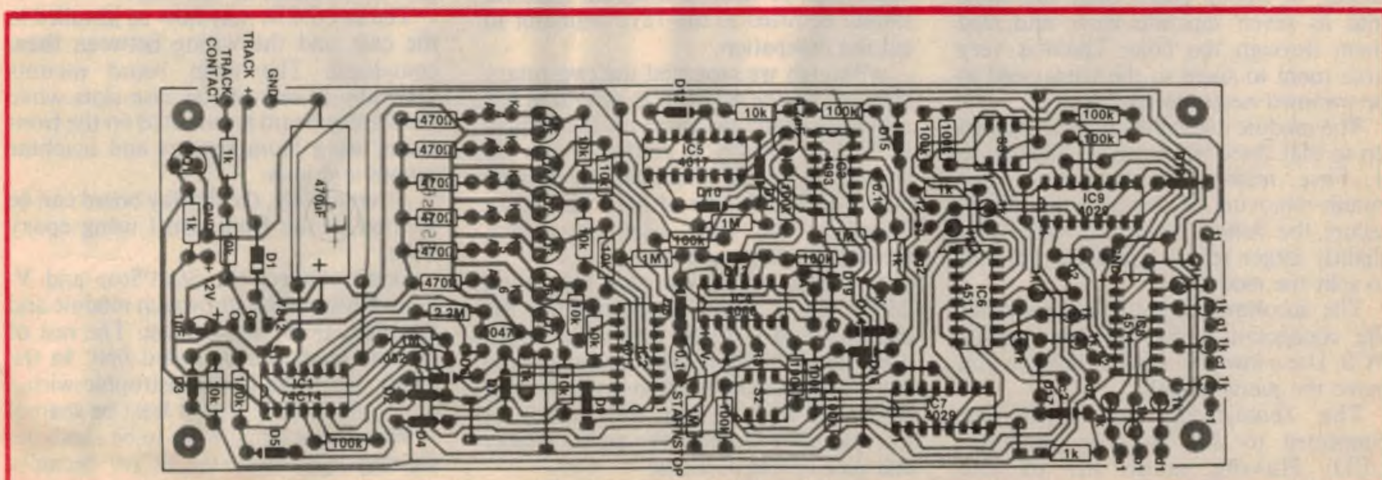
Parts layout for the display PCB (S2 and S3 optional on this board, see text).

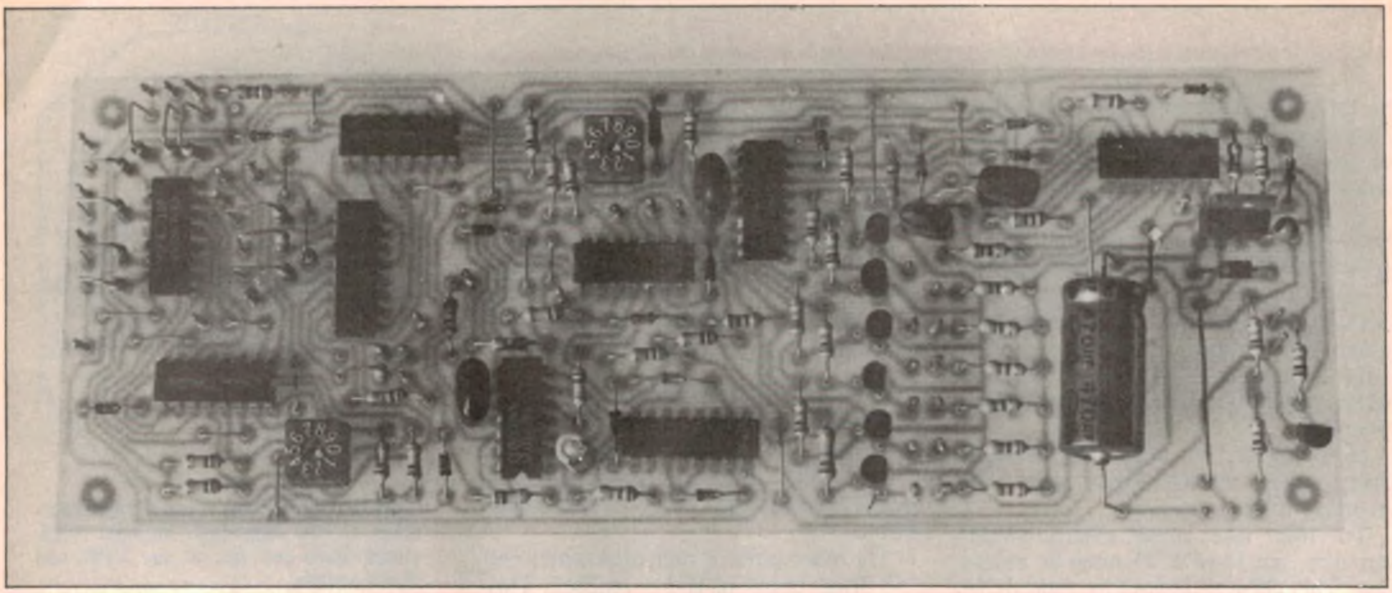
With the Scalextric set we used, the power pack includes a full wave rectifier but no filtering. The nominal voltage is 12V (RMS), but the actual voltage is closer to 25V peak with no load.

Construction

With the stopwatch we used, it was impractical to use the existing Reset

Below: parts layout for the main PCB. Take care when installing the semiconductors and electrolytic capacitors.





Close-up view of the main PCB. Note that the final version differs slightly from this prototype.

Timer/lap counter

switch for external switching. Instead, we replaced it with a compact single pole, single throw momentary contact switch. Whilst this arrangement looks a little ungainly, it actually works quite well.

Firstly, remove the module from the casing. If the "Race in Progress" LED is to be mounted in the stopwatch case (as ours was), drill the hole now. This done, remove the Reset button and drill two small holes through which to feed the leads for the new Reset switch.

The switch we used was of the type intended for PCB mounting. We chose it because of its low profile. Once the leads were soldered to it, we used super glue to hold the switch in place.

A 1-metre length of 7-way rainbow cable is used to connect the stopwatch module (and Reset switch) to the main PCB. The access hole for the cable is drilled in the bottom of the case and should be about 3mm. Split the cable into its seven separate wires and feed them through the hole. There is very little room to spare so the wires need to be trimmed neatly to length.

The module itself must now be opened up so that three wires can be soldered to it. First, remove the battery — this entails removing two small screws which secure the battery holder. Another two slightly larger screws are then removed to split the module.

The accompanying diagram indicates the connection points on the module PCB. Use a low power soldering iron and make the joints quickly.

The remaining two leads are connected to the "Race in Progress" LED. Having made all of the connections, re-assemble the module and check that the back cover of the case can still be fitted. The other end of the rainbow cable is terminated in a DIN socket connector.

PCB assembly

Two printed circuit boards take care of the circuit assembly. These are coded 85ms6a (205 × 75mm) and 85ms6b (70 × 75mm). The larger board accommodates all the ICs while the smaller board carries the 7-segment displays and the six Start LEDs.

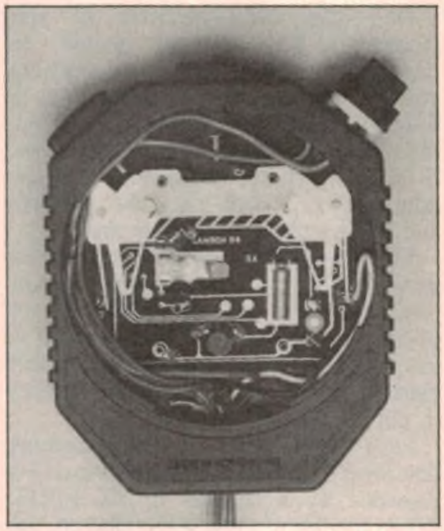
The main board can be assembled first. No particular order need be followed but we suggest that the 16 wire links be installed first and the ICs left until last. We used PC stakes to terminate the external wiring connections.

Note carefully the orientation of the semiconductors and the electrolytic capacitors. A small aluminium heatsink should be fitted to the 7812 regulator to aid the dissipation.

Although we mounted the two rotary switches on the main PCB, provision has also been made for them on the display PCB. The choice is yours. If you do choose to mount them on the display board, then a couple of holes should be drilled in the front panel to permit screwdriver adjustment.

A plastic instrument case measuring 260 × 190 × 80mm is used to house the circuitry and is fitted with a Scotchcal dress label. A 7-pin DIN socket on the front panel accepts the stopwatch plug connector while a 3-pin DIN socket on the rear panel accepts the power supply and pick-up connections.

Attach the Scotchcal label to the front panel, then drill and cut the necessary holes for the displays and the DIN socket. The rear panel DIN socket can also be mounted at this stage.



View inside the modified stopwatch. Compare this with the wiring diagram on page 67.

The two PCBs may now be installed in the case and the wiring between them completed. The main board mounts vertically in one of the case slots while the display board is mounted on the front panel using 6mm spacers and machine screws and nuts.

Alternatively, the display board can be secured to the front panel using epoxy resin.

Don't connect the Start/Stop and V- wires between the stopwatch module and the main PCB at this stage. The rest of the circuit should be tested first. In the event that there is a catastrophic wiring error, the module will at least be spared!

Where two circuits are to be used, the starting light oscillator (IC1d) becomes

continued on page 70

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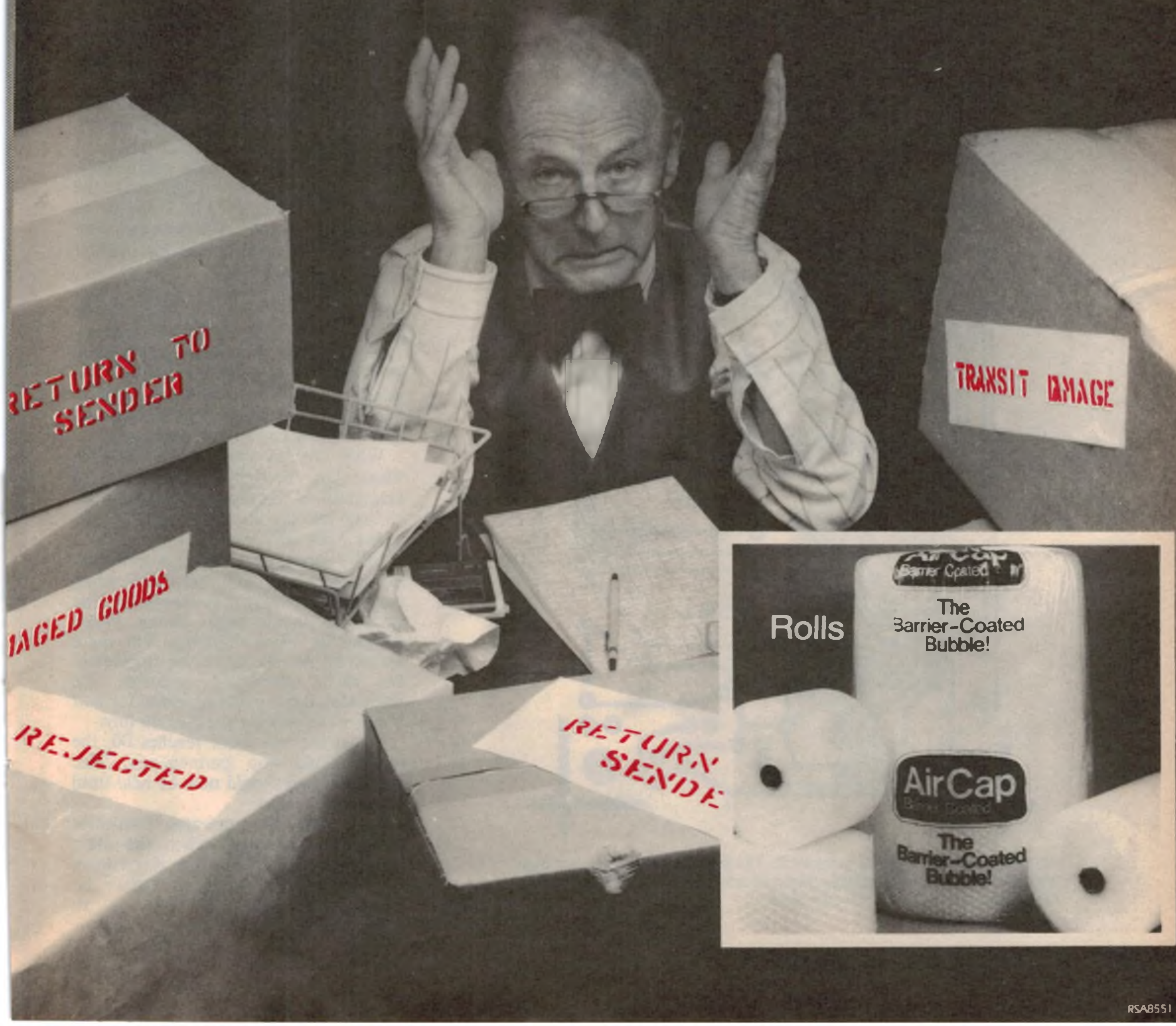
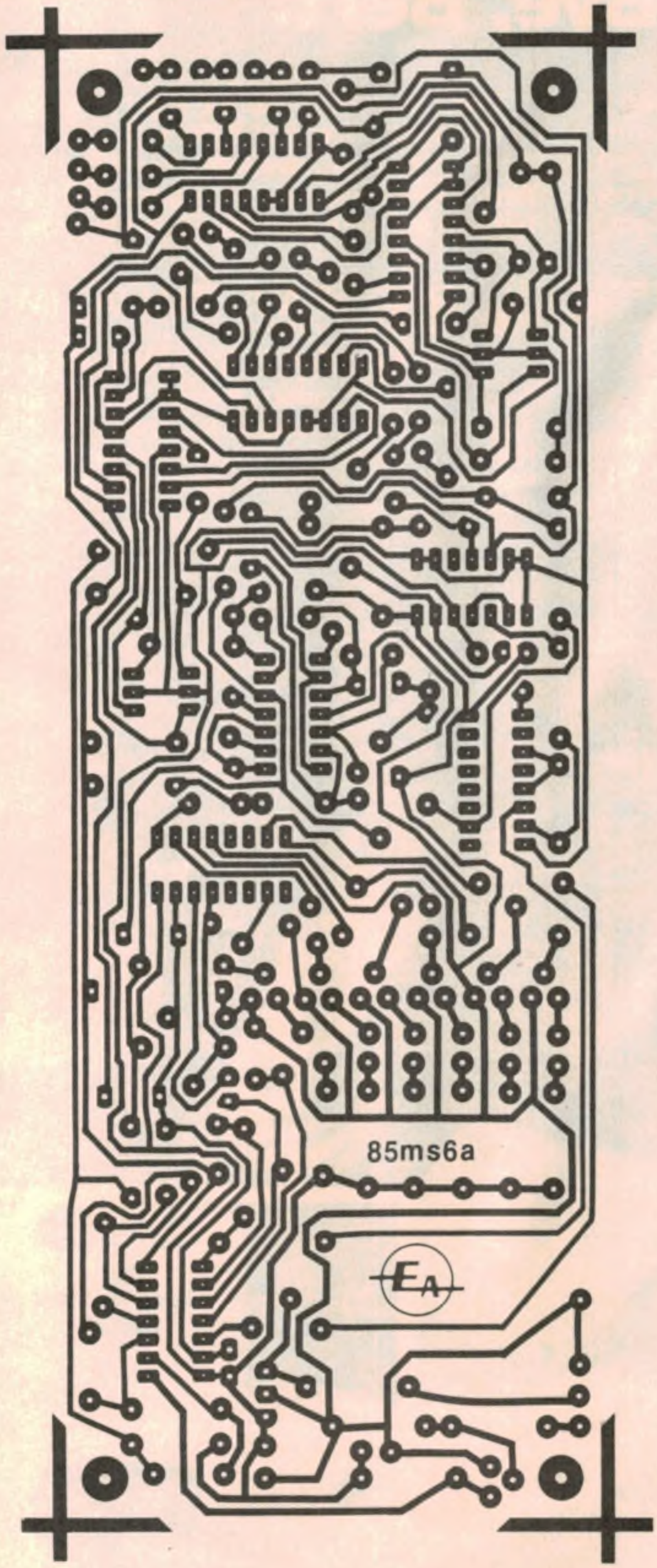


RSA8551

Timer/lap counter



Actual size artwork for the main PCB. The front panel artwork has been omitted due to space limitations. Finished artworks can be obtained from Electronics Australia for $3 post paid.

redundant for the second circuit. Whilst we are not suggesting that one sixth of IC1 can be omitted from the circuit, the associated 2.2MΩ resistor and .047μF capacitor most certainly can be. Link 1 must also be omitted from the slave board.

The two boards are then slaved together by installing a connection between Link 1 on the master board and pin 15 of IC2 on the slave board (this is available at one of the Link 1 mounting holes). Note that the input of IC1d (pin 11) on the slave board should be soldered to the adjacent pin 12. It would otherwise be left floating, leaving IC1d prone to spurious oscillations.

Testing

Check first of all that the regulator is in fact regulating to +12V. If the output voltage is only about 2V, the regulator is probably installed backwards. If the output voltage is more than 12.5V, the regulator is either defective or the PCB has a bridge between the copper tracks.

Assuming that you've made first base, plug in the stopwatch connector and try operating the Reset switch. The first start LED should be illuminated while the switch is held down and the countdown sequence should begin as soon as it is released. The preset number should be indicated on the lap counter display after resetting.

Next, set the preset to a low 2-digit number (eg, 11), press the Reset button and short the pickup to the Vin terminal. The "Race in Progress" LED should illuminate. Now momentarily short the pickup to the Vin terminal at about 1s intervals — the lap counter should now decrement by one on each occasion.

When the lap count reaches 00, the "Race in Progress" LED should extinguish. If this checks out, switch off and connect the Start/Stop and V- leads to the 7-pin DIN socket.

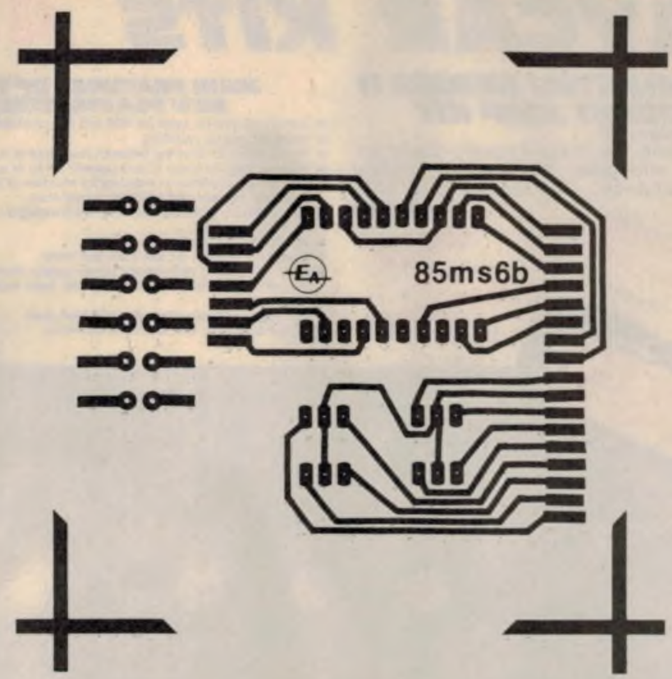
Make sure that the timer is set to the stopwatch mode and is reset. Now, when the start countdown is completed, the stopwatch should begin timing. When the pick up is first shorted to Vin, there should be no change to the stopwatch. On each subsequent occasion, the stopwatch display should freeze for half a second to indicate the elapsed time.

When the lap count reaches 00, the timer should stop (permanently). The indicated time should now be held until the circuit is reset.

Note that the stopwatch connector should be unplugged when the main circuit is switched off. If this is not done, the stopwatch controls may be permanently activated, leading to premature battery failure.

Troubleshooting

Fault: no count down on starting LEDS.
Check: is the clock (IC1d) for IC2 working? The correct frequency is 12Hz. Is pin 13 of IC2 (clock enable) low after resetting? Is pin 15 (reset) low when the reset switch is released?
Fault: stopwatch does not start when countdown is finished.
Check: remove the base resistor for Q7. If fault persists, check that the 1MΩ pulldown resistor on pin 13 of IC4c is the correct value. Otherwise, check the wiring to the stopwatch module. If OK, replace the base resistor. If the base resistor is the problem, replace it with a higher value eg 22kΩ.
Fault: stopwatch does not stop counting after each lap.
Check: does pin 10 of IC4b latch high after the car starts? If not, does its pin 12 go high when the pickup is shorted to Vin? Does a pulse arrive at pin 15 of IC5 after each lap? Is the clock (IC1f) for IC5 working? A 30Hz clock signal should be present at pin 14. Is pin 5 of IC4d normally low? — it should be.
Fault: "Race in Progress" LED does not work.
Check: Pin 12 of IC3d must be low after resetting and before the car begins racing. If it isn't, make sure that the counter ICs have a high carry out (pin 7). Pin 8 of IC4a should be low after the start — if not check IC4b as per above.
Fault: lap count displays do not indicate the preset numbers or do not illuminate.
Check: carefully check that the various control pins of ICs 6, 7, 8 and 9 are tied either high or low as per the circuit diagram. Look for unsoldered pins or solder bridges. Try running a razor between non-connected adjacent pads.



Here is the actual size artwork for the display PCB.

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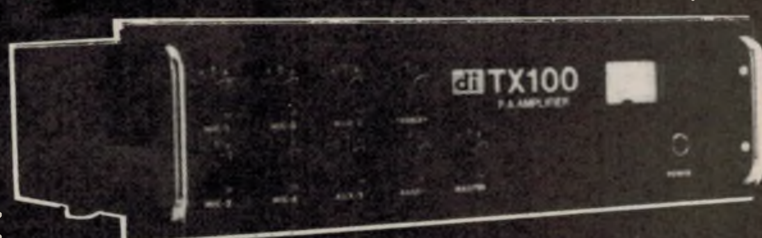

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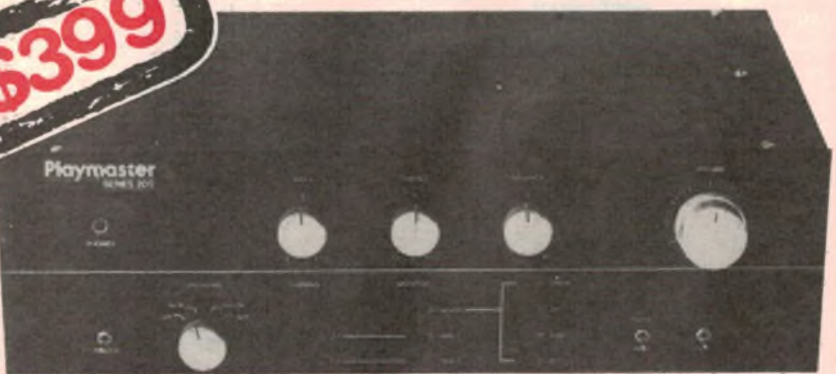

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Ref: ETI May 1985

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Ref: EA June 1982

Cat. KA-1574

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Ref: EA December 1984

This unit enables you to program 2716 & 2732 EPROMs and copy 2708, 2716 & 2732's. It is easy to make and works well. The Jaycar kit includes all PCB components (inc. ZIF sockets) and panel.

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This simple add-on project extends the functions of your multimeter to the measurement of temperature. It is particularly suited to digital multimeters. It can be used to measure temperature over the range from −55°C to +150°C with an accuracy of 0.5°C or better. The Jaycar kit includes the Jiffy case and Scotchcal panel. The AD590 is supplied but not the probe case which is in fact the plastic case of a BIC biro.

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"RAILMASTER" Pulse-Power Train Controller

Ref: EA September 1984

"We feel that it is the best controller available, regardless of cost" - John Clarke or Leo Simpson (or both) Sept. '84

This is a state-of-the-art train controller offering tremendous features. ● Variable simulated inertia ● Full short circuit protection including both audible and visual indicators ● Power and track monitor indicators ● Adequate power for double and triple heading of locos ● Fixed 12V DC and 15V AC power for lighting and accessories ● Optional walk around throttle.

The Jaycar kit includes realistic Scotchcal front panel and the special console case only available from us. The large paddle switches have been specially imported just for this kit. We believe that you will be delighted with this unit.

Cat. KA-1560 **ONLY $79.95**

Optional Walk-around controller

Cat. KA-1559

ONLY $9.95

Diesel Sound Simulator

Ref: EA November 1984

This project mounts inside a model train (i.e. goods wagon) and produces a noise similar to a diesel locomotive. The speed varies according to the throttle action for added realism. All parts supplied.

Cat. KA-1561 **ONLY $19.95**

Steam Sound Simulator

Ref: EA December 1984

Build this realistic steam sound simulator for your model train layout. It features an Infra-Red optical switch to synchronise the "chuffs" to the wheel rotation. Like the KA-1561 this unit picks up its power from the railway tracks. All specified components supplied including 32 ohm headphone type transducer.

Cat. KA-1562 **ONLY $15.95**

JUNE SPECIAL!!

Electronic Crossover Kit

(Ref: EA November 1984)

NEW SHORT FORM KIT!

You can *NOW* build this desirable project for a lot less! There have been requests for a version of this kit that can be built into other equipment. This is it!

The kit contains PCB and all board components etc. The box (inc. front panel) and selector switches are not supplied but everything else! Special price for June only.

Cat. KA-1571

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SQUEAKY CLEAN MAINS FILTERS - Two fantastic low cost models. MS-4010 will supply up to 4 appliances. Each 240V socket is isolated from the other, i.e. interference from disc drives is de-coupled from the CPU power supply etc. It will supply up to 4 outlets with a total load of 6 amps (unswitched).

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Plug Pack This unit will give a DC output of 1½, 3 or 4½V @ 250mA (max). A switch on the back of the unit changes the voltage. It is also supplied with a 1.6m cord, polarity reversing plug and multiway connecting plug. We have over 500 of them.

This voltage range is fairly useless except for small transistor radios, calculators etc. At this price however, it's worth having one or two for the inevitable occasion when such a power source is required.

Cat. MP-3002

ONLY $2.95

You could pay over $10 elsewhere!

DC Convertor This unit plugs into your car cigarette lighter socket and will provide up to 300mA at 6 and 9V DC. Ideal to power the Ghetto Blaster in your car! We only have just over 200 so hurry!

Cat. MP-3015

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High voltage insulation tester

Everyone knows how to do a simple insulation test on mains wiring, appliances and components using the ohms ranges on a multimeter, but this is only a go/no-go test. To do it properly you need our Insulation Tester which has an internal 500V supply.

by ANDREW LEVIDO

The problem with using a multimeter to perform insulation tests is that it only tests at 1.5V DC. Very few components operate at this very low voltage so it really is not valid.

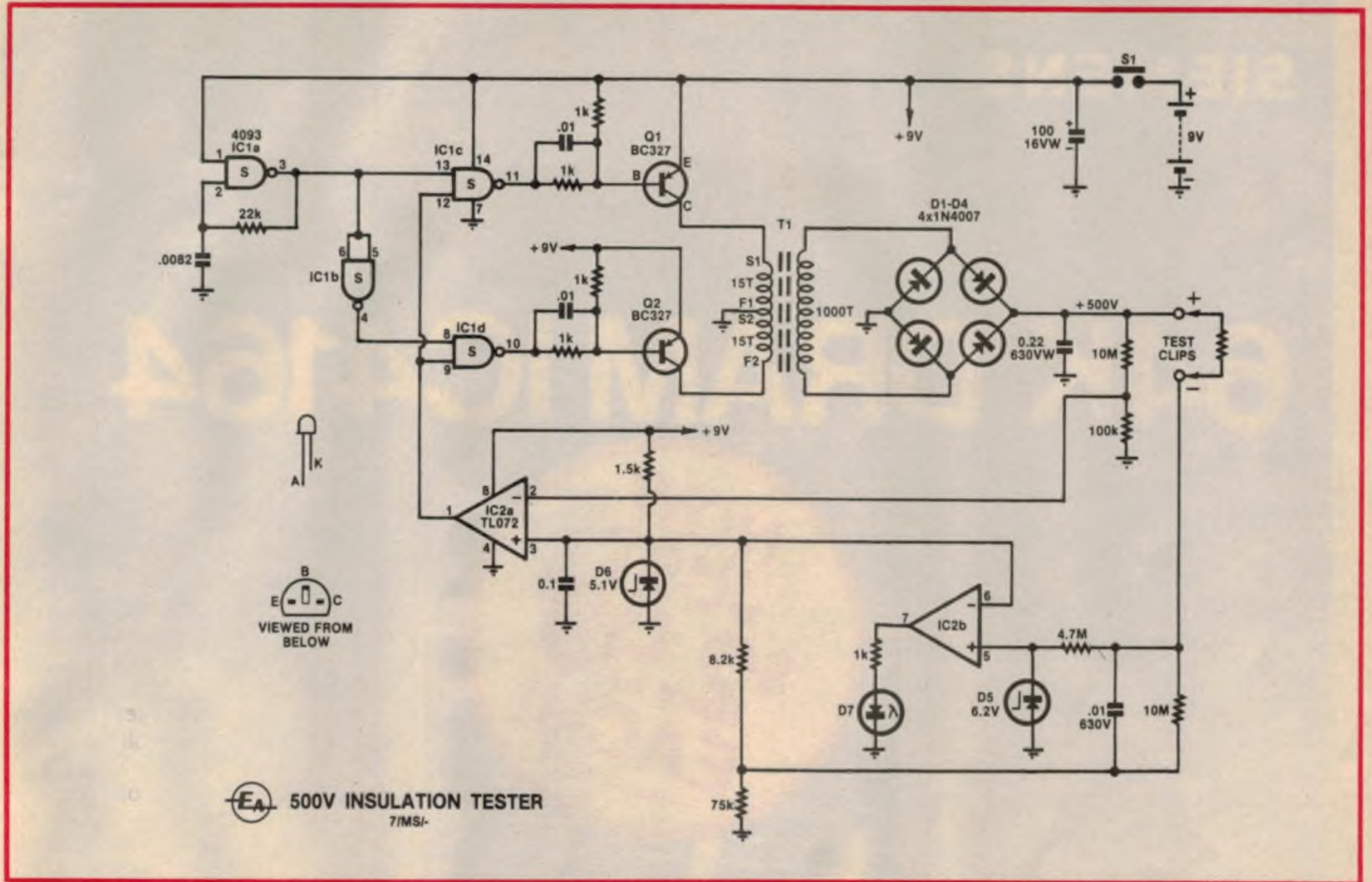
Consider a mains operated appliance. It may easily give an open circuit reading when tested between the active leads and the frame. But plug in to the mains and you have a different kettle of fish altogether. The peak voltage of the 240VAC mains is 340 volts which increases the chances of insulation breakdown enormously. Add to that the strong possibilty of spike voltages rising on top of the mains voltage and you can see why mains operated appliances have to have such good insulation.

The same arguments apply when testing transformers, capacitors, high voltage semiconductors and other components, so there is a real need for a convenient self-contained insulation tester which can test at a voltage at least as high as that which will be present in the circuit under normal operating conditions. The voltages most commonly used in tests of this kind are 500V and 1000V.

A further disadvantage of the majority of multimeters is their lack of resolution when measuring large resistances. Most multimeters simply read infinity (open circuit) when the resistance is above a few tens of megohms. There are meters especially designed to measure large resistances at high voltages and these are often referred to as a "Megger". Many people use the word "Megger" as a generic term but it is actually a trade-name. While we intend to describe a similar Megohm Meter in the near future, we considered that a simpler tester would also be worthwhile.

We selected 500V as the most suitable test voltage, since it provides a reasonable margin over the typical mains voltages present in electronic equipment, while keeping the design of the inverter as simple as possible.

Having decided on this, it remained to select a threshold value of resistance



A feedback-controlled inverter is used to generate 500V DC from a 9V battery.

which would be considered suitable. One tester published in this magazine some years ago used the value of one thousand Megohms which seems quite a high figure. However, these days it is possible to test for a much higher figure which is closer to the ratings of typical components.

Accordingly, we selected a value of 10,000 Megohms or, in today's parlance, 10 Gigohms. That's a lot of ohms in anybody's language. At a test voltage of 500V, an insulation resistance of 10 Gigohms will have a leakage current of nanoamps.

At this point it would be a good idea to have a look at how the tester is used in practice. Consider a typical mains powered project as published in this magazine. The mains cable enters through a grommet in the back panel, and is terminated at a barrier strip. From this point the mains wiring is routed to the primary of the transformer, perhaps via a switch and possibly a fuse as well. The chassis is earthed.

There are any number of points at which the mains may break down to the chassis under fault conditions, so an insulation test should be made. One of the test leads is clipped to the chassis, and the other to one of the mains conductors. The test button is pressed, and the indicator LED mounted on the front panel of the tester is observed. If the LED glows continuously, the insulation between the mains and the chassis is suspect. If the LED flashes briefly and then goes out, then the insulation resistance is higher than 10GΩ, and hence the insulation between the mains and chassis can be considered adequate.

Further, the Insulation Tester can be used to provide indication of leakage in capacitors and other components. Naturally, the tester can only give an indication that capacitor leakage current is less than 50nA, however this gives a fair indication of the condition of the capacitor. Large value capacitors will take a considerable time to charge up to the full 500V because of the high series resistance of the tester, so be sure to allow for this before discarding a capacitor as leaky.

How it works

The heart of the 500V Insulation Tester is an inverter to generate the 500V supply from the 9V battery. A feedback-controlled inverter was selected because it gives a much improved regulation of the output voltage and much lower current drain at no load.

In a previous tester of this type (Capacitor Insulation Tester, EA November 1971), a self-excited inverter was used. When we tried an inverter of this type again, we found that the current drain when there was no load was undesirably high for a single 216 type 9V battery. This problem did not arise with our previous circuit because it employed a much larger battery. Unfortunately, such batteries are no longer available.

We therefore settled on the driven inverter shown in the accompanying circuit diagram, based on a quad NAND Schmitt trigger, IC1. One gate, IC1a, is connected as a Schmitt trigger oscillator with a square wave output and a nominal frequency of 5kHz.

The oscillator works as follows. Consider the initial condition whereby the capacitor has no voltage across it. This means than pin 2 of IC1a will be low and the output, pin 3, will be high. The capacitor therefore begins charging up via the 22kΩ resistor and will continue to do so until it reaches the positive threshold of the input. When this happens the output at pin 3 will switch to low and the capacitor will begin discharging via the 22kΩ resistor. It continues to do so until the voltage at pin 2 drops to the negative threshold of the input which causes pin 3 to switch high and begin the cycle again.

The result is a square wave at pin 3 and a sawtooth waveform at pin 2.

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Insulation tester

The square wave signal is fed via the other three gates of IC1, to the bases of transistors Q1 and Q2. IC1c and IC1d have two of their inputs connected together and are used to gate the drive signals to Q1 and Q2 off or on, depending on whether the inverter voltage is above or below a determined reference level. IC1b is used as an inverter to obtain a complementary signal to that from pin 3 of the IC1a, the oscillator. IC1c and IC1d gate the complementary signals from pins 3 and 4, in response to a control signal from pin 1 of IC2a.

Transistors Q1 and Q2 are driven from the outputs of IC1c and IC1d via 1kΩ current-limiting resistors. Since transistors driven via such large-value resistors tend to be rather slow in their switching action, .01μF capacitors are connected across the 1kΩ resistors to provide a "speed-up action". 1kΩ resistors are also connected between the bases of the transistors and the positive rail to ensure that the transistors switch off properly.

Q1 and Q2 drive the inverter transformer primary winding. Because Q1 and Q2 are driven out of phase, the supply voltage will be applied alternately to each half of the primary. When one transistor turns on, it will apply the full 9V to one half of the primary winding. By transformer action, this will apply 9V across the other half of the primary winding. This means that the opposing transistor has 18V appearing across it.

So each half-primary winding sees a waveform of 18V peak-to-peak and the total primary winding sees a voltage of 18V RMS. This is stepped up by the transformer turns ratio (1000:30) to obtain 600V peak to peak across the secondary. When rectified and filtered, this gives a DC voltage of 600V.

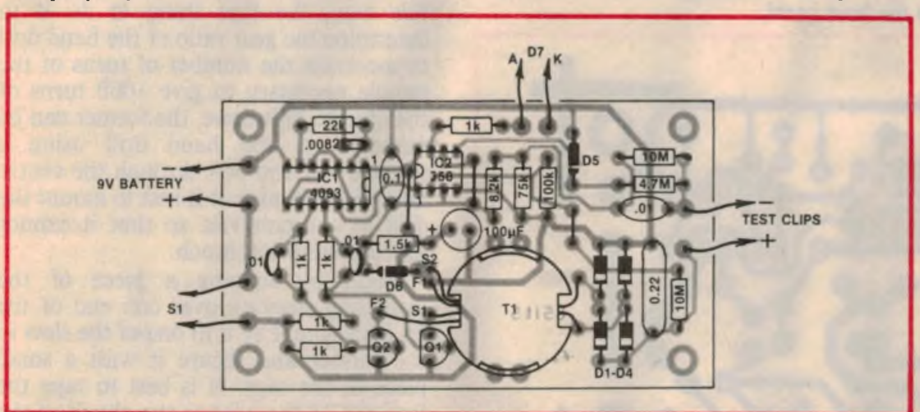
But we don't want 600V. We want 500V, so we turn off the inverter every time the DC output voltage rises by a small margin over 500V. This is accomplished in the following way.

A voltage divider consisting of a 10MΩ and a 100kΩ resistor is connected across the DC supply to sample the output voltage. The divider produces 5.1V at the input of IC2a when the DC output voltage is 515V.

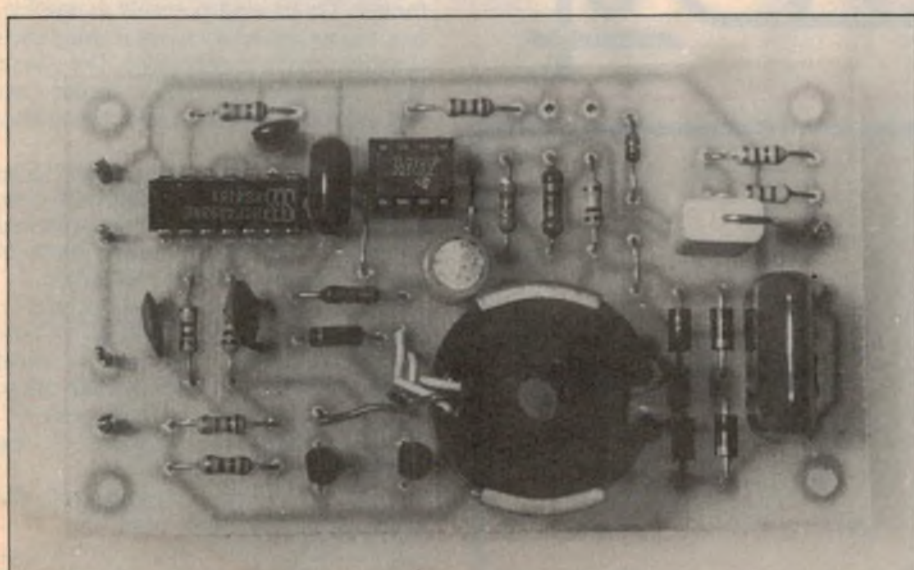
This sampled voltage is compared with the zener diode voltage applied to pin 3 of comparator IC2a. Now whenever the sample voltage at pin 2 rises by the smallest smidgin above 5.1V, IC2a switches its output, pin 1, low. This turns gates IC1c and IC1d off and removes the drive from both transistors. The output voltage will now drop until the voltage at pin 2 of IC2a is sufficient to let its output go high again and enable the oscillator.

Thus, the nominal output voltage of the inverter is maintained at around 510V or so, depending on the resistor and zener diode tolerances.

The +500V is connected to one of the test terminals, while the other terminal is connected to a 4.6V reference via a 10MΩ resistor. For a resistance of 10GΩ across the test terminals, a current of 50nA will flow through the 10MΩ resistor. This will produce a voltage of



Above is the parts layout and wiring diagram while below is a view of the assembled PCB. Take care with component orientation.



Parts List

1 PCB, code 85it5, 54×95mm
1 plastic case, 130×68×41mm
1 Scotchcal label
1 SPST momentary pushbutton switch
1 FX2240 potcore with former and mounting clip
1 9V battery clip
1 5mm LED clip
1 figure-8 cable clamp grommet
2 alligator clips
8 PC pins
2.5 metres 26 B&S enamelled copper wire
50 metres 36 B&S enamelled copper wire
4 5mm spacers

Semiconductors

1 4093 quad Schmitt NAND
1 TL062, TL072, LF352 dual Fet-input op amp
2 BC327 PNP transistors
1 5.1V 400mW zener diode
1 6.2V zener diode
1 red LED
4 IN4007 diodes

Capacitors

1 100μF 16VW PC electrolytic
1 0.22μF 630V metallised polyester
1 0.1μF 100V metallised ployester
2 .01μF ceramic
1 .01μF 630V metallised polyester
1 .0082μF 100V metallised polyester

Resistors (0.25W, 5%)

2×10MΩ, 1×4.7MΩ, 1×100kΩ, 1×75kΩ, 1×22kΩ, 1×8.2kΩ, 1 × 1.5kΩ, 5 × 1kΩ

Miscellaneous

Machine screws and nuts, hookup wire, figure-8 cable, solder etc.

0.5V across the resistor. It is this voltage that is monitored by IC2b to determine if the resistance between the test terminals is lower or higher than the threshold value.

The 4.6V reference for the negative test terminal, and thus for pin 5 of IC2b, is set by the voltage divider resistors (8.2kΩ and 75kΩ) connected across the 5.1V zener diode.

If the current through the 10MΩ resistor exceeds 50nA, the voltage developed across it will be more than 0.5V and the non-inverting input of IC2b, pin 5, will be raised above the inverting input, pin 6, which is held at 5.1V by the zener diode. When that happens, the LED will glow.

We had to use a Fet-input operational amplifier for IC2 because IC2b must have a very low input bias current in order to work properly in this circuit. Typical Fet-input op amps have an input bias current of around 50 picoamps at room temperature so this condition is easily met.

A .01μF capacitor is connected across the 10MΩ sensing resistor to prevent the LED from flashing due to the variation of the 500V supply as the inverter is turned on and off. This capacitor requires a rating in excess of 500V in order to withstand the full voltage of the test circuit when there is a short circuit between the test clips.

Op amp IC2b, however, could not withstand such a high input voltage, even for the briefest interval. For this reason, the 4.7MΩ resistor and zener diode D5 have been included. D5 limits the maximum voltage applied to the non-inverting input, pin 5, to 6.2V while the 4.7MΩ resistor keeps the current flowing through the diode to a low level, even if the test terminals are short circuited. The output of IC2b drives the indicator LED via a 1kΩ current limit resistor.

The LED will light when the voltage across the 10MΩ sensing resistor exceeds 0.5V. This will occur only when the current through the sensing resistor reaches the value corresponding to a resistance of 10GΩ or less between the test terminals. For resistance greater than this value, the LED will flash briefly while whatever capacitance exists across the test terminals is charged and then will be extinguished.

The whole circuit, as mentioned earlier, is powered from a single type 216 9V battery. The battery is connected to the circuit via a momentary pushbutton switch, SI.

Construction

Construction of the 500V Insulation Tester is, for the most part, very simple. Winding the potcore is probably the most difficult, and certainly the most tedious, job. It is best to do this first. Apart from the core assembly itself, and the wire, you will need some ordinary adhesive tape, some 50mm pieces of thin insulating sleeving (we used insulation which we stripped off some scraps of telephone cable) and a certain amount of patience.

The 1000 turn secondary is wound first. This can be done by hand if necessary, although we used a hand drill to make the job easier. If you are doing it this way, the first thing to do is to determine the gear ratio of the hand drill to ascertain the number of turns of the handle necessary to give 1000 turns of the chuck. This done, the former can be mounted in the hand drill using a suitable nut and bolt through the centre hole of the former. It is best to mount the drill in a bench vice so that it cannot move around too much.

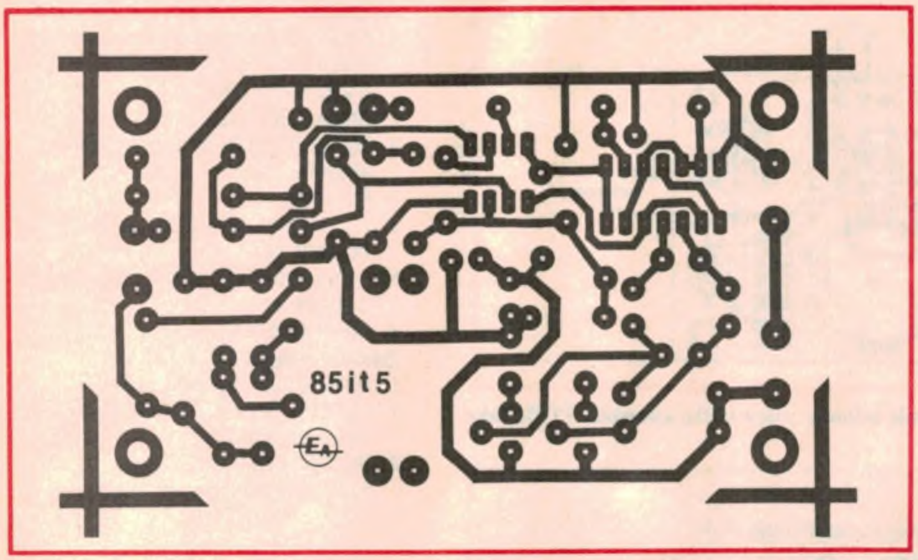
Begin by slipping a piece of the insulating sleeving over one end of the 36 B&S wire. Lay it in one of the slots in the former and secure it with a small piece of the tape. It is best to tape the free end of the wire to the chuck of the drill to prevent it getting in the way. Carefully wind 1000 turns onto the former. Try to wind as evenly as possible, but it is not necessary to try to wind each turn next to the previous one. The wire is very thin, and breaking it means that you will have to start again, so be very careful.

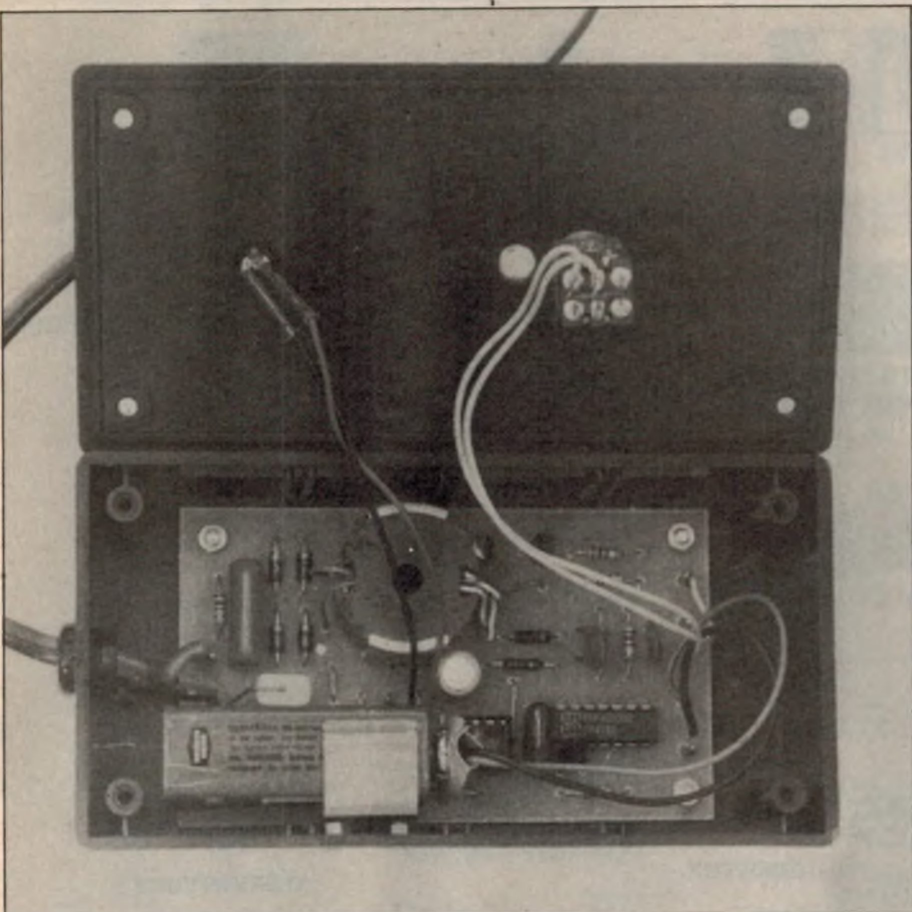
When the 1000 turns have been wound on the former, slip another piece of sleeving over the end of the wire and secure the winding with a few layers of tape. This completes the secondary.

The primary is bifilar-wound; that is, two wires are wound together, as one. Divide the 26 B&S wire into two equal lengths. Sleeve both ends of both wires, and label the two starts S1 and S2. Similarly, label the finishes of the respective wires F1 and F2.

Wind 15 turns, finishing off the windings at the same place that they started. Move the sleeving up to the core, and trim off any excess wire. Wind a few

Below are actual size artworks for the PCB and the front panel.





View inside the completed insulation tester. Use 240VAC cable for the test leads.

more layers of tape over the whole former and trim the wires back to about 25mm long. Strip and tin the last 5mm or so of all the windings.

The potcore can now be assembled, ready for mounting on the printed circuit board (PCB).

The ideal op amp for this circuit is the Texas Instruments TL062 which has a current drain of 0.5 milliamps. However, we recognise that this can sometimes be difficult to obtain and so the TL072 or LF352 can be substituted without any other changes. The difference will be slightly higher total current drain.

The PCB measures 54×95mm and is coded 85it5. Begin by mounting the PC pins, the two wire links and the low profile components such as resistors and diodes. This done, mount the other semiconductors taking due care with their orientation. Mounting the capacitors and the potcore completes the printed circuit board. Note that the primary wires of the transformer must be connected to the printed circuit board as shown on the component overlay, or the inverter will not function.

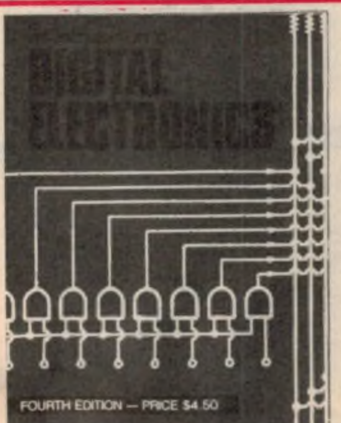
The next job involves the preparation of the plastic case. Apply the Scotchcal label to the front panel and use this as a drilling template for the LED and switch holes. Both of these were ¼-inch for the LED clip and switch that we used. Using a very sharp blade, carefully cut away the Scotchcal panel where it covers the lid mounting holes. A further hole must be drilled in the end of the box for the test leads. We used a cord clamp grommet.

Mount the PCB in the bottom of the box, using 6BA machine screws and nuts. Use a 5mm spacer under each corner of the board to raise it off the bottom. We used a clip for the 9V battery, but this is not strictly necessary; a piece of double sided sticky tape would do the job equally well. Next, mount the front panel hardware and wire this to the appropriate pins on the PCB. Do the same for the battery clip and test leads.

Use a good quality 240VAC-rated twin-lead for the test leads, since any leakage between them will be measured as well. We soldered insulated alligator clips to the ends of the leads to facilitate connection to the device under test.

To test the unit, simply push the test button and observe the LED. If all is well, it should flash briefly and the inverter should make a faint sound. Try pushing the button with the test leads shorted — the LED should light. We found that by firmly grasping the insulation of both alligator clips we could get the LED to light, showing just how high a leakage resistance is 10 Gigohms. Note that this may not work if the humidity is very low or if the insulation covering the clips is particularly good.

Finally, here is a word of warning. Although the high voltage produced by this instrument is itself quite safe because it is delivered from a high impedance source, the unit can deliver a substantial bite. Be careful. If it is used to charge large value capacitors, these then become dangerous and could deliver a very severe electric shock (possibly fatal). For this reason, you should carefully discharge capacitors after they are tested, as they can remain charged to a high voltage for a long time afterwards, just waiting to a shock the unwary.



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Edge Connectors to Disk Drives Etc.

	1-9	10+
P12060 10 Way Card Edge Con	2 95	2 50
P12062 20 Way Card Edge Con	3 25	2 75
P12064 26 Way Card Edge Con	3 55	2 95
P12066 34 Way Card Edge Con	3 95	3 50
P12068 40 Way Card Edge Con	4 50	3 90
P12070 50 Way Card Edge Con	5 50	4 50

Plus 20% Sales Tax where applicable

UNPROTECTED HEADERS STRIP HEADERS

Dual in Line 2 54mm

	1-9	10+
P12240 10 Way Unprot Header	1 25	1 10
P12246 16 Way Unprot Header	1 35	1 20
P12250 20 Way Unprot Header	1 45	1 25
P12256 26 Way Unprot Header	1 50	1 40
P12260 30 Way Unprot Header	1 75	1 65
P12264 34 Way Unprot Header	1 95	1 75
P12270 40 Way Unprot Header	2 25	1 95
P12275 50 Way Unprot Header	2 75	2 50
P12280 60 Way Unprot Header	2 95	2 75

Plus 20% Sales Tax where applicable

R.A HEADERS

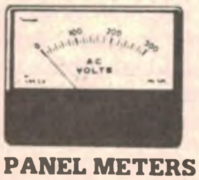
	1-9	10+
P12241 R.A. 10Way Unprot Head	1 45	1 30
P12247 R.A. 16Way Unprot Head	1 55	1 40
P12251 R.A. 20Way Unprot Head	1 65	1 45
P12257 R.A. 26Way Unprot Head	1 70	1 50
P12261 R.A. 30Way Unprot Head	1 95	1 85
P12265 R.A. 34Way Unprot Head	2 15	1 95
P12271 R.A. 40Way Unprot Head	2 45	2 15
P12276 R.A. 50Way Unprot Head	2 95	2 70
P12281 R.A. 60Way Unprot Head	3 15	2 95

Plus 20% Sales Tax where applicable

COMPUTER CONNECTORS

Cat No.	Description	1-99	100+	1000+
P10900	DB25 Plug	1 30	1 20	1 00
P10901	DB25 Socket	1 40	1 30	1 20
P12210	Centronics Solder	3 50	3 15	3 00
P12200	Centronics Crimp	6 00	5 50	5 00
P10880	DB9 Plug	1 30	1 20	0 90
P10881	DB9 Socket	1 40	1 30	1 00
P10890	DB15 Plug	1 30	1 20	0 90
P10891	DB15 Socket	1 40	1 30	1 00
P10902	DB25 Cover	80	75	70

Plus 20% tax where applicable



PANEL METERS

		1-9	10+
Q10500	MU45 0-1mA	5 95	5 75
Q10502	MU45 50-0-50uA	5 95	5 75
Q10504	MU45 0-100uA	5 95	5 75
Q10505	MU45 0-50uA	5 95	5 75
Q10510	MU45 0-5A	5 95	5 75
Q10518	MU45 0-1A	5 95	5 75
Q10520	MU45 0-20V	5 95	5 75

Plus 20% tax where applicable

NICADS

Cat No.		1-99	100+
S15020	AA	1.60	1.50
S15021	C 1 8AH	3 25	2 90
S15022	D 4 0AH	5.90	5.50

Plus 20% tax where applicable

SEALED LEAD ACID BATTERY 12V 1.2 AH

	1-9	10-99	100+
S15061	12.50	11 00	10.50

75OHM COAX CABLE

Cat No.	100M	500M	1000M
W11222 3C2V	18 00	17 00	16 00
W11224 5C2V	23 00	22 00	21.00

(5C2V WHITE OR BLACK)
100M ROLLS
LINE LOSS PER 100' (33M 200MHz)
W11222 6.2dB (Approx)
W11224 3.9dB (Approx)
Plus 20% tax where applicable

DIGITAL MULTIMETER YFE YF1100

- Large easy to read 3½ digit dispaly
- Facilities for transistor and diode testing
- Clearly laid out front panel
- 10A DC AC range
- Priced to undersell the others

	1-99	100+
YF1100	59.50	57 50

Plus 20% tax where applicable

IBM ADD ON HARD DISK

- 10 Mbyte
- Seagate hard disk
- Hard disk controller by Xebec

Cat. X20010 $1295
Plus 20% tax where applicable

RELAYS

Massive 3A connectors

	1-9	10+	100+
S.P.D.T. Cat. S14060	$1 20	$1.10	$0.90
D.P.D.T. Cat. S14061	$1.50	$1 40	$1 20

HORN SPEAKERS

Cat No.		1-99	100+
C12010	5" Plastic 8W Max	4 80	4 70
C12015	5" Metal 8W Max	4 70	4 30
C12012	12V Siren	8 50	8 00

Plus 20% tax where applicable

SOLDERING IRON STANDS

Cat No.	1-99	100+
T113023	3 25	3 00

Plus 7½% tax where applicable

CANNON TYPE ADUIO CONNECTORS

We've sold 1000's because of their great value!!

	1-9	10+
3 Pin Line male Cat. P10960	1 60	1 50
3 Pin Chas male Cat. P10962	1 70	1 60
3 Pin line female Cat. P10964	2 10	1 80
3 Pin Chas FMle Cat. P10966	2 50	1.90

Plus 20% Sales Tax where applicable

TRANSISTOR

	1-99	100+
2SJ49	3 90	3 70
2SK134	3 90	3 70

Plus 20% tax where applicable

ADD ON DISK DRIVES FOR 6502 SYSTEM

1-9	10
$195	$189

SIP RESISTORS

Standard values.

	1-9	10+
6 Pin	0 50	0.40
8 Pin	0 60	0 50
10 Pin	0 65	0.60

MINITURE BUZZER

5-15V White or black

	10-99	100+
Cat. A15062	0.90	0 80

Plus 20% tax where applicable

RCA INSULATING SOCKETS

Cat No.	Desc	1-99	100+
P10232	2 Way	0 25	0 21
P10234	4 Way	0.45	0 40
P10236	6 Way	0.75	0 60

Plus 32½% tax where applicable

RCA CHASSIS MOUNT METAL

Cat No.	1-99	100+
P10231	0.16	0 13

Plus 32½% tax where applicable

MONITORS

Cat No.		1-3	4+
X14500	Ritron 1 Green	$140 00	$135 00
X14502	Ritron 1 Amber	$145 00	$140.00

WHILE STOCKS LAST
Plus 20% tax where applicable

RITRON II

Swivel base monitor in stylish case

	1-9	10+
Green Cat. X14506	$169	$159
Amber Cat. X14508	$179	$169

Plus 20% tax where applicable

FANS

		1-9	10+	100+
240V	4½"	10 50	10 00	8 00
240V	3½"	10.50	10 00	8 00
115V	4½"	10.50	10 00	8 00
115V	3½"	10 50	10 00	8.00

Plus 20% tax where applicable

VOLTAGE REGULATORS

	10+	100+	1000+
7805uC	45	44	43
7805KC	1 50	1 40	1 20
7812uC	45	44	43
7815KC	1.50	1 40	1 20
7818uC	50	49	48
7818KC	1 50	1 40	1 20
7905uC	50	46	44
7912uC	50	46	44
uA323KC	4.50	3 90	3 75
78H12	7 00	6 00	5 90
78HGKC	7 50	6 50	6 00
79HGKC	16 50	16 00	14 00
78P05	11 50	11 00	10 50
78P12	14 00	13 50	13 00

Plus 20% tax where applicable

RESISTORS

¼ WATT E12 CARBON BULK
PACKED $5.25/1000
TAPED AND BOXED $5.25/1000
$5.00/1000 10K LOTS
¼ METAL FILM TAPED AND BOXED
$13.00/1000 $12 00/1000/10K LOT
SUPPLY E24 VALUE
Plus 32½% tax where applicable

NEW SWITCHES

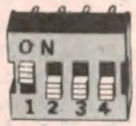
	10-99	100+
SPDT Cat. S11040	1 00	95
DPDT Cat. S11042	1 20	1 00

Plus 20% Sales Tax where applicable

ENCLOSED ROTARY SWITCHES AT SPECIAL PRICES!!

1-9	10+
1 20	1 00

Plus 20% Sales Tax where applicable



DIP SWITCHES

	10+	100+	1000+
S13402 2 Way	70	65	60
S13404 4 Way	80	75	70
S13405 5 Way	90	85	80
S13407 7 Way	1.10	1 00	95

20% Sales tax where applicable

QUALITY MOMENTARY (RED BODY)

	10-99	100+
SPDT Cat. S11050	1 00	90
DPDT Cat. S11052	1 20	1 00

Plus 20% Sales Tax where applicable

ECONOMY TOGGLE SWITCHES

Unbelievable Value!

	10-99	100+
S11010 (SPDT)	0 70	0.60
S11020 (DPDT)	0 90	0 80

Plus 20% Sales Tax where applicable

Please find listed below our special wholesale pricing for a fraction of the range of products we import and are distributors for. Please feel free to ring Peter Jones or Dean Wilson for competitive quotes on all your components and computer peripheral needs. New price lists and products will now be issued at regular intervals. Please note minimum account orders for these prices is $50 per order. Minimum Cash Sale or Mail Order is $20.

Best regards, Rod Irving

Northcote (03) 489 7099 (2 lines)
Clayton (03) 543 2166 (2 lines)

RITRONICS WHOLESALE

Incorporated in Victoria

MAIN WAREHOUSE:
56 Renver Rd., CLAYTON 3168.
Phone (03) 543 2166
HEAD OFFICE:
1st Floor, 425 High St., NORTHCOTE 3070.
Phone (03) 481 1923 Telex AA38897

Don't buy until you've got a quote from us!

MEMORY

"Check for the latest memory prices!"

	10-99	100+	1000+	10K+
4164-15P	$2.70	$2.50	$2.20	$1.80
41256	$14.00	$12.00	$11.00	$8.80
6116P-3	$5.00	$4.90	$4.00	$3.00
2716	$4.90	$4.50	$4.25	$4.00
27128	$12.00	$11.00	$10.00	$8.00
2532	$7.50	$6.50	$6.40	$6.30
2732	$6.50	$6.10	$5.90	$5.50
27256	$29.00	$27.00	$22.00	19.00

Plus 20% tax where applicable

IC's GALORE!

	1-9	10+	100+	250+
8035	3.90	3.70	3.50	3.00
8085	4.00	3.90	3.50	3.00
8088	25.00	23.00	19.00	17.00
8155	3.90	3.75	3.50	3.00
8156	3.50	3.30	2.90	2.50
8212	1.90	1.70	1.50	1.00
8224	2.40	2.00	1.90	1.50
8226	1.90	1.70	1.50	1.00
8253	3.90	3.70	3.50	3.00
8255	4.00	3.50	2.90	2.00
8257	3.90	3.50	3.00	2.50
8259	3.90	3.50	3.30	2.70
8279	3.90	3.50	3.30	2.70

Plus 20% tax where applicable

RING 489 7231 FOR OUR LOW PRICING ON THESE.

Desc	Qty	Desc	Qty	Desc	Qty
7402	3K	74LS02	2K	74LS195	2K
7404	11K	74LS08	2k	74LS245	3K
7405	2K	74LS10	1K	74LS273	3K
7406	12K	74LS14	2K	74LS393	2K
7407	4K	74LS40	1K	UA774	4K
7416	2K	74LS74	12K	UA339	6K
7445	3K	74LS86	2K	1488	7K
7446	2K	74LS123	2K	1489	5K
7447	2K	74LS138	3K	7812UC	4K
7473	1.5K	74LS139	2K	7805UC	5K
7474	1.2K	74LS155	1K	UA555	4K

Plus 20% tax where applicable

ELECTROLYTICS

Cat No	Desc	10+	100+
R1415	1uF 63V PCB RB	0.05	0.04
R15461	10uF 16V PCB RB	0.05	0.04
R15462	10uF 25V PCB RB	0.05	0.04
R15482	22uF 25V PCB RB	0.06	0.05
R15521	47uF 16V PCB RB	0.07	0.06
R15522	47uF 25V PCB RB	0.08	0.07
R15581	1000uF 16V PCB RB	0.21	0.20
R15582	1000uF 25V PCB RB	0.28	0.25
R15591	2200uF 16V PCB RB	0.39	0.33
R15592	2200uF 25V PCB RB	0.55	0.50
R15904	2200uF 50V AXIAL	1.50	1.00

Plus 32½% tax where applicable

RG CAN TYPE WITH LUGS

		1-99	100+
R164585	8000uF 75V	6.00	5.80
R16587	10,000uF	7.00	6.50

Plus 32½% tax where applicable

	10+	100+
R15593 2200uF 35v RB	70	65
R15531 100uF 16v RB	07	06
R15465 10uF 63v RB	07	06
R15535 100uF 63v RB	18	17
R15532 100uF 25v RB	08	07

Plus 32½% tax where applicable

Errors and ommisions excepted

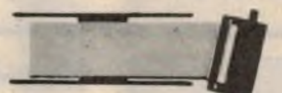
VERBATIM DATA LIFE DISKETTES

	10-99	100+	1000+
SS/DD MD525-01	2.50	2.35	2.25
DS/DD MD550-01	3.20	3.00	2.80

XIDEX DISKETTES

SS/DD	2.50	2.50	2.25
DS/DD	3.40	3.05	2.85

Plus 20% tax where applicable



DIRECT RIBBON FLAT RIBBON CABLE

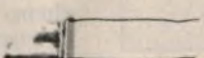
Cat No	Desc	Per Mtr	PER 100 FT ROLL 1-3	4+	10+
W12616	16 Way	1.29	21.50	19.50	19.00
W12625	25 Way	1.40	32.50	29.00	28.50
W12626	26 Way	1.60	34.00	32.00	29.00
W12634	34 Way	1.80	44.00	42.00	39.00
W12640	40 Way	2.20	55.00	52.50	49.50
W12650	50 Way	2.75	62.00	59.50	58.50

EX STOCK
LARGER QUANTITIES NEGOTIABLE
Plus 20% tax where applicable

TELEPHONE CABLE

		1-9	10+
W11302	2 Pair	22.00	21.00
W11303	3 Pair	34.00	32.00
W11310	10 Pair	120.00	115.00

20% Sales tax where applicable



CRYSTALS

Cat No	Frequency	Can	10+	100+	1000+
Y11000	1MHz	HC33	5.50	4.75	4.50
Y11005	2MHz	HC33	2.25	1.95	1.85
Y11008	2.4576MHz	HC33	2.25	1.95	1.85
Y11015	3.57954MHz	HC18	1.20	90	65
Y11020	4.00MHz	HC18	1.30	1.00	75
Y11022	4.194304MHz	HC18	1.40	1.00	75
Y11025	4.75MHz	HC18	1.40	1.00	.75
Y11026	4.9152MHz	HC18	1.40	1.00	75
Y11042	6.144MHz	HC18	1.40	1.00	75
Y11050	8.00MHz	HC18	1.40	1.00	75
Y11055	8.867238MHz	HC18	1.40	1.00	75
Y11070	12.00MHz	HC18	1.40	1.00	75
Y11072	14.318MHz	HC18	1.40	1.00	75
Y11080	16.00MHz	HC18	1.40	1.00	75
Y11085	18.432MHz	HC18	1.40	1.00	75
Y11090	20.00MHz	HC18	1.40	1.00	.75

FULL RANGE OF CRYSTALS AVAILABLE ON INDENT
Plus 20% tax where applicable

DIODES

Cat No	Desc	10+	100+	1000+	10K+
Z10135	IN4148	0.03	0.02	0.015	012
Z10105	IN4002	0.04	0.03	0.03	025
Z10107	IN4004	0.05	0.04	0.03	025
Z10110	IN4007	0.10	0.06	0.05	050
Z10115	IN5404	0.18	0.14	0.11	
Z10119	IN5408	0.20	0.16	0.13	

Plus 20% tax where applicable

TRANSFORMERS

Cat No		1-99	100+
M12851	2851	2.50	2.25
M12155	2155	4.80	4.20
M16672	6672	6.35	6.15

Plus 20% tax where applicable

MITSUBISHI DISK DRIVES

		1-9	10+
4851	5¼"	$160.00	$150.00
4853	5¼"	$220.00	$205.00
4854	5¼"	$250.00	$220.00
2896	8"	$450.00	$420.00

Plus 20% tax where applicable

LOW PROFILE IC SOCKETS

How cheap can they go ??

	10+	100+	1000+	10K
8 Pin	08	07	06	05
14 Pin	10	09	08	07
16 Pin	11	10	09	08
18 Pin	12	11	10	09
20 Pin	13	12	11	10
22 Pin	14	13	12	11
24 Pin	15	14	13	12
28 Pin	19	17	15	14
40 Pin	25	24	22	20

Plus 20% tax where applicable

POLYESTER 100V "GREENCAP" TYPE

Cat No		1-99	100+	1000+
R15131	001uF	0.06	0.04	036
R15137	0012uF	0.06	0.04	036
R15138	0015uF	0.06	0.04	036
R15140	0022uF	0.06	0.04	036
R15142	0033uF	0.06	0.04	036
R15143	0039uF	0.06	0.04	036
R15145	0047uF	0.06	0.04	036
R15146	0056uF	0.06	0.04	036
R15147	0082uF	0.06	0.04	036
R15148	01uF	0.07	0.05	045
R15150	015uF	0.07	0.05	045
R15152	022uF	0.07	0.05	045
R15154	033uF	0.07	0.05	048
R15155	039uF	0.07	0.05	045
R15156	047uF	0.08	0.06	055
R15157	056uF	0.08	0.06	055
R15158	068uF	0.08	0.06	055
R15159	082uF	0.08	0.07	055
R15160	1uF	0.09	0.08	07
R15162	15uF	0.11	0.10	09
R15164	22uF	0.15	0.14	13
R15165	27uF	0.16	0.15	14
R15172	1uF	0.70	0.55	0.50
R15176	2.2u	1.20	1.10	1.00
R15178	3.3uF	1.50	1.20	

Plus 32½% tax where applicable

BRIDGES

	10+	100+	1000+
6A 400V	1.00	0.80	0.75
W02	0.24	0.23	0.20
W04	0.25	0.24	0.21

Plus 20% tax where applicable

74F SERIES

Full range of Fairchild "Fast" series in stock!

	1-9	10-99	100+	1000-
74F00	0.64	0.60	0.56	PLEASE
74F02	0.64	0.60	0.56	PHONE
74F04	0.64	0.60	0.56	
74F08	0.64	0.60	0.56	
74F10	0.64	0.60	0.56	
74F109	0.88	0.83	0.77	
74F11	0.64	0.60	0.56	
74F112	1.30	1.22	1.13	
74F113	1.30	1.22	1.13	
74F114	1.30	1.22	1.13	
74F138	1.50	1.41	1.32	
74F139	1.50	1.41	1.32	
74F148	1.39	1.31	1.22	
74F151	1.50	1.41	1.32	
74F153	1.50	1.41	1.32	
74F157	1.50	1.41	1.32	
74F158	1.50	1.41	1.32	
74F160	3.34	3.14	2.93	
74F163	3.34	3.14	2.93	
74F164	1.88	1.77	1.65	
74F168	3.68	3.45	3.22	
74F169	3.68	3.45	3.22	
74F174	1.73	1.62	1.51	
74F175	2.34	2.20	2.04	
74F181	4.08	3.83	3.57	
74F189	7.15	6.69	6.26	
74F190	3.36	3.15	2.94	
74F191	3.36	3.15	2.94	
74F192	4.72	4.43	4.13	
74F193	4.72	4.43	4.13	
74F20	0.64	0.60	0.56	
74F219	6.78	6.36	5.94	
74F240	2.98	2.79	2.60	
74F241	2.43	2.28	2.13	
74F243	3.70	3.47	3.23	
74F244	2.98	2.79	2.60	
74F245	7.00	6.56	6.12	
74F251	1.64	1.54	1.43	
74F253	1.44	1.35	1.26	
74F257	1.60	1.50	1.40	
74F258	1.63	1.53	1.43	
74F280	1.34	1.26	1.18	
74F283	1.81	1.75	1.59	
74F299	6.94	6.51	6.08	
74F32	0.64	0.60	0.56	
74F322	5.80	5.43	5.07	
74F323	7.66	7.19	6.70	
74F350	3.00	2.81	2.62	
74F352	1.63	1.53	1.43	
74F353	1.63	1.53	1.43	
74F373	3.36	3.15	2.94	
74F374	3.36	3.15	2.94	
74F378	2.04	1.92	1.79	
74F379	2.14	2.01	1.87	
74F381	5.00	4.69	4.37	
74F382	5.20	4.82	4.55	
74F384	11.23	10.53	9.83	
74F385	9.82	9.21	8.60	
74F398	3.82	4.82	4.55	
74F399	2.33	2.19	2.04	
74F521	3.56	3.34	3.12	
74F524	10.69	10.02	9.35	
74F533	3.36	3.20	2.90	
74F534	3.36	3.20	2.90	
74F537	5.02	4.70	4.39	
74F538	5.02	4.70	4.39	
74F539	5.02	4.70	4.39	
74F543	7.06	6.62	6.17	
74F544	6.94	6.51	6.08	
74F545	5.39	5.05	4.72	
74F547	5.17	4.84	4.52	
74F548	4.47	4.19	3.91	
74F568	3.94	3.70	3.45	
74F569	3.94	3.70	3.45	
74F582	9.87	9.25	8.64	
74F583	7.33	6.87	6.42	
74F588	5.69	5.34	4.98	
74F64	0.60	0.57	0.53	
74F675	1.22	1.14	1.06	
74F74	0.64	0.60	0.56	
74F86	0.88	0.81	0.76	

Plus 20% tax where applicable

Minimum wholesale cash sale purchase $20

ADDRESS ALL MAIL ORDERS TO
P.O. Box 235, NORTHCOTE VIC 3070
Minimum P/Pack $3.00
Minimum Account P/Pack $5.00
Comet Road Freight is extra, for items that are bulky and/or over 10Kg
Bankcard, Mastercard, Visacard Welcome

FAIRCHILD DISTRIBUTORS
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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. As a consequence, we cannot accept responsibility, enter into correspondence or provide constructional details.

Infrared remote keyboard

In March, an infrared data link was described in these pages. This month the entire remote keyboard is presented. The keyboard is powered by a rechargeable battery, and has provision for hardwire operation as well as infrared operation.

The heart of the remote keyboard is IC1, an MM57499 serial keyboard interface. This chip scans a 96 key keyboard and outputs ASCII data serially. This chip has many functions built in, and the reader is referred to the National Semiconductor applications notes for further details.

The clock input for the keyboard interface is obtained from the three gate oscillator formed by IC3a, IC3b and IC3c. This oscillator is designed to run at a frequency of 895kHz and trimpot VR1 is included to trim the frequency to this value.

IC2, an 8-bit parallel out shift register is used to display the status word generated by the keyboard encoder. This feature could be omitted if desired. D1, the 100kΩ resistor and the 0.1μF capacitor form a power on reset network.

The serial data appears at pin 24 of the MM57499. Transistor Q2 drives the optocoupler IC4, which provides isolation between the keyboard and the computer when the two are connected directly.

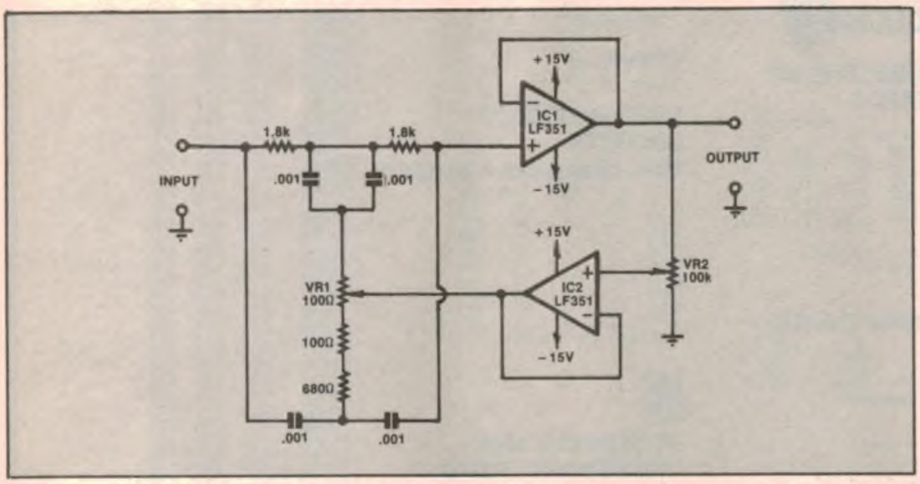
The data is also used to modulate the infrared transmitter, published in March. The only difference between the circuit presented in March and this one is the network containing D20, D21, the 100kΩ resistor and the 1μF capacitor. This network provides a turn on delay to the 100kHz oscillator to prevent the turn on glitch produced by the MM57499 being transmitted. ►

The power supply for the remote keyboard is based around 4 C-sized Nicad cells. These are connected via a fuse and an on/off switch to the circuitry. No regulation is required since all ICs are MOS types. Q1 and associated components form a "battery OK" indicator. The voltage level at which the LED extinguishes can be adjusted by means of trimpot VR2.

The prototype used a Jameco 62 key keyboard — those keys that are not required are simply left open circuit. The keyboard and electronics were housed in a sloping front keyboard case, with the infrared LEDs mounted along the top edge, so that as much of the LED body as possible is protruding through the case.

A. Sinton,
Taupo, New Zealand.

$30



88kHz notch filter for CD players

This notch filter was developed in the EA lab for use when testing compact disc players which use the oversampling technique. These machines have a residual output signal at 88.2kHz which, although well out of the audio band, masks the noise and distortion signals, making them unmeasurable.

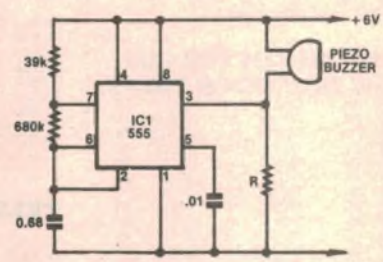
The filter is used between the CD player output and the input of the distortion measuring equipment. There are two controls to be adjusted: VR1, which allows the notch to be tuned over a small range; and VR2, which allows the Q of the circuit to be set.

The circuit is a standard active twin-T filter with component values selected such that the notch is centred at the desired frequency. Ideally, close tolerance components should be used in the circuit.

Total harmonic distortion of the circuit is around .005% at 1kHz and 2V RMS, remaining below .01% right up to 80kHz. While this is not sufficiently low to enable definitive measurements of CD player distortion, the circuit does allow signal-to-noise ratio and separation between channels to be determined.

A. Levido,
Electronics Australia.

Hee-haw siren using piezo buzzer



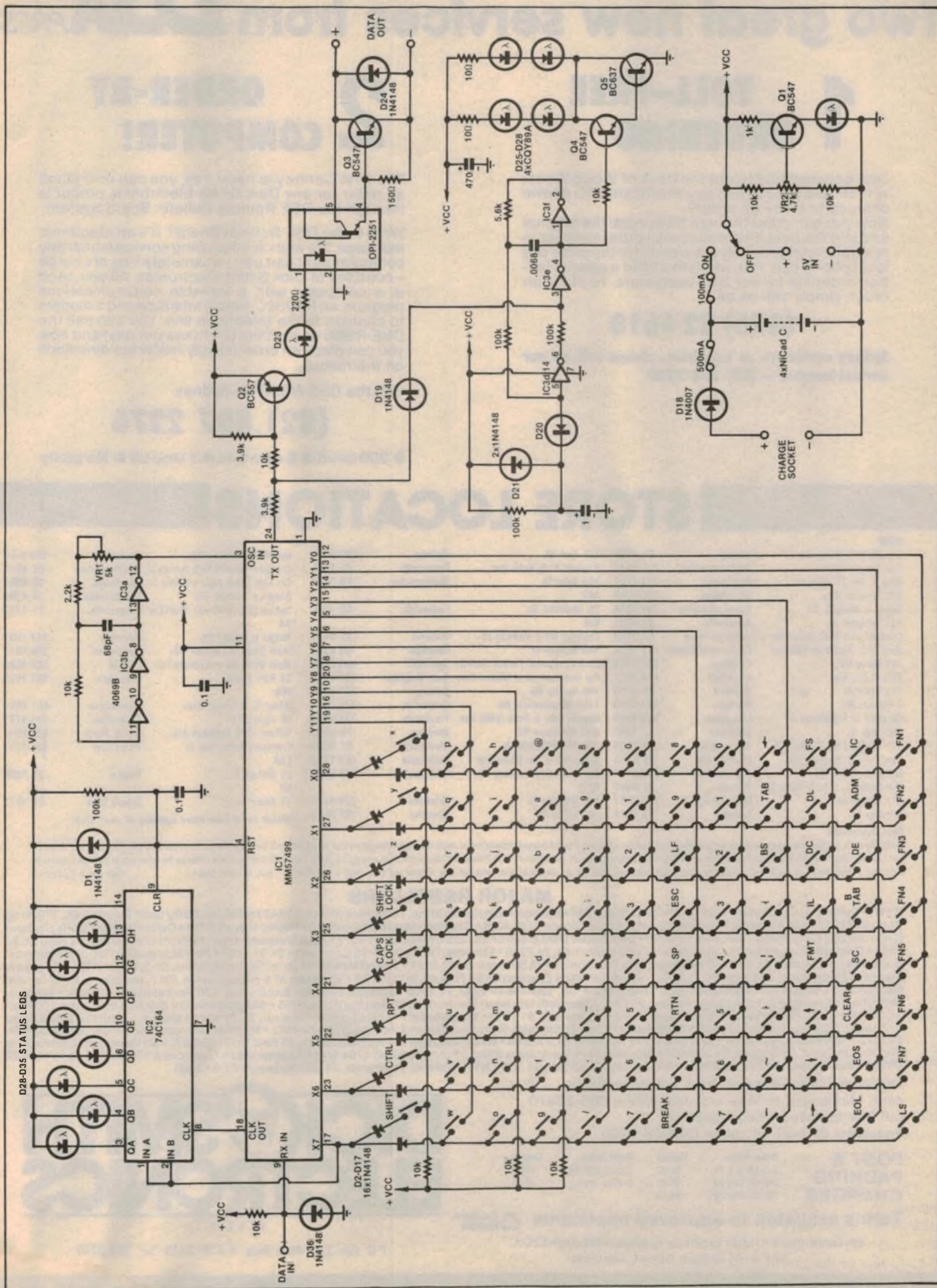
Most small piezoelectric buzzers change pitch and intensity with supply voltage, and hence current. This can be put to good effect to produce a simple hee-haw siren sound, either as an alarm or for model use.

A 555 timer wired as an astable is used to pulse the buzzer in the normal way as shown in the circuit diagram. The difference here is that resistor R is added to bleed a small current through the buzzer when it would otherwise be silent. A suggested starting value for R is 39Ω, but this may need to be varied somewhat in individual cases. Alternatively, a 6.3V 150mA pilot lamp could replace R to give a visual backup to the sound effect.

Using the components shown, the pulse rate frequency of the 555 is 1.5Hz.

D. Bolton,
Mt Waverley, Vic.

$15


D28-D35 STATUS LEDS
IC2 74C164
IC1 MM57499
IC3 4069B
OPI-2251
Q1 BC547
Q2 BC557
Q3 BC547
Q4 BC547
Q5 BC637
D25-D28 4xCQY89A
D18 1N4007
D19 1N4148
D23
D24 1N4148
D1 1N4148
D36 1N4148
D2-D17 16x1N4148
4xNiCad C
CHARGE SOCKET
5V IN
DATA OUT
DATA IN
VR1 5k
VR2 4.7k
100mA
500mA
ON
OFF
BREAK
RTN
SP
ESC
LF
TAB
SHIFT
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Circuit & Design Ideas

Infrared diode amplifier

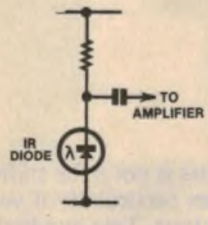


Fig. 1

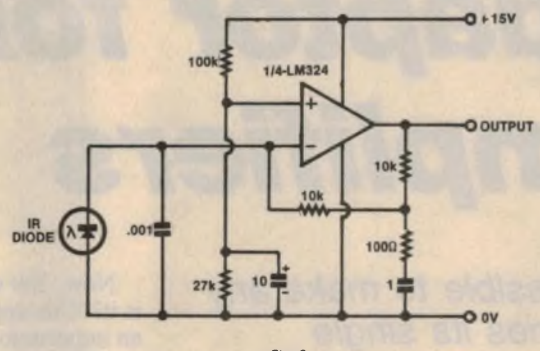


Fig. 2

A problem which often occurs with modulated infrared beam systems is that of detector diode saturation under conditions of high ambient light. Saturation of the diode results in poor gain. Any attempt to reduce the effect by lowering the value of the series resistor results in decreased sensitivity to the wanted signal. This problem is basically a result of the simple bias system that is usually used (Fig. 1).

Some years ago, the front end stage shown in Fig. 2 was designed for a VDU optical touch pad system. The system had to cope with a wide variation in ambient light conditions, including indirect sunlight and fluorescent lighting. The beam was modulated at 3kHz.

The diode is reverse biased at 3V by 100kΩ and 27kΩ resistors in conjunction with the two 10kΩ feedback resistors. The two 10kΩ resistors provide current feedback under high ambient light conditions, providing the high dynamic range of the unit.

Frequency response of the amplifier is set by the 100Ω resistor and 1μF capacitor which roll off the response below 1kHz. This gives a reasonable degree of attenuation at 50Hz and 100Hz, which is necessary to avoid interference from room lighting. The amplifier has maximum gain at about 5kHz, just above the modulating frequency. High frequency rolloff is determined by the natural response of the op amp.

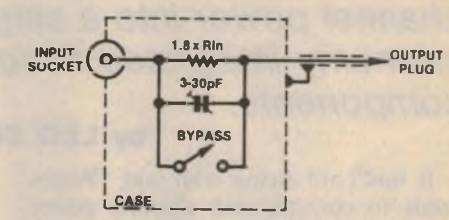
The .001μF capacitor provides protection from RF interference while the 10μF capacitor attenuates supply noise at the bias divider.

G. R. Grey,
Christchurch, NZ. **$20**

CRO adaptor for RMS measurements

A simple voltage divider adaptor can be used to allow a CRO to indicate directly the RMS value of a sine wave input. It consists simply of an appropriate value resistor in series with the input resistance of the CRO.

In the case of the usual 1MΩ input impedance, a 1.8MΩ resistor is used in parallel with a 3-30pF trimmer capacitor. A bypass switch could be included to restore the peak-to-peak reading when necessary. For CROs with Rin other than 1MΩ, simply use a total adaptor resistance of 1.8 x Rin.



The components should be mounted in a small earthed metal case and the output brought out on a short length of coax fitted with the appropriate plug. The input is terminated on a suitable socket mounted on the case.

The trimmer capacitor should be adjusted, with a square wave input to the adaptor, to restore the "squareness" of the signal. Once set for a particular CRO, it should need no further adjustment. Since many CROs have a vertical calibration accuracy of not better than 10%, resistors of 5% tolerance should suffice for most applications.

D. Bolton,
Mt Waverley, Vic. **$10**

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For those who seek more power

Bridge adaptor for stereo amplifiers

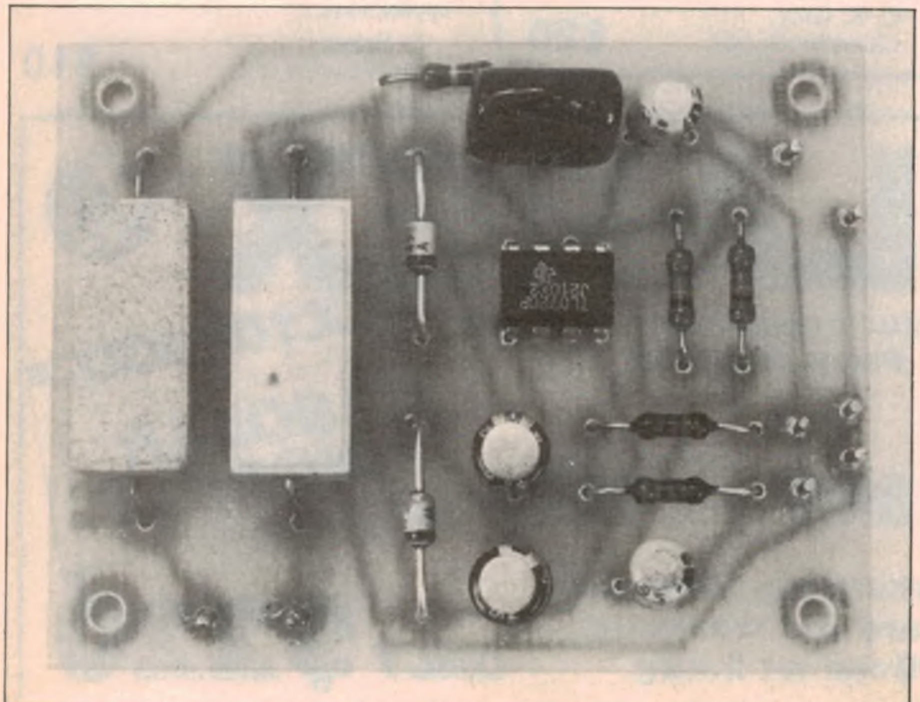
With this simple circuit it is possible to make any stereo amplifier deliver four times its single channel power into a single load. It uses just one economy integrated circuit and a few other components.

by LEO SIMPSON

It was Lord Acton who said, "Power tends to corrupt, and absolute power corrupts absolutely. Great men are almost always bad men". However, since he lived last century, he couldn't have been thinking of audio power. As far as the average audio enthusiast is concerned, "Power is good and more power is better". The only way in which corruption may enter is if you scheme and rob to get it. If you are a power hungry audiophile, it is not necessary to be a tea-leaf to get it. Many of us have stereo amplifiers which we don't use any longer. We may have bought a new system and the old amp has been relegated to the storeroom.

Often those older amplifiers have little wrong with them, particularly as far as the power amplifiers are concerned. They may have nois phono inputs, the volume control may be scratchy or the whole unit may look on the dowdy side. But if the amplifier has a rating of, say, 50 watts per channel (into 8-ohm loads), it is not to be overlooked. Fifty watts is not such a large rating these days but by adding this simple circuit we are about to present, it could be turned into a powerful mono amplifier capable of delivering 200 watts into an 8-ohm loudspeaker.

Below is a larger than lifesize photo of the assembled PC board.



Now, 200 watts is not to be sniffed at, is it? This applies particularly if you are an impecunious type. Two hundred watt amplifiers are not cheap.

The way to get this high power is to connect both channels of the amplifier so that they both drive the loudspeaker, in push-pull. In other words, the loudspeaker is connected across the active outputs of the two amplifiers, with no connection to ground. Fig.1 shows the general concept.

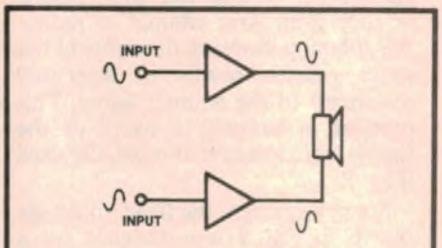


Fig. 1

In the normal course of events, if two amplifiers were connected in this way and both were fed the same input signal, virtually no sound would be heard in the loudspeaker. Any sound heard from the loudspeaker would represent the slight difference in gains between the two power amplifiers. If the two power amplifiers were absolutely identical in every respect, ie, in gain, frequency response, phase response, distortion and so on, then absolutely nothing would be heard from the loudspeaker.

But if we were to feed one power amplifier with a signal which was identical to the signal in the other channel but reversed in phase, we would get an entirely different result. Each amplifier would work in the way it was intended, delivering a substantial signal from its output terminal. If we examined each output with an oscilloscope we would find the same signal at each end of the loudspeaker, which is not surprising.

If we then were to measure the signal applied across the loudspeaker, we would find that it would be the sum of the amplifier outputs. So if each amplifier was delivering 20 volts RMS, the voltage for 50 watts into an 8-ohm load, we would find a total of 40 volts across the loudspeaker. And by doubling the voltage, we get four times the power! All that, just by reversing the phase of one channel. Two hundred watts!

This concept is called "bridged mode" and power amplifiers operated in this way are said to be "bridged".

Well, the concept is great as far as you, the power hungry audiophile is concerned, but what does it mean to the amplifier? Is it going to be quite happy doing far more than you ever thought possible? You could say, "Who cares?" After all, it is not a beast of burden. It is inanimate. But there are ramifications which we should consider.

Think about what happens when each power amplifier drives the loudspeaker. If it delivers eight volts RMS to an 8-ohm loudspeaker in the normal course of events, we would expect one ampere of current to flow. But since there is an amplifier at the other end of the speaker also applying eight volts, the resultant current is two amps. So as far as each amplifier is concerned, it does not "see" an 8-ohm loudspeaker; it "sees" a 4-ohm loudspeaker. Hmm. For a given output voltage, twice the current flows. That is why we get twice as much power from each amplifier.

What this means is that we cannot extend the concept indefinitely. We cannot look at the ratings and say, "Ahah, this amplifier gives, say, 90 watts, into 4-ohms, with both channels driven, therefore I can get 360 watts in bridge mode". That isn't possible, unless the amplifier can safely handle 2-ohm loads at full power. That is what it would be required to do. Many amplifiers would blow their output transistors under this treatment and even the most rugged could be expected to blow their fuses.

There is another proviso too. Since each power amplifier driving an 8-ohm loudspeaker in bridge mode sees a 4-ohm load, a more accurate guide to the power we can expect is provided by the 4-ohm ratings. Most amplifiers are not able to deliver twice the power you expect into 8-ohms. For example, if an amplifier is rated to deliver 50 watts into 8-ohms, it might only deliver 90 or less watts into 4-ohm loads. This is because of inevitable losses in the power stages themselves and less than perfect regulation in the amplifier's power supplies. (Many amplifiers have fairly poorly regulated power supplies and so they do not deliver much more power into 4-ohm loads than they do into 8-ohm loads.)

Such a stereo amplifier (delivering 90 watts into a 4-ohm load) can only be expected to deliver 180 watts into an 8-ohm load when operating in the bridged mode. Still, while it is not the full 200 watts it is still a very worthwhile increase. And the power capability on musical peaks can be expected to be a little above the continuous power. So a closer guide to the full power output of a stereo amplier in bridge mode, into 8-ohm loads, is "double the rated power output into 4-ohm loads".

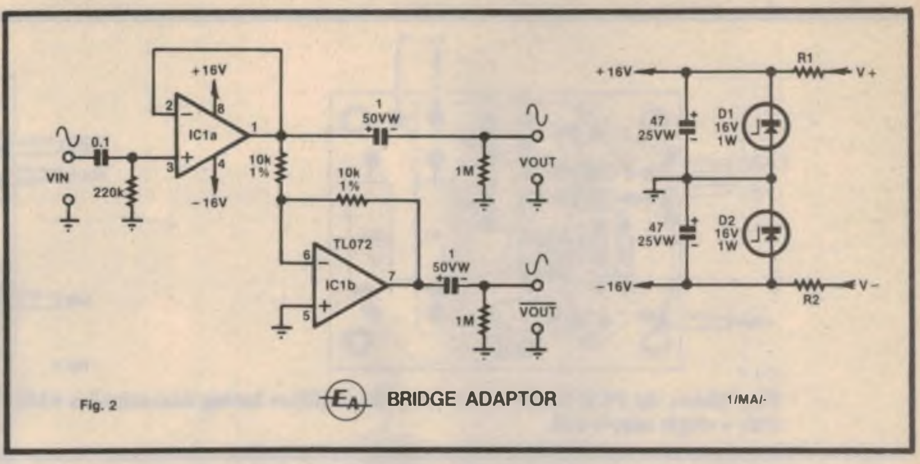


Fig. 2

IC1a is a non-inverting voltage follower while IC1b functions as a unity gain inverter.

Specifications

Input impedance	220kΩ
Output impedance	< 1kΩ
Gain	unity
Maximum input and output	> 8V RMS
Frequency response	10Hz to 300kHz ±1dB
Harmonic Distortion	< .001% @ 8V RMS
Signal/noise ratio	−104dB with respect to 1V RMS and with 1kΩ source impedance

The circuit

Now let us have a look at the circuit of the Bridge Adaptor in Fig.2. It really is dead simple; just a pair of op amps in a single IC package. We used a TL072 dual Fet-input op amp which has good noise and distortion performance, and is cheap and readily available.

The first op amp, IC1a, is connected as a non-inverting voltage follower stage. Since it has its output connected directly to its inverting input, it has 100% negative feedback applied around it. This results in the op amp having unity gain which is why it is called a "voltage follower"; any input signal is reproduced exactly at the output. IC1a also has a very low output impedance as a result of

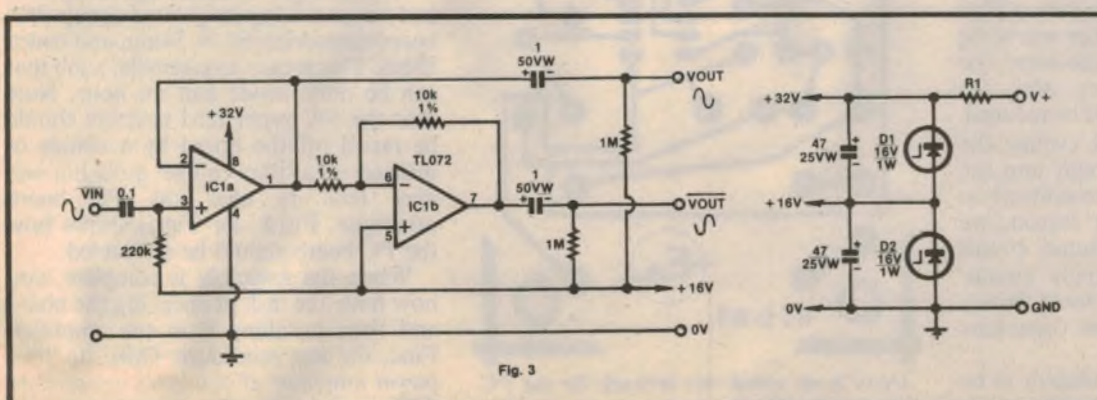


Fig. 3

This diagram shows how the power supply circuit is modified for amplifiers with a single supply rail.

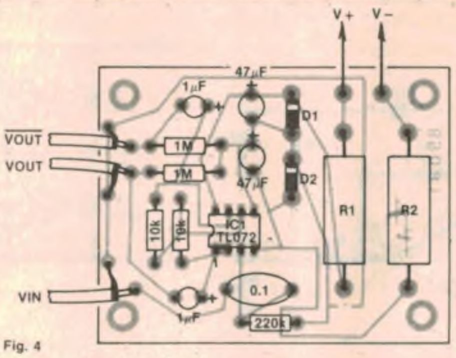


Fig. 4

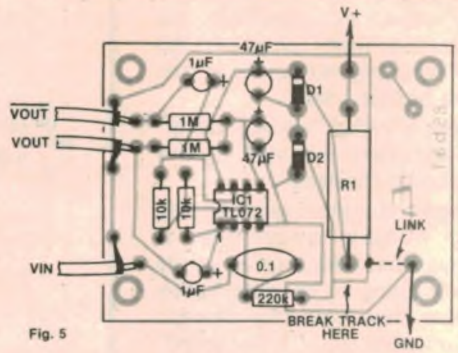


Fig. 5

Fig.4 shows the PCB layout to be used with amplifiers having dual suipplies while Fig.5 shows the layout for amplifiers with a single supply rail.

Bridge adaptor

the 100% feedback, and a high input impedance, which is set by the 220kΩ resistor at pin 3. This means that it performs well as a buffer stage.

The output of IC1a is fed in two directions. The first is to one of the circuit outputs, via a 1µF capacitor. The other is to the input of IC1b. This op amp is set up as a unity gain inverter, so that its output signal will have exactly the same amplitude as the input but reversed in phase by 180°.

We have used relatively low value input and feedback resistors (10kΩ) for IC1b, to ensure low noise output. After all, we want the Bridge Adaptor to have as low a noise and distortion output as possible, to avoid degrading the performance of the amplifiers as much as possible. The accompanying specification panel shows that we have achieved that aim.

Note also that we have specified 1% tolerance resistors for IC1b. This is to ensure that the gain of this stage is as close to unity as possible. The reasoning behind this is to make sure that the amplitudes of the two output signals from the Bridge Adaptor are almost exactly equal. This ensures that the following power amplifiers "see" the same load value and will ultimately "clip" at the same time, giving maximum power output. If one amplifier was to be driven slightly harder than the other, the former would clip sooner and the ultimate power output would be reduced.

In the normal course of events, the Bridge Adaptor would be built into the stereo amplifier you wish to convert to bridge operation. For this reason, we have included, on the printed circuit board, a simple power supply circuit. This employs two 16V/1W zener diodes, together with 47µF bypass capacitors and 5W resistors.

This enables the Bridge Adaptor to be powered from the balanced supply rails

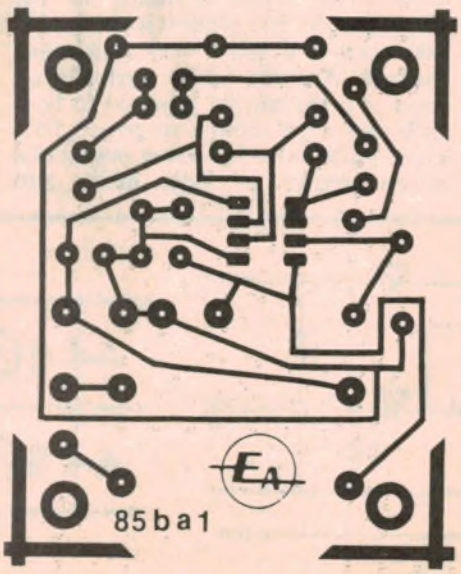
TABLE 1

Dual supplies	
Voltage range	R1, R2
20 to 45V	470Ω/5W
45 to 72V	1.2kΩ/5W
70 to 100V	5.6kΩ/5W

Single supply	
Voltage range	R1
40 to 60V	470Ω/5W

of most solid-state amplifiers. It will be necessary to select the zener feed resistors to suit the amplifier supply rails. Table 1 shows values and power ratings for a range of supply voltages.

If the stereo amplifier proposed for conversion has output coupling capacitors and therefore a single supply rail, it will be necessary to modify the power supply circuit, as shown in Fig.3. This involves the use of a single feed



Above is an actual size artwork for the PC board (code 85ba1).

resistor and connection of the negative supply point to the printed circuit board earth connection. It will also be necessary to modify the printed circuit layout slightly, as shown in Fig.5.

Before you can construct the Bridge Adaptor, you will have to discover what are the voltages of the main DC supply rails in your amplifier. If you have the amplifier service manual, this is easy. Look at the circuit of the power amplifiers and check the value of the supplies feeding the power output stages. These are usually the highest DC voltages within the unit. That done, check the recommended value of feed resistors in Table 1, and you can start construction.

If you don't have access to the amplifier's service manual, you will have to measure the supply rails. You will need a multimeter switched to the 100V DC range. Now check the voltages across the main electrolytic filter capacitors. These will usually have a value of 1000µF or considerably more, in most cases. And be careful now when measuring the two supply rails. Remember that one will be reversed in polarity to the other and it will be necessary to reverse the leads to your multimeter when measuring the negative supply rail.

Construction

As noted above, the Bridge Adaptor is laid out on a compact printed circuit (PC) board measuring 69 × 54mm and coded 85bal. This is easy to assemble, a job that can be done inside half ar. hour. Note that the 5W zener feed resistors should be raised off the board by a couple of millimetres as they can get quite hot and may tend to char the PC board otherwise. Fig.4 (or Fig.5) shows how the PC board should be assembled.

When the assembly is complete, you now have the task of checking the board and then installing it in the amplifier. First, the test procedure: Open up your power amplifier, if you have not already done so, and identify the main supply filter capacitors. You will have to run the supply leads to the Bridge Adaptor directly from these filter capacitors. Do not run the supply leads from the main output transistor collectors of the power amplifiers. That would be asking for trouble and may result in unstable amplifier operation.

Temporarily run positive and negative supply leads from the stereo amplifier to the Bridge Adaptor. You will need an earth lead too. This can be run from one of the power amplifer input earths.

Now turn on the power and measure the voltages across the two zener diodes. They both should be within ±0.5V of 16V. Check also that the 16V supplies are present at the IC: +16V at pin 8 and −16V at pin 4. Now check that the output voltage of each op amp is very close to zero, ie, pin 1 and pin 7 should be no more than +100mV DC.

Now you have to select a position within the stereo amplifier to install the Bridge Amplifier board. It should be kept away from the amplifier output stages and the power transformer. At the same time, do not place its input and output leads too close to sensitive phono input stages. Within all these restraints, it should be possible to find a suitable spot. If not, it may be worthwhile to consider installing the Bridge Adaptor inside a metal or plastic box on the rear panel of the amplifier.

When you have mounted the PC board in position in the amplifier, you can run the supply leads mentioned earlier. Do not run a separate earth lead as this function will be performed by one of the shielded cables carrying the output signal. Note that it will be necessary to disconnect the existing power amplifier inputs.

PARTS LIST

- 1 PC board, 69 x 54mm, coded 85ba1
- 1 TL072, LF352 dual Fet-input op amp IC
- 2 16V/1W zener diodes
- 1 0.1μF/100VW metallised polyester capacitor (greencap)
- 2 1μF/50VW PC-mounting electrolytic capacitors
- 2 47μF/25VW PC-mounting electrolytic capacitors

Resistors

2 x 1MΩ, 2 x 220kΩ, 2 x 10kΩ 1%, 2 x 1.2kΩ/5W wirewound or as selected from Table 1 (see text)

Miscellaneous

8 PC pins, PC board mounting hardware, hook-up wire, shielded cable, RCA panel-mount socket (optional)

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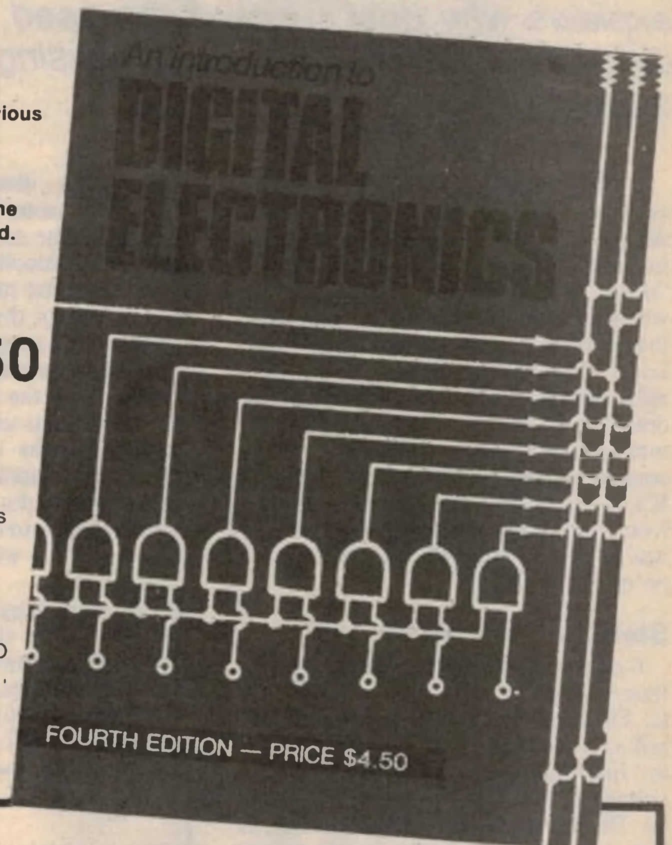

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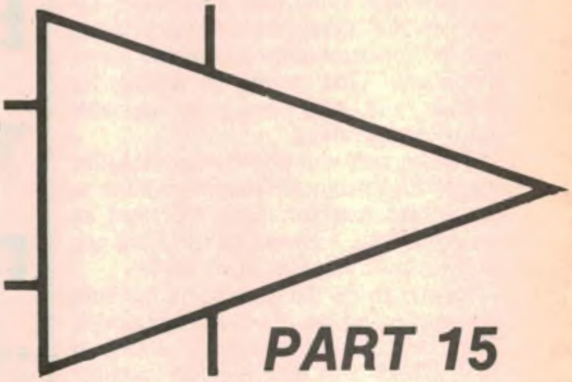
2. Basic logic elements
3. Logic circuit "families"
4. Logic convention and laws
5. Logic design: theory
6. Logic design: practice
7. Numbers, data & codes
8. The flipflop family
9. Flipflops in registers
10. Flipflops in counters
11. Encoding and decoding
12. Basic readout devices
13. Multiplexing
14. Binary arithmetic
15. Arithmetic circuits
16. Timing & Control
17. Memory: RAMS
18. ROMs & PROMs
19. CCD's & magnetic bubbles
20. D-to-A Converters
21. A-to-D Converters
Glossary of terms, index

by BRYAN MAHER

OP AMPS Explained



PART 15

This chapter discusses the power supply requirements of operational amplifiers and explains why dual supplies are used. Also discussed are decoupling, bypassing and power supply rejection.

All operational amplifiers, being active circuits, need some form of power supply. Various names traditionally used include "supply", "power supply", "power source", "bus" and "rail", all of which mean exactly the same thing. The first three are obvious, but "bus" (from Latin "omnibus" = "for all") and "rail" refer directly to the conductor line we draw on circuit diagrams, for example marked +15V. Such conductors may connect power to many amplifier stages, ICs or transistors and "rail" is a hangover from valve days when a bare copper bar was used so that stages could be clipped on or off in testing.

Standard practices

Common drawing practices, to save time, include:

(a) Drawing the actual power supply, the rail and connections as Fig. 1(a).

(b) Just drawing blocks, marked with a voltage, to indicate supply, as Fig. 1(b).

(c) The drawing of only a straight line, as Fig. 1 (c) to indicate the supply rail or bus, leaving the details of the necessary power supply itself somewhere in your imagination.

(d) Drawing nothing at all of the power system, on the assumption that you know that power supplies must exist and you will even be familiar with the correct pins of the IC for the connections. Fig. 1(d) illustrates this drawing shorthand practice, mostly reserved for integrated circuits. Many 8-pin linear ICs use pin 7 for positive supply and pin 4 for negative, but beware, this is by no means universal and you must check the data sheets if uncertain.

Fig. 1(b) illustrates an essential connection sometimes overlooked by beginners. The centre connection of the dual power supplies **must** be connected to the zero line and ground and also to the low side of the source voltage.

Each op amp design requires an appropriate supply voltage, taking into consideration the load to be driven and the components used. For example, if we want ±5 volts output swing from a stage, any supply voltage somewhat higher would do, eg, ±9V, ±12V or ±15V. Which to choose? It's a matter of convenience, within the following constraints:

(a) Supply voltage usually must exceed required output voltage.

(b) Supply voltage must not exceed the op amp ratings. For example, for National's LM101A the supplies must not exceed ±22V. For the LM301A, the limit is ±18V while for the Analog Devices 171K module op amp the limit is 150 volts.

(c) Every circuit has an absolute minimum supply voltage, below which operation is not guaranteed. For example contrast the older type 302 IC which required a supply greater than 12 volts with National's type LM4250 which will work happily on ±1V

Dual supplies

A question which has vexed electronic enthusiasts for years is "Do we really need dual voltage supplies to run our circuits??" And older enthusiasts may object that years ago they never used more than a single power supply for their valve circuits. So why now? Looking objectively at the question it boils down to this:

(1) Do you want your amplifier to be DC-coupled?

(2) If so, do you want input and output to swing across zero, ie, positive to negative and back?

(3) When input and output are both zero volts, do you simultaneously want low output impedance?

A "yes" to all three questions means that you must use dual supplies, one

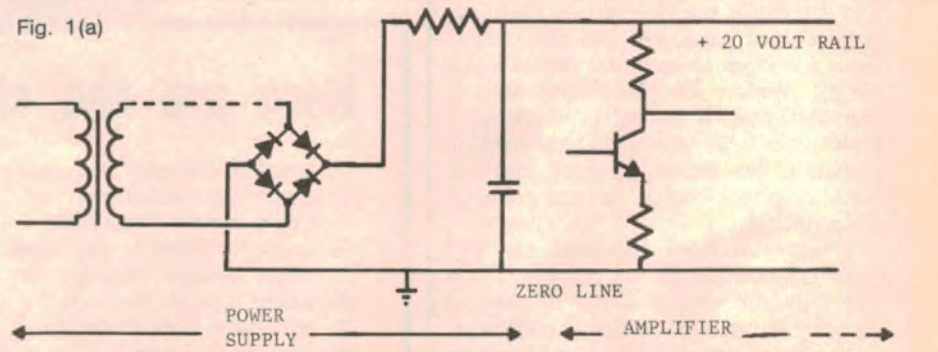


Fig. 1: four different methods of drawing power supply connections to an amplifier. (a) is only drawn for special circuits; (b) is drawn for inexperienced students for their first metting with dual power supplies; (c) is drawn if there is uncertainty as to pin numbers; and (d) shows the entire power supply system omitted from the drawing.

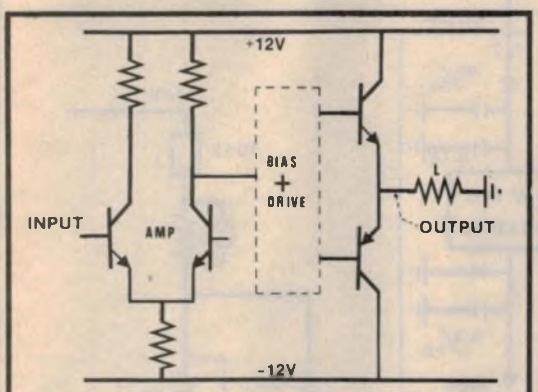


Fig. 2: only by using dual power supplies can we provide a low impedance DC-coupled output capable of swinging both positive and negative (feedback not shown).

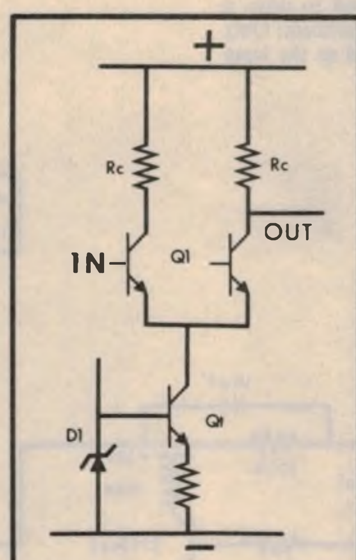


Fig. 3: the long tail pair. Only by using dual rails can this circuit be DC-coupled to its input signal source. The bias will then look after itself.

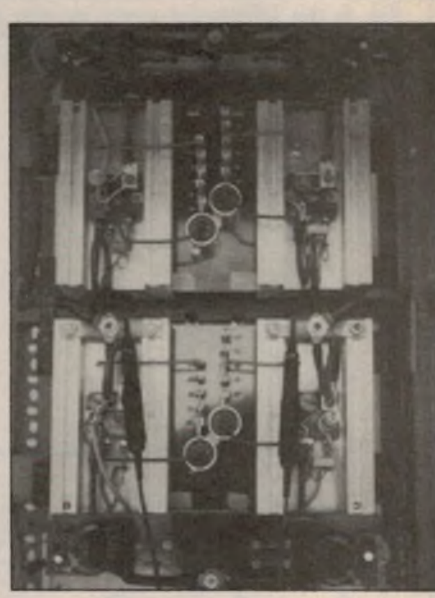


Fig. 4: this 6kW power output stage operates happily from a single power supply. Four NPN transistors are used, as shown in Fig. 5. (Photo courtesy P. Wolfs, Capricornia Institute, Rockhampton.)

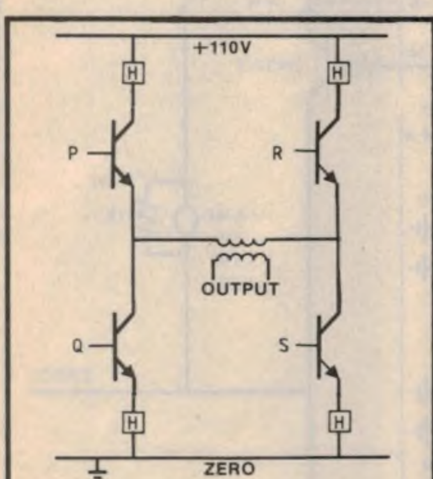


Fig. 5: basic circuit of the 6kW power stage of Fig. 4. Note single supply rail (+110V at 60A). Positive and negative output voltages are made possible by transformer coupling to the output. P, Q, R and S are separate drive points.

positive and one negative. They do not have to be the same voltage but they usually are for convenience.

Why is it so that twin supplies are necessary? Consider Fig. 2, a fundamental op amp circuit of an IC and its "innards" in a phase reversing or inverting op amp configuration. Only by using positive and negative supplies can this circuit fulfil each of the three conditions above.

We observe that:

(1) The circuit is DC-coupled.

(2) Input may be positive, zero or negative and always the output will obey the gain equation:

$$V_{out} \text{ approx} = -(R_f/R_i)\,V_{in}$$

provided the voltage at pin 2 and the output pin 6 are within limits (always some margin within the supply rail voltages). Except for the class-B output transistors every NPN base is always considerably more positive than its emitter and less positive than its collector, so such transistors remain in linear conduction and have gain at all times. The same applies for all PNPs, with reverse polarities of course. Therefore the open loop gain G remains high for all such inputs, including zero.

It follows that the closed loop gain T continues to obey the well known equation:

$$T = V_{out}/V_{in} = G/(1+GH)$$
$$= -(R_f/R_i)(G/(1+G+(R_f/R_i))$$

Furthermore, the system remains operating as a negative feedback amplifier meaning that the output impedance Zo is given, as in earlier episodes of this tale, by the natural output impedance of emitter followers (perhaps 100Ω) divided by the feedback factor (1 + GH). Now if G = 100,000 and H = 1/10 then:

$$T \text{ approx} = 10$$
$$Z_o = 100\Omega/(1+(100{,}000(1/10)) = 10\text{m}\Omega$$

This low output impedance is valid

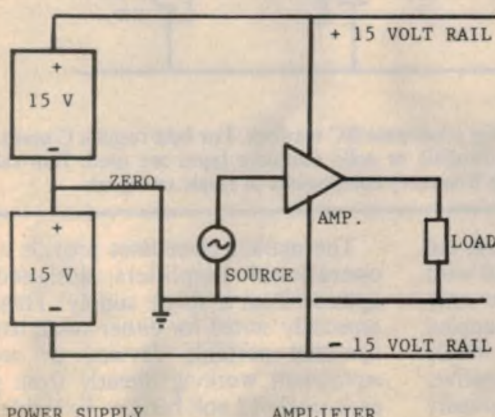


Fig. 1(b)

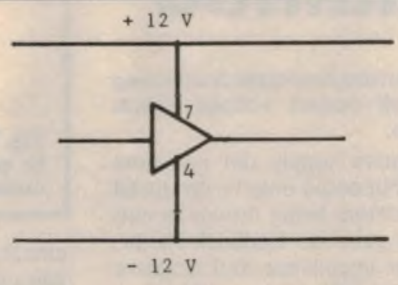


Fig. 1(c)

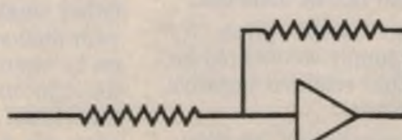
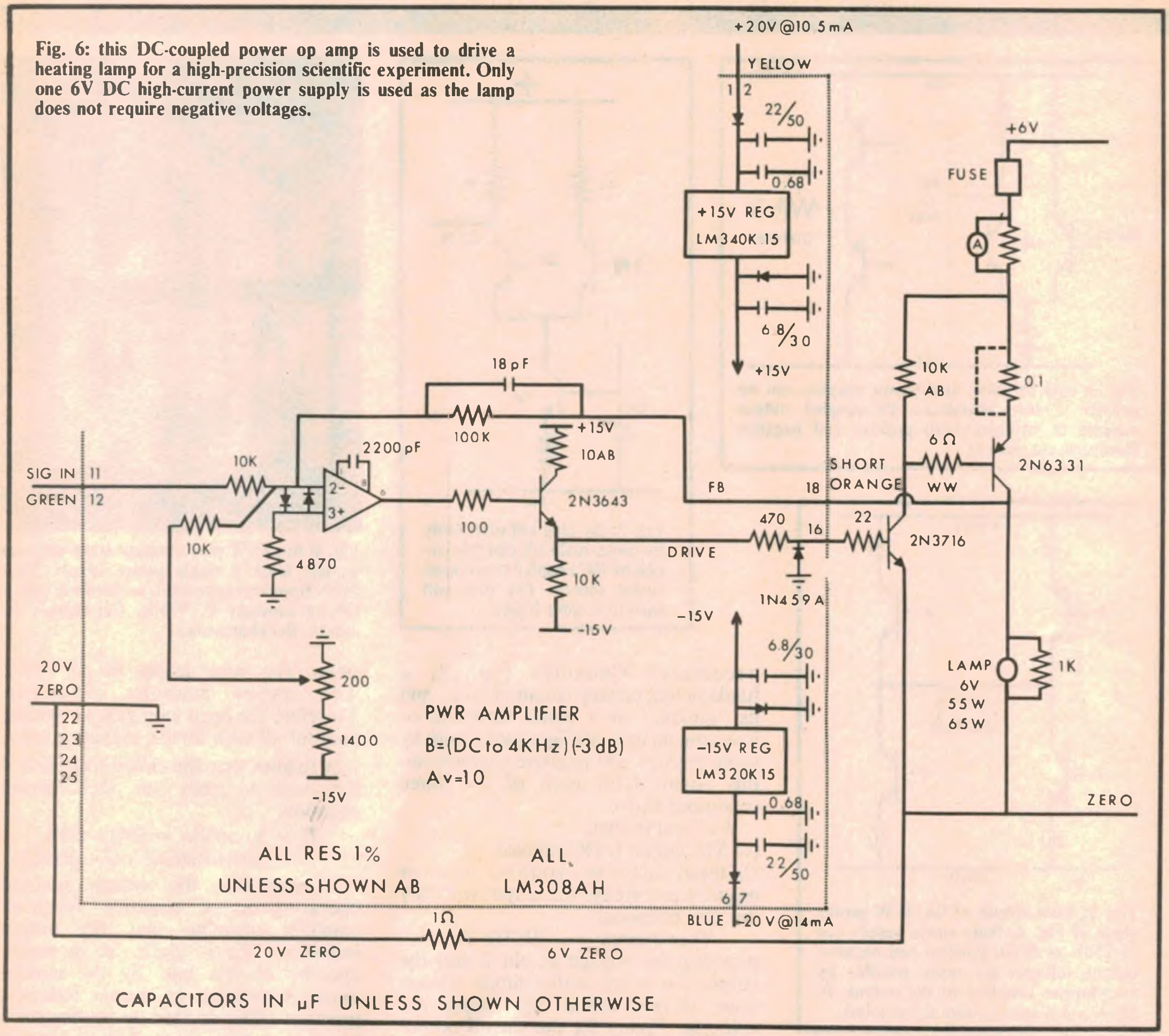


Fig. 1(d)

Fig. 6: this DC-coupled power op amp is used to drive a heating lamp for a high-precision scientific experiment. Only one 6V DC high-current power supply is used as the lamp does not require negative voltages.



OP AMPS Explained

because all transistors remain conducting to produce all output voltage values including zero.

If the negative supply did not exist then zero output could only be produced by some transistors being driven to cut-off, hence no gain, no feedback factor, no low output impedance and negative voltage output could not be achieved.

Of course, the reasons given for needing a negative supply would hold for any circuit at all that required negative voltage output at times.

Apart from the question of necessity, dual supplies allow wider choice of circuit. For example the simple long tail pair depicted in Fig. 3, can be used with either single or dual supplies. But only with dual supplies can it be DC-coupled (at its input) to the outside world. While the input may swing positive or negative, the virtual earth point x automatically takes on a voltage level exactly "one junction voltage" below the input.

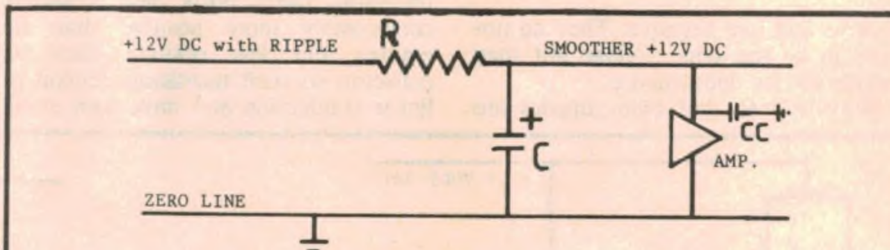


Fig. 7: an example of decoupling using a low-pass RC network. For best results, C needs to be quite large, hence polarised electrolytic or solid tantalum types are used. Low-value ceramic capacitor CC bypasses high frequency components of ripple or signal.

The market place does provide a few operational amplifiers designed to operate from a single supply. They are especially suited for either small battery operated portable devices, or mobile equipment working directly from your car's single 12 volt battery. Examples are Motorola's LM158-258-358 and LM2904.

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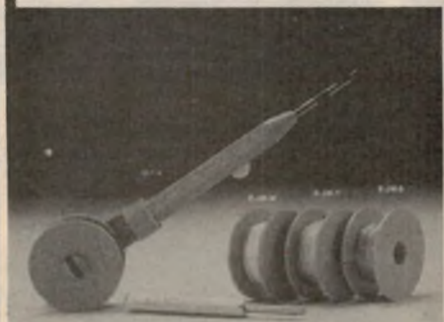

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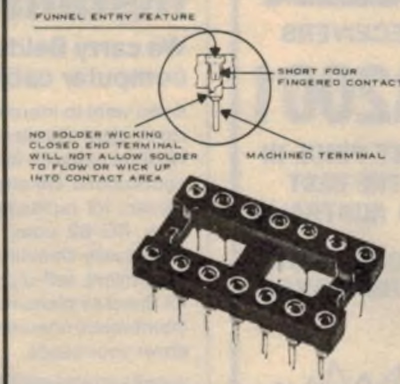

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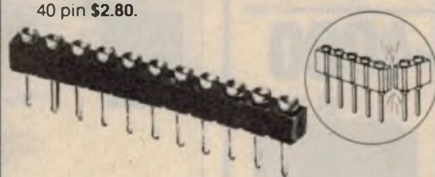

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OP AMPS Explained

Over the last few months we have considered high power operational amplifers, many of which are internally DC-coupled but capacitor coupled to the outside world, quite successfully using a single large power supply. If that doesn't scotch the false rumour that "a single supply circuit is necessarily small" consider Figs. 4 and 5, a 6 kilowatt output stage consisting of four NPN transistors, Motorola type MJ10101, in a bridge configuration, transformer coupled to the load and operating from a single 110 volt DC supply.

Yet another fable needs to be laid to rest. Some users of professional electronics believe that to be a high precision circuit dual power supplies are necessary. As illustrated in Fig. 6 this is not true. Here a single 6 volt 50 amp supply provides power for the output stage of a highly stable feedback control system. The load on the system is a 6 volt 11 amp tungsten filament quartz-iodine lamp used to apply heat via a lens to a small region of a scientific experiment, to control temperature. The control system is in fact a high gain power operational amplifier, successfully controlling the temperature of that small region to an accuracy of ±0.25°C (Ref. 1). Although low current ±15V supplies are also employed, only one high current 6 volt supply is used, as lamps don't need current in both directions.

For many low power circuits such as filters, tone controls and preamplifiers, dual power supplies do give greater design flexibility in that whole sections can be DC-coupled. Where only one DC supply is available, it is possible to use a DC-to-DC converter, to derive dual output voltages at ±12 volts or ±15 volts as desired. Such converters can be constructed or purchased, eg, Analog Devices Modular DC/DC converter model 964 will give ±15 volts at 33mA, all derived from one 12 volt car battery. Or the model 953 could supply larger output current, 150mA. If in building your computer you have plenty of 5V DC logic power supply available but want a few milliamps at ±12V for an analog-to-digital converter, then you could use the model 960 which gives ±12V DC output supply when powered by your computer's +5V logic supply rail. These converter modules are also useful in providing zero line isolation for specialised input isolation amplifiers.

Other manufacturers also make such products. In general they convert the DC supply input to square wave AC by transistor choppers, operating at about 22kHz (to make it inaudible), transform up as necessary, rectify, filter and possibly regulate to provide smooth output. Multiple transformer windings can easily provide multiple outputs.

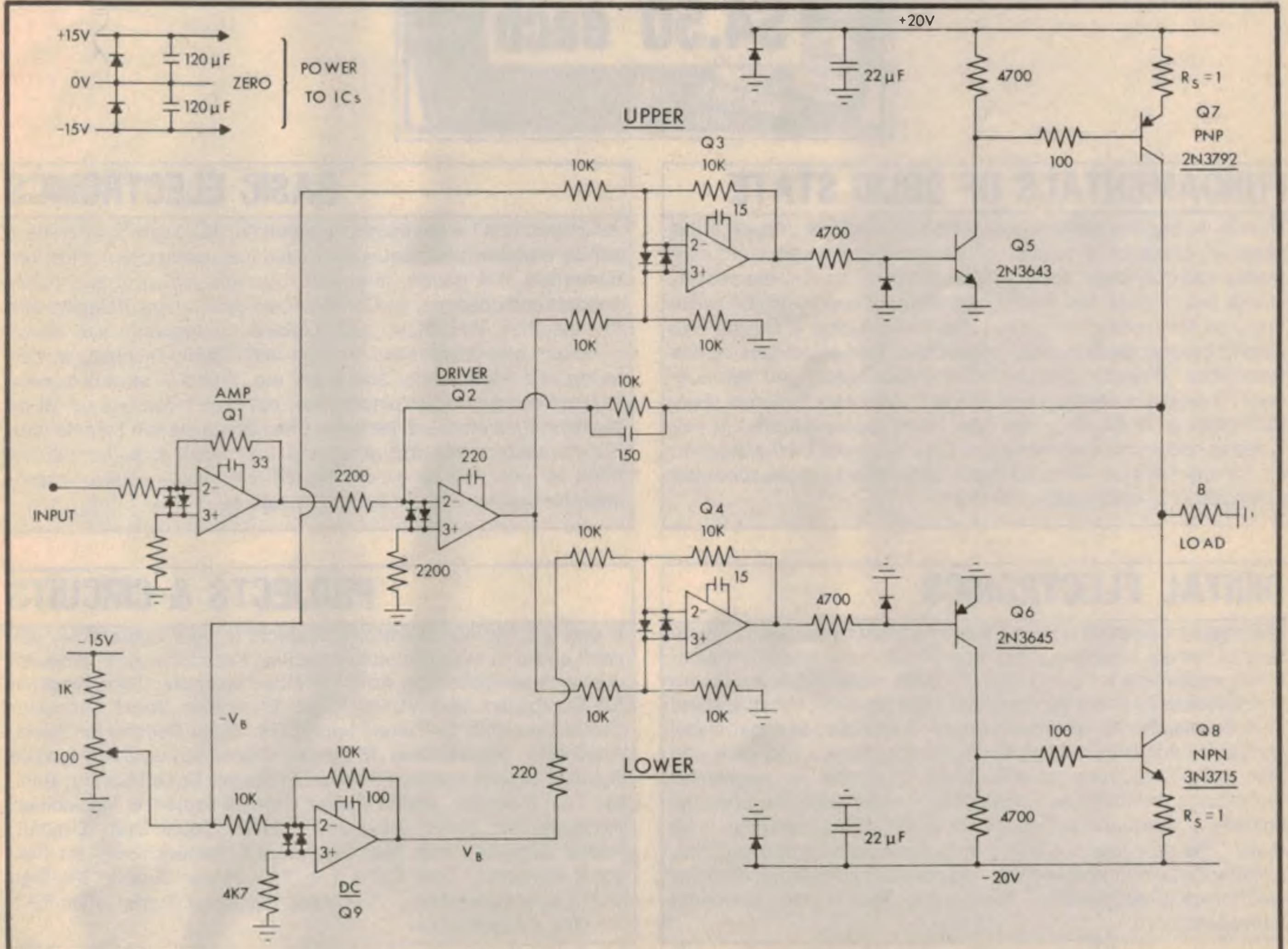

Fig. 8: diagram illustrating the use of four supply rails. Because this variable class amplifier is sometimes operated at conducting angles less than class B, the +20V rails carry high current pulses. Therefore, separate +15V rails are used to supply the ICs.

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OP AMPS Explained

Specifications

Designers need to know how accurate the power supply must be for successful operation of their circuits. Will your circuit perform correctly if the nominal ±15 volt supply actually is producing ±14.9 volts, or ±16 volts, or even +15.1 volts/-14.8 volts? Will you notice anything untoward if the +12V rail has some 50Hz or even 100Hz ripple (hum) superimposed upon it due to insufficient filtering or poor regulation. Supplies derived from the mains **always** have some residual ripple at 100Hz (from full wave rectification). But how much can be tolerated by your circuit? More correctly, how much can be rejected by your circuit. This is an important specification of every op amp. You will generally find figures quoted in Integrated Circuit data sheets as "Supply Voltage Sensitivity" or "Power Supply Rejection Ratio" (PSRR).

This denotes the ratio of the ripple or change measured in the amplifier output due to a ripple or change existing in the supply rail. Most integrated circuit op amps are designed with such excellent balance and such constant current active load and tail impedances that quite large voltage variations occurring in the supply produce only tiny changes in the output, which are unnoticed in many applications. If 100mV ripple in the supply only produces 10 microvolt ripple in the amplifier's output, then we say the power supply rejection ratio is equal to 10,000 to 1, or 80dB. Data books quote PSRR for the 101A-201A-301A series op amps as typically 96dB, an excellent figure. The LM108A-208A-308A series is quoted higher still at typically 110dB. As a little mains ripple in the supply rails produces no noticeable effect on reasonable size signals, these integrated circuits can be used on unregulated rails (supplies which are simply rectified and filtered). But if you are dealing in microvolt size signals, you will need to use ICs having such high rail rejection ratios and use regulated supplies to reduce supply ripple to a very low figure.

Occasionally you will see (Ref. 2) supply rail rejection properties of an amplifier fully specified by stating the ratio measured for changes made in the positive or negative rails separately at DC and a range of frequencies.

Decoupling

Ripple superimposed on DC rails can be reduced by decoupling the supplies as shown in Fig. 7 where capacitor C is chosen quite large, and is generally an electrolytic type. A rule-of-thumb used by some designers is to choose C equal to 10μF per milliamp of load current. If you cannot sufficiently reduce supply ripple by decoupling, then you need one of the many voltage regulation methods available. A second, quite separate, use of decoupling has as its purpose the removal of signals from the supply rails.

Large output stages, especially those in class B, will draw varying currents and cause voltage variations in the supply at signal frequency. If early low level stages do not have sufficient supply rejection ratio **at signal frequency,** such signals will appear in the early stages to be amplified and promptly fed to the output stage. The effect can be cumulative, resulting in positive feedback and instability. The amplifier uses the common power supply as a positive feedback loop. The cure is more effective decoupling of power rails and the use of early stages having a greater power supply rejection ratio.

Alternatively, voltage regulators can be used to supply low voltage rails for early stages, taking the power needed from output stage rails or, as a further variation, use separate power supplies for the early stages, ie, use four separate supplies, such as in Fig. 8. (Refs 3, 4)

Also we observe that the lower the output impedance of the power supply itself, the less is the above problem (hint — next month's topic).

High frequency bypassing

In every amplifier it is wise to decouple or at least bypass the positive and the negative rail for every stage as a

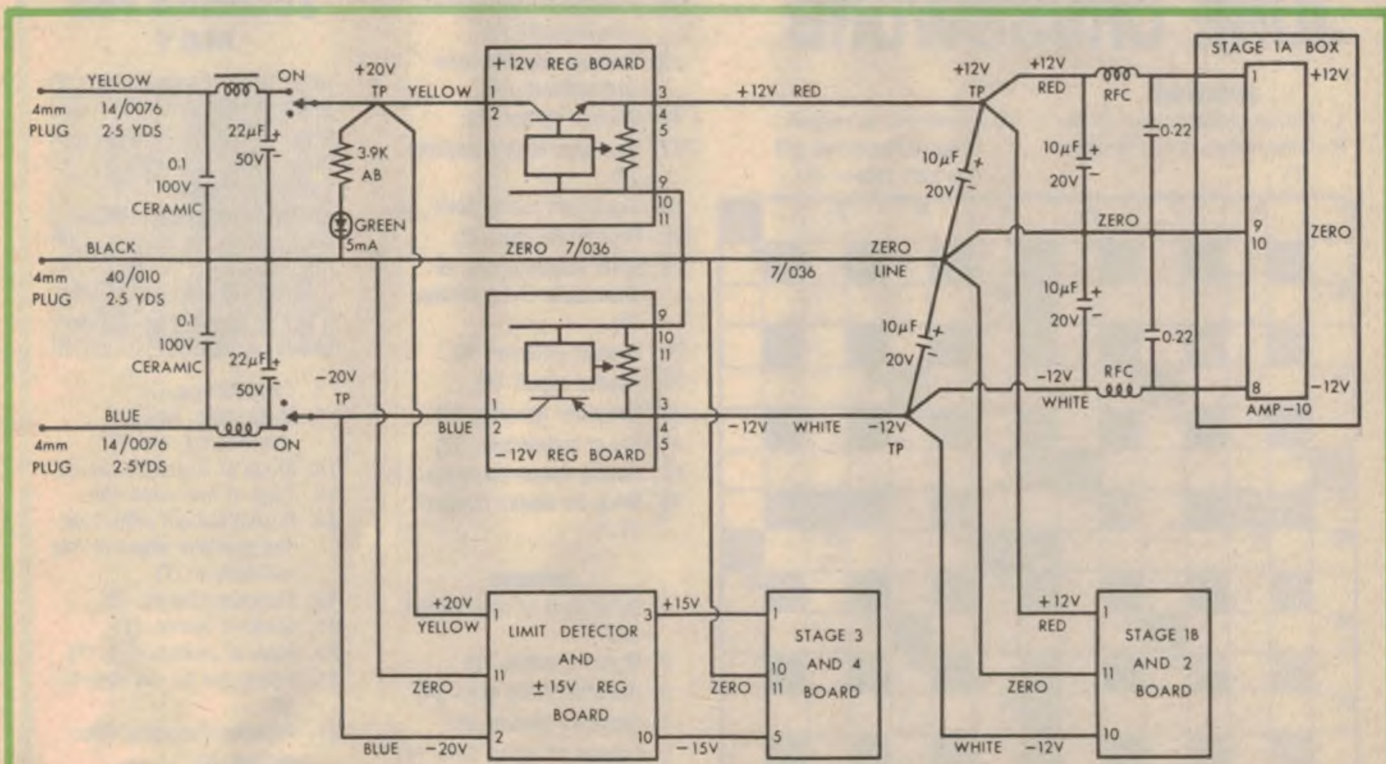

Fig. 9: power supply block diagram for a five-stage amplifier (overall gain 1,000,000) operating from +20V DC supply. At left, "yellow", "black" and "blue" are the +20V, 0V and −20V supply points. Multiple regulation prevents rail-coupled instability.

OP AMPS Explained

precaution against high frequency rail-coupled feedback. Ceramic capacitors of 0.01μF to 0.1μF should be used, for sufficient bypassing at high frequencies. These are in addition to the larger electrolytic or tantalum types used to bypass the low frequencies, as electrolytic capacitors do not work at high frequencies.

The reason why every IC should have its own ceramic bypass capacitors close by is that even a short section of supply rail conductor has some inductance (at high frequencies) which prevents ceramic capacitors at one stage being effective in bypassing adjacent stages. Some designers may regard the above prescription as somewhat too strict and on occasion get away with less. Generally the more stages used and the higher the overall gain, the more necessity to be generous with bypassing.

A stage example is shown in Fig. 7. For very high closed loop gain systems to operate from a common power source, great care must be taken to prevent rail-coupled instability. Fig. 9 shows the supply arrangement used for an amplifier which has closed loop gain of 1 million and bandwidth of 0.1Hz to 50kHz.

Drift

We define "drift" as a very slow change in an amplifier's operating voltage levels caused by temperature changes. The importance of this factor multiplies enormously as soon as a few stages are DC-coupled, because the second stage thinks the **drift** in the first stage's output voltage is a valid part of the signal to be amplified. Further stages compound the problem.

If the first stage has too low a supply rail rejection ratio (measured at DC) or should its supply rail voltages drift in value too much, then that stage's output voltage will drift excessively. We note that: (a) No stage has infinite supply rail rejection ratio; (b) Some voltage drift exists in every power supply and (c) Whether the resulting amplifier's output drift is acceptable or not depends on how much DC-coupled gain follows and the final user requirements.

If changes in DC level of the source voltages are a vital part of the input signal to be amplified, then your amplifier just has to be DC-coupled throughout. You have no choice. Many such situations occur in industry and science. Examples include position, force or level transducers and load cells in control systems. Should your input signal be small, say 20 microvolts, you have a real problem. You may find it difficult to produce a first stage amplifer and associated power supplies so stable that the **drift** in the output voltage of that stage is small enough compared to the wanted signal excursions.

It can be done! As we saw in part 4 (June '84) of this series, a combination of careful amplifier design, choice of IC having high rail rejection, **and very low drift power supplies** can successfully produce DC-coupled linear amplifiers having gains of 50,000 or more. The exact value of the power supplies' voltage is not very important, but the value must not change any more than a few microvolts per hour.

Just how to design such stable power supplies we must leave till next month's episode. Bye!

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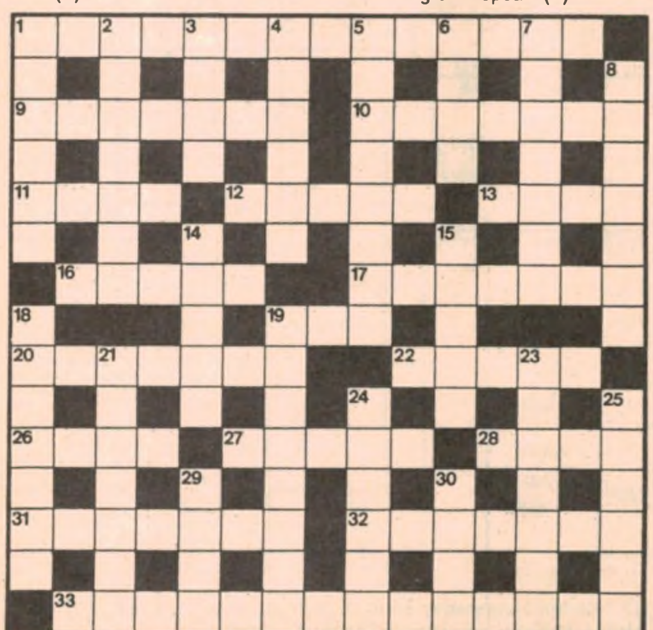
JUNE CROSSWORD



ACROSS

1. Carrier characteristic. (5-9)
9. Components of hifi systems. (7)
10. Pertaining to certain charged particles. (7)
11. Program repeat. (4)
12. Example of successful interference? (5)
13. Possible speaker cone arrangement. (4)
16. Without defect. (5)
17. Discharge tube accessory. (7)
19. Significant replay point. (3)
20. Regenerate data. (7)
22. What electronics is for thousands of EA readers. (5)
26. Type of antenna. (4)
27. Applied signal. (5)
28. Computer operator. (4)
31. Set of instructions. (7)
32. Having advanced phase. (7)
33. What do diodes restrict? (7,7)

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2. Stylus material. (7)
3. Radiotelephony term. (4)
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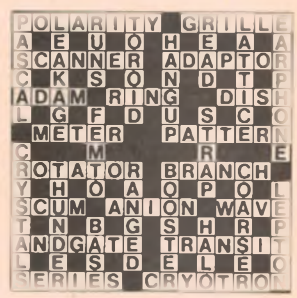
5. Convert to digital form. (8)
6. Final instruction in 31 across. (4)
7. Carry charge. (7)
8. Mass, time, energy, capacitance, etc. (7)
14. Stage of IC production. (5)
15. Type of transistor. (5)
18. Project pattern printed on the previous pages of this publication. (7)
19. Frequency bands. (8)
21. Death of device. (7)
23. Form of multiplexing. (7)
24. Addressed by the system? (6)
25. Possible state of a video picture. (6)
29. Terminal condition? (4)
30. Current cat's whisker! (4)

SOLUTION FOR MAY



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An antenna for those other bands

This simple trapped antenna offers good performance on the 80, 40, 30, 17 and 12 metre bands. It uses readily available materials and is easy to build and erect.

by BRIAN J. WARMAN, VK5BI

Most amateurs sometime or other get around to putting up a beam for the HF bands; ie, for 10, 15, and 20 metres. In the past a simple Windom, G5RV, or a couple of dipoles on 40 and 80 metres would suffice for the remaining popular amateur frequencies.

WARC '83 changed all that. If we dismiss a log periodic beam as too large, not having enough gain and too expensive (especially if you have a perfectly adequate tri-bander up there on the tower), there are still five bands to be catered for. These are 80, 40, 30, 17, and 12 metres.

A compromise antenna may be erected of course; perhaps a G5RV, made to work by the use of an antenna tuner. Such an antenna will work, and many amateurs may be heard using such antennas, particularly on 30 metres. However, if you want DX, a resonant antenna erected as high as possible must be your aim.

I have constructed such an antenna using coaxial traps. There have been a number of very fine articles dealing with design and construction of such traps and I commend them to the reader. My antenna has a total length of just over 12 metres each side; ie, just slightly longer than a full sized dipole on 40 metres.

The first step in constructing this antenna will be to obtain a one-metre length of 32mm poly pipe. This is the white pipe used for irrigation and may be obtained from all hardware stores. If you have any doubts about the dielectric qualities of the material obtained you may perform a simple test by putting a piece in a microwave oven for one minute. There should be no reaction.

A 10-metre length of RG-58U coaxial cable will be required. The dimensions given for the traps in this article will be correct only when used with this cable.

Cut the trap material as follows:

Band	Length of coax (mm)	Length of former (mm)
40m	1800	110
30m	1330	90
17m	830	70
12m	710	70

Once the formers have been cut to length, drill three holes in each as follows: one 5mm hole, 25mm from one end, which is to secure the beginning of the coaxial coil; and two 2mm holes 10mm from each end. These are to attach the antenna wires to the trap and should be in line.

Strip 75mm of jacket off each end of the length of coax followed by 50mm off the centre conductor. I have found the neatest way of finishing off the braid is to part the strands near the jacket and then fish the centre conductor out through this hole. In this way, the weaving remains intact and makes for a very neat finish. Push one end of the coax through the 5mm hole at the end of the former until 5mm of the jacket is inside. Wind the coax to form a coil on the former then mark a hole at the finish to allow 5mm of jacket to be pushed inside to finish the coil. Pull the remaining coax through this hole. You will now have approximately 70mm of coax inside the former at each end.

Solder the centre conductor from one end of the coil to the braid at the other end. Fig. 1 shows the general idea but note that the connection will be inside the former, not on the outside as shown. (The figure has been drawn this way for clarity.) The remaining braid connects to the element coming from the feedpoint (centre) of the antenna, while the remaining inner conductor goes to the next element.

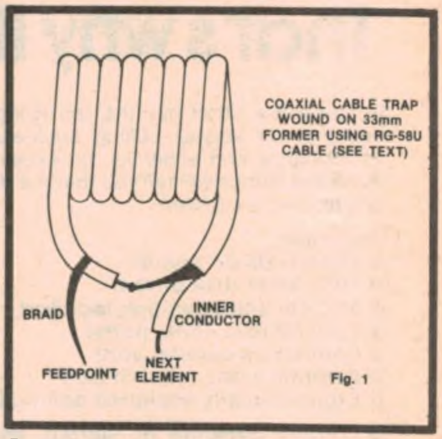
I sealed the ends of the coaxial cable using CRC Lectra Shield (tradename) — you may care to use silicone.

The antenna may now be assembled, using the following element lengths:

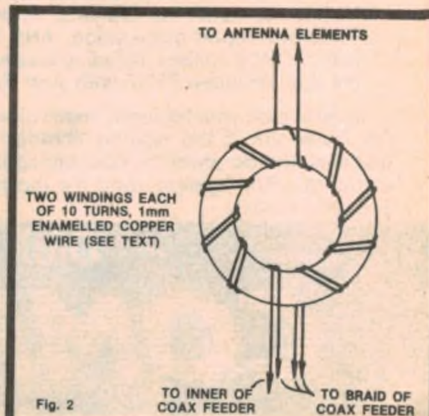
12 metres . . . . 2 x 260cm
17 metres . . . . 2 x 22cm
30 metres . . . . 2 x 244cm
40 metres . . . . 2 x 144cm
80 metres . . . . 2 x 545cm

When cutting the element lengths, allowance must be made for terminating the element to the former. I allowed about 30mm extra, thus allowing for the wire to pass through the 2mm hole in the former, to be passed back, and then twisted around the element.

I used a balun to terminate RG-58U coax feeder to the feed point. An advantage of using a balun is in the reduction of radiation on the coax (with consequent TVI reduction) and also a

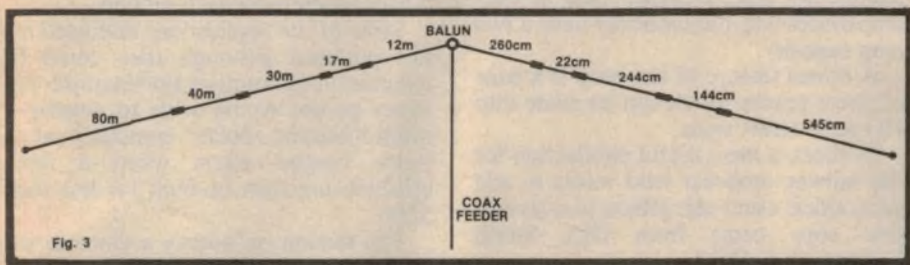


Connect the traps as shown in this diagram.



Here are the winding details for the balun.

The coaxial traps can be clearly seen in this photograph of the author's antenna.



This diagram shows the assembly details. The element lengths are shown on the right while the corresponding bands are shown on the left.

more uniform radiation pattern from the antenna.

Fig. 2 shows the winding details for the balun. There are two windings of 10 turns each but note that one of the windings is split; ie, it consists of five turns each side of centre. The balun core dimensions are not all that critical — I used cores with an outside diameter of about 40mm.

Amidon ferrite rings suitable for balun construction may be obtained from the suppliers listed at the end of the article, or ready made baluns purchased from the remaining source.

The balun should be mounted in a plastic box to protect it from the weather. Entry holes for the coax feeder cable and for connections to the antenna elements should be sealed with silicone.

The two 260cm (24.9MHz) elements are soldered to the balun at the centre of the antenna then passed through the holes in the 12-metre traps and soldered to the coaxial cable forming the trap. The 17-metre element is then attached to the other end of the trap and so on. Fig. 3 shows the assembly details. Do not use excessive heat on the centre conductor of the coaxial trap when soldering.

The length of the 80-metre element resonated my antenna at 3.6MHz. This resonant frequency will be attained with the antenna in the air and clear of obstructions. The resonance may be affected if the antenna is not in the clear. Adding and subtracting lengths to this element will not affect other bands.

For those who wish to have all traps spot on frequency, the following procedure may be adopted. Before drilling the second 5mm hole to terminate the coil winding, temporarily connect the inner conductor at one end to the braid at the other end. The coax can now be held in position on the coil former and tested for resonance using a dip oscillator.

I resonated the traps at the following frequencies:

40 metres 7.1MHz
30 metres 10.1MHz
17 metres 18.1MHz
12 metres 24.9MHz

Similarly, if you wish to be sure the element lengths are exact for your requirement, each section may be tuned before the next one is attached. I did this using an antenna noise bridge. If such an instrument is unavailable, trim the lengths for best SWR.

Footnote: Amidon cores are available from: Ian J. Truscott Electronics, Croydon, Victoria 3136; and R.J. and U.S. Imports, PO Box 157, Mortdale, NSW 2223. Ready made baluns are available from K. Brucesmith, 110 Rosemead Rd, Hornsby, NSW 2077.

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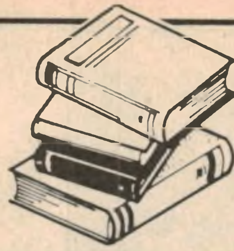

Model railway electronics

ELECTRONICS FOR MODEL RAILWAYS: by Ken Stone. Published 1984 by Talking Electronics, Melbourne. Soft covers, 210 × 275mm, 73 pages, illustrated with diagrams and photographs, ISBN 160884-40-16K. Recommended retail price $3.30.

As any model railway enthusiast can attest, there is a dearth of books on the subject of railway modelling and particularly on the electronics side of it. So the arrival of this Australian publication is likely to be very welcome.

The content of this small text is strictly at a hobby level and would be well within the grasp of most railway modellers. All the circuits are simple and easy to build, with readily available components.

The list of circuits comrises the following: Warning lamp flasher unit, capacitor discharge unit (for point motors), scale fluorescent lamps (flickering), air horn, power supply, remote relay unit, pedestrian crossing, light chasers and shop displays, level crossing flasher, crossing boom control, light sequencer, throttle and train detectors.

There is also a brief introduction on the use of computers and a section on three-coloured LEDs which are most useful in railway modelling.

All the circuits appear to be workable although several show some lack of theoretical knowledge on the part of the author. One example of this is in the power supply which specifies the use of parallel-connected one-amp diodes in a bridge rectifier to gain a two amp current capacity. Since any diode in a bridge rectifier conducts for only half the total conduction time, a bridge made of one-amp diodes will automatically have a two amp capacity.

A bonus feature of the book is a page of street names which can be made into HO scale street signs.

In short, a most useful publication for the railway modeller who wants to add economical electronic effects to a layout. Our copy came from Dick Smith Electronics (L.D.S.)

Interfacing the IBM PC

THE IBM PC CONNECTION: by James W. Coffron. Published 1984 by Sybex Inc, Berkeley, California. Soft covers, 177 × 227mm, 264 pages, illustrated with diagrams. ISBN 0-89588-127-6. Recommended price $24.95.

This book is aimed at the user of an IBM Personal Computer or IBM compatible who wants to use his machine for more than just running programs. It discusses the use of an IBM PC to operate as a home security system and a home temperature control, adding voice synthesis, digital-to-analog conversion and analog-to-digital conversion.

Much of the discussion revolves around a proprietary input/output board available in the USA (but not necessarily in Australia) however the reader would not have to be a prospective buyer of this unit to benefit from reading the book.

There is also an assumption that the reader will be willing to solder ICs and other components into printed boards. Whether many IBM PC owners are wont to do this is a moot point.

Perhaps the most useful feature of the book are the short programs in Basic which accompany each section.

Some of the applications discussed are not practical although they could be regarded as instructive. For example, not many people would wish to employ a multi-thousand dollar computer as a home burglar alarm when a more effective unit can be built for less than $200.

The section on adding a voice to the IBM is based on using the Votrax chip. This is available in Australia but is not cheap or easy to obtain.

The book can be regarded as helpful as there is not much information published on this subject but whether it will encourage users to interface their machine to the "outside world" is another matter. (L.D.S.)

Z80 machine code programming

AN INTRODUCTIN TO Z80 MACHINE CODE: by R. A. & J. W. Penfold. Published 1984 by Bernard Babani (publishing) Ltd, London, UK. Soft covers, 110 × 178mm, 132 pages, illustrated with tables and lists. ISBN 0-85934-127-5. Recommended retail price $6.75.

Here is a useful little text for those people with a Sinclair Spectrum or ZX81, or an Amstrad CPC464 or anyone with a need to be familiar with Z80 machine code programming. It gives a brief but well written introduction to assembly language, which mentions such topics as binary coded decimal, hexadecimal, stacks and flags.

There is a chapter each on addressing modes, on the Z80 instruction set, on storing and execution and on input/output characteristics of the Z80 CTC (counter/timer circuit). There is also a chapter of sample routines in machine code for the above mentioned computers. (L.D.S.)

at the leading edge

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Liquid Crystal Displays take one step closer to emulating the attributes of the C.R.T. with Sharp's **LM64004G.** Its **640x200 dot** capacity will give word processing and spreadsheet capabilities to laptop and portable computers and increased graphics flexibility to instrumentation and monitoring equipment. The LM64004G is supported by the Sharp **LR3692 L.S.I. controller.**

MEGAVAULT LAUNCHES 330 AND 660 MEGABYTE WINCHESTERS
An average seek time of **18 ms** puts these **8″ hard disks** in a high performance class normally the preserve of 14″ and "washing machine" storage units. OEMs and mainframe installers can look forward to big savings right across the board. Cost, weight, power drain and size are way down on these **SMD** and **SCSI** interfaced devices.

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Configured like two 5Mbyte floppy drives **Interdyne's ID1010** provides a rapid and economical back up for the most popular hard disk configurations. **Track access is totally electronic** overcoming offset problems associated with the head positioning mechanism used in most streamers.

REDUCTIONS ALL ROUND ON MINISCRIBE HARD DISKS
Miniscribe follows the release of their low power, half height **3212 10MByte** Winchesters with a **25MByte** model designated the **3425.** Average access time for both units has been reduced to **88 msec,** putting them among the fastest stepper positioned drives commercially available.

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Adelaide: DC Electronics (08) 223 6946
Brisbane: Baltec (07) 369 5900

GUC-2010 100MHz frequency counter

The GUC-2010 Universal Counter made by the Goodwill Instrument Company certainly lives up to its name. This versatile piece of test gear performs a multitude of timing and counting functions, and is priced well within the reach of the serious hobbyist.

by ANDREW LEVIDO

The GUC-2010 is built into a grey plastic case measuring 237mm x 85mm x 284mm (W x D x H) which includes a tilting bail. The front panel is dark grey with white lettering and orange detailing. An 8-digit LED display occupies the upper half of the right hand side of the front panel, with the control buttons and indicator LEDs set out below this. At the left of the front panel are the two BNC input sockets.

There are six control buttons in all: a mains power switch, a reset switch, a gating time select switch, a function select switch, a range switch and an input attenuator switch. The mains power switch requires no explanation, but the others are worth a closer look.

The input attenuator works only on the main (A) input and attenuates the input signal by a factor of 10 when it is in circuit. Pushing the switch once removes this attenuation when measuring low level signals. Pushing it again restores the attenuation.

A range button is provided to switch an extra divider into the input circuit to facilitate measurements of high frequency waveforms. Dividers are switched into both the main (A) input channel and the secondary (B) input simultaneously.

The required function is selected by means of the function button and indicated by a row of six LEDs. Pushing the button repeatedly steps the counter through all the available functions. There are six possible functions: Frequency, Period, Time Interval, Frequency Ratio, Totalise and Check.

Frequency and Period are self-explanatory while the Totalise function is similar to Frequency except that the user controls the gating time. Thus, the meter actually counts the number of input pulses. This is quite a useful feature.

The above three functions require the use of only one input (the A input), while Frequency Ratio and Time Interval measurements require the use of both the A and B inputs. In the Frequency Ratio mode, the display shows the quantity of F1/F2 where F1 is the A input and F2 the B input. This function is especially useful in determining the frequency ratio of harmonically related signals.

The Time Interval measurement function displays the time interval between negative transitions of the signals applied to the inputs. The signal at input A provides the start input, while that at input B provides the stop input.

The next pushbutton on the front panel is the Gating time control. This works in a similar manner to the Function control in that pushing the button repeatedly steps through the available options. There are four gating times available, each indicated by a separate LED: .01s, 0.1s, 1s and 10s.

Incidentally, each time either the Function or Gating time switches are pressed the counter emits a short "beep" (this tone is different for each switch). We found this quite annoying during regular use. Had the instrument been ours, the piezo transducer would have been disabled in very short order!

Finally, there is a Reset switch which is used in the Totalise mode to reset the count to zero.

Construction

Opening the case of the GUC-2010 reveals a large printed circuit board covering the whole of the bottom of the chassis. On this board are all the components except the digital display and the LEDs — these have their own board mounted at right angles to the main board.

Construction appears to be of a high standard and most components are readily available types. This, combined with the fact that there is a circuit diagram in the instruction manual, should simplify servicing should it ever be needed. Goodwill are one of the few manufacturers of test gear who consistently include a circuit diagram with their equipment.

One thing we did notice is that the mains fuse is located on the PC board which means that the case will have to be opened whenever the fuse blows. However, there is little chance of the fuse blowing in normal circumstances, so this is no real drawback.

So how does the GUC-2010 perform?

The Goodwill GUC-2010 frequency counter covers the range from 5Hz to 100MHz.

Brief Specifications

Frequency measurements (channel A only)	
Range	5Hz to 100MHz
Gating times	10ms, 0.1s, 1s, 10s
Resolution	100Hz, 10Hz, 1Hz, 0.1Hz
Accuracy	Timebase accuracy + 1 digit
Period measurements (channel A only)	
Range	0.04μs to 10s
Resolution	0.1ns to 0.1μs (10MHz range), 0.01ns to 0.01μs (100MHz range)
Accuracy	Timebase accuracy + trigger error + 1 digit
Frequency ratio (channels A and B)	
Range	CH A: 5Hz to 100MHz CH B: 5Hz to 25MHz
Accuracy	1 digit of CH A + trigger error of CH B
General	
Input sensitivity	CH A: 20mV to 100MHz CH B: 20mV to 25MHz
Input impedance	1M Ω shunted by less than 30pF
Max input voltage	250V DC + AC peak, 150V RMS to 1kHz, 5V RMS to 100MHz

We found that the unit took a little getting used to. The controls tend to be somewhat confusing at first and the instruction manual does not help much. While this did tend to slow us down, it was not an insurmountable obstacle and, after a period of fiddling, we quickly mastered the controls.

Taking readings is quite simple and requires little thought on the part of the operator. The decimal point moves as different ranges and gating times are selected and two LEDs indicate whether the display is reading in kHz or μs. An additional LED lights if there is a display overflow. The only point which we found that we had to watch was that it was easy to forget that the divide by 10 circuit had been switched on.

Sensitivity was quite adequate for most uses (see specifications panel) and performance on the Frequency Ratio and Time Interval modes was good. As a frequency and period meter the device also performed well, but the usefulness of the self check facility is a little doubtful.

When this function is selected the frequency meter measures the frequency of its own 10MHz reference oscillator. This is meaningless as far as accuracy is concerned since all frequency measurements are made with respect to this oscillator. Even if the oscillator is significantly off frequency the display will read 10000.000kHz.

Unfortunately, this test function does not test the input stages of the meter either, the 10MHz signal being injected directly into the converter chip. So this function does nothing except check that the converter IC is working — a correct test result does not mean that the entire circuit is OK.

In conclusion, the Goodwill GUC-2010 Universal Counter represents fair value for money. It is a versatile counter with very respectable specifications and good performance. It requires a little time to get used to but the display provides an unambiguous readout of the measured quantity.

The Goodwill GUC-2010 Universal Counter is supplied complete with a mains cord, spare fuses, two test leads and an instruction manual. It is available from Geoff Wood Electronics, 656A Darling St, Rozelle, NSW 2039. Phone (02) 810-6845. Price is $634.80 (including tax).

Variable volume piezo buzzer

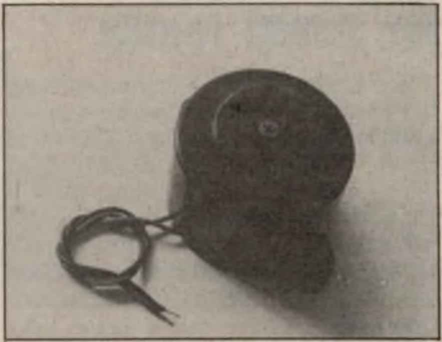
Piezo buzzers normally operate with fixed volume but the new KPE 960 from IRH has provision to vary the sound output. This is achieved by means of a knurled knob which is rotated to increase the hole dimensions at the front of the buzzer.

According to IRH, the KPE 960 is ideal for applications where a high sound pressure is required. Its small size, low cost and variable sound pressure make it particularly suitable for the security industry.

With the acoustic volume control "open", the sound pressure level at 100cm is a claimed 95dB minimum (12V supply). This sound pressure is reduced by 15dB with the control in the closed position.

The KPE 960 can operate from any DC source between 1.5 and 16V DC. The resonant frequency is 2.5kHz and current consumption is 3.5 −70mA, dependent on voltage.

IRH Components, 53 Garema Circuit, Kingsgrove 2208. Phone (02) 750 6444.

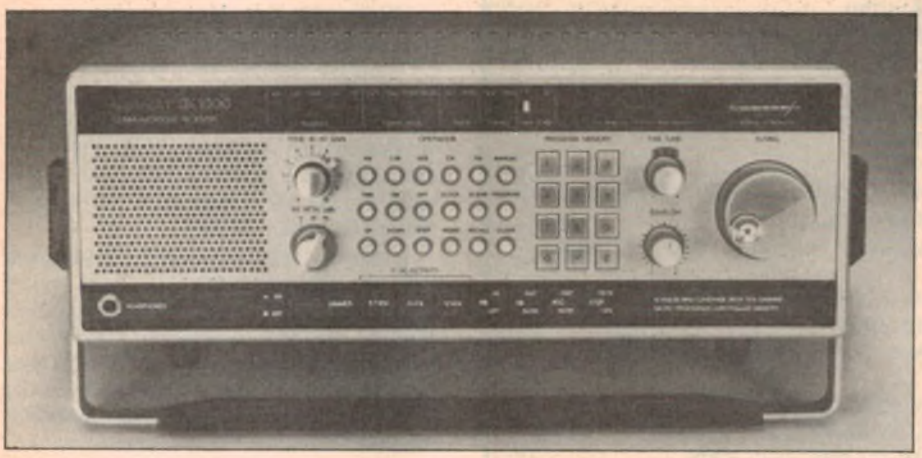


IRH's KPE 960 variable volume piezo buzzer.

Videophone for security systems

DESIGNED FOR installation in apartment complexes etc, this videophone system allows homeowners to view visitors before permitting access to the building. Main features include a 10cm monochrome screen, a wide angle lens with built-in lighting lamps, and a two-way intercom. For further information contact Electron Alarm Supplies, 225 Ramsay Rd, Haberfield, NSW 2045. Phone (02) 799 4745.

The control centre features a 10cm screen.



Bearcat DX1000 communications receiver

Featuring microprocessor control, the Bearcat DX1000 communications receiver covers 10kHz to 30MHz continuously. It has PLL synthesized tuning, 10 memory channels and automatic band scanning.

In addition to indicating the frequency with a resolution of 1kHz, the digital display doubles as a two time zone 24-hour clock. By utilizing the internal clock, the DX1000 can be programmed to record up to five different broadcasts on any frequency and in any mode.

An IF bandwidth selection control is provided to help separate high powered stations on adjacent frequencies. Receiving modes are AM, LSB, USB, CW and FM.

Further information is available from all Dick Smith stores.

Low cost EPROM eraser

Erasing the contents of EPROMs can now be carried out quickly and safely with the Ango Eprom Eraser from Jaycar Electronics. The unit can erase up to nine 24-pin devices in around 40 minutes.

The Ango Eprom Eraser uses a high intensity UV tube operating at 2540 angstroms to ensure reliable chip erasure. This is mounted inside a moulded plastic case which prevents leakage of the UV light. A slide out drawer with a conductive foam pad accepts the EPROMs.

According to Jaycar, the tube life is rated at 3000 hours. The unit features mains operation, measures 80 × 217 × 70mm (W × D × H) and retails for $79.50.

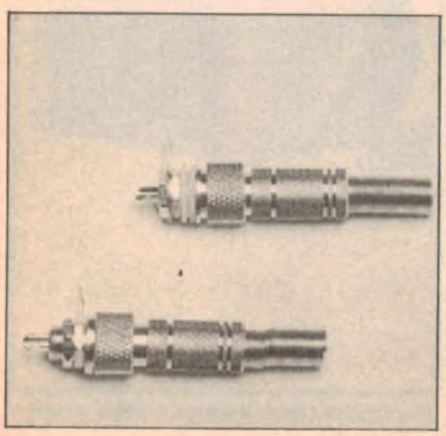
Jaycar Pty Ltd, PO Box 480, Auburn, NSW 2144. Phone (02) 643 2000.

Gold-plated RCA plugs & sockets

Looking for some high qualilty RCA plugs and sockets? These fancy units from Arista Electronics feature screw locking and gold plating to ensure reliable contact. An integral cable entry spring provides protection against cable breakage.

The sockets are single hole chassis-mounting types and are supplied with nylon insulating washers.

Arista Electronics Pty Ltd, 39 Jones St, Ultimo, 2007. Phone (02) 648 3488.



New products for Z8000 family

The George Brown Electronics Group has released several new products in the Z8000 range. They are: the Z8065 Burst Error Processor, the Z8068 Data Ciphering Processor, the Z8090 Universal Peripheral Controller (UPC) with 2K ROM, the Z8094 Prototyping Device with EPROM/RAM interface, and the Z8530 Serial Communications Controller.

The George Brown Electronics Group, 174 Parramatta Rd, Camperdown 2050. Phone (02) 519 5855.

High density bubble memory

Recently released by IRH, the Fujitsu FBC504M4M series high-density memory cards have an interface compatible with the IEEE796 multibus. Main features include the DMA controller equivalent of the 8527 selectable 8 or 16-bit bus, built-in power supply protection circuitry (+5V rail required) and four levels of memory expansion from 128K to 512K. The memory can be further expanded to 4MB if required.

Also available from IRH components are the Bubble Memory Module series types FBM-M128TA and FBM-M128TC. The modules consist of a bubble memory device and peripheral linear ICs mounted on the same package. All the components use TTL level I/O.

IRH Components, 53 Garema Circuit, Kingsgrove, NSW 2208. Phone (02) 750 6444.

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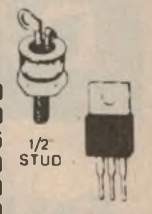
SCR	T10601	200v	4A	Sensitive Gate	T0220	$1.00
Triac	Q4025H	400v	25A	Gated Triac	½" Stud	$3.00
Triac	Q4001L	400v	1.6A	Gated Triac	T0220	$1.00
Triac	Q6025H	600v	25A	Gated Triac	½" Stud	$3.50



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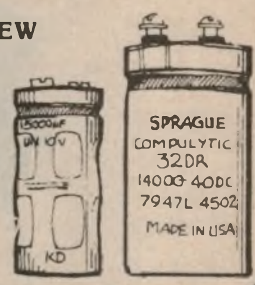

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Give away specials Limited stocks only

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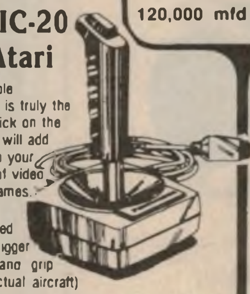
The Ultimate joystick for the VIC-20 and Atari



The incredible Pointmaster is truly the finest Joystick on the market and will add incredibly to your enjoyment of video computer games.

Just look:

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$32.95

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New Products...

VHF marine transceiver

◄ *JUST RELEASED by Dick Smith Electronics, this hand-held VHF marine transceiver features diode programming for frequency selection without the need of additional crystals. The D 1404 covers the marine frequency band from 156MHz to 162MHz, has switchable 0.5W/2.5W output power and comes complete with a NiCd battery. For further information, contact your nearest Dick Smith store.*

LMC669 CMOS auto-zero circuit

National Semiconductor has introduced an auto zero circuit that automatically and continuously corrects the offset voltage of an operational amplifier or any other linear circuitry.

The LMC669 is intended for designers who need more precision than they normally get out of an op amp. It is available in two versions. The 8-pin package is a stripped-down circuit while the 16-pin version offers extra features such as a reset mode, start-up circuitry and precision comparator functions.

National Semiconductor (Aust) Pty Ltd, 23 Cleg St, Artarmon, NSW 2064. Phone (02) 439 6455.

Sealed batteries from Chloride

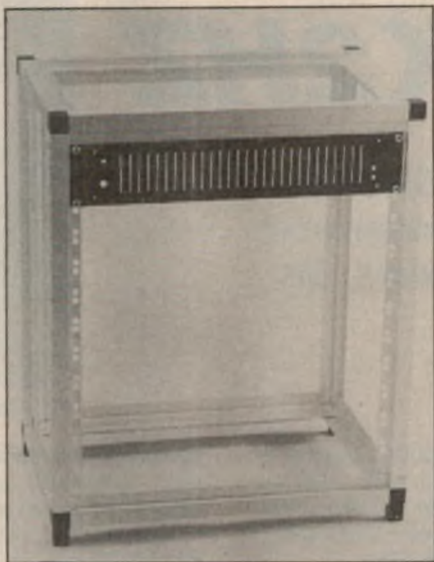
Chloride has launched a comprehensive range of rechargeable batteries using RE (recombination electrolyte) technology. The new Exide Powerstore batteries provide primary or standby power in neat, clean packages that resemble building blocks more than they do rechargeable batteries.

Indeed, the Powerstore batteries can be treated like building blocks. Containing no free electrolyte, the batteries can be stacked side or end on, or even upside down if necessary. There is no gassing on charging, no water loss and no need for topping up.

Ten batteries comprise the Powerstore range and deliver voltages ranging from 2V at 5.8Ah to 12V at 240Ah. The batteries are ideal for portable equipment and as standby power packs in computers, cash registers, security alarms, and telecommunications.

Chloride Systems Division, 55 Bryant St, Padstow, NSW 2211.

New rack system



Autotron Australia have released a new concept in 19-inch racking systems called Zip-Rack. Based on an exclusive aluminium extrusion together with specially tooled interlocking plastic corner pieces, Zip Rack is supplied in kit form with all necessary items for frame assembly.

These include blank panels, recessed bins, floor and bench mounting brackets, Eurocard bins and cassettes, PCB card panels, dust covers, cable support bars and roller castors.

Zip-Rack is available in two standard depths, 358mm and 500mm, and five standard rack heights. The entire Zip-Rack system has been designed and manufactured in Australia.

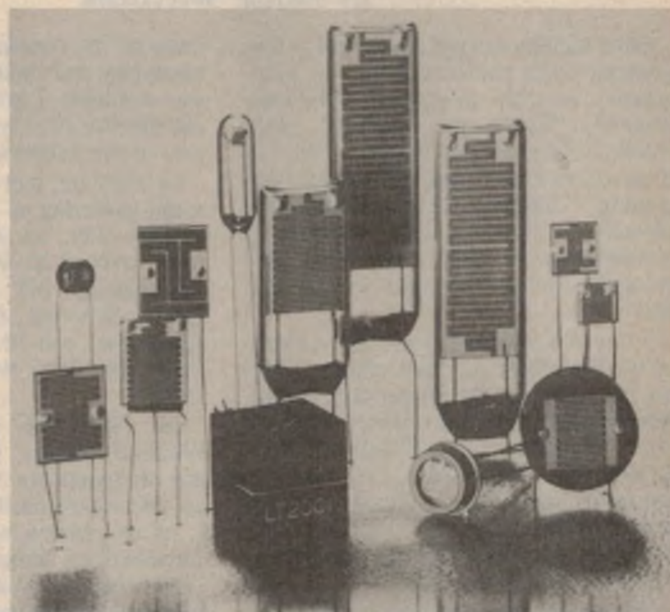
Zip-Rack frames can be supplied unanodised which enables end users to anodise to their own colour choice or to use an alternative finish. Further product information is available from Autotron Australia, PO Box 202, Glen Waverley, 3150. Phone (03) 763 6423.

A consumer version of the Zip-Rack range will be available in three sizes from all Jaycar Electronics stores. See advertisement on page 14.

The Exide Powerhouse batteries are ideal for portable equipment.

SEE THE LIGHT

With Heimann Light Dependent Resistors



These highly sensitive detectors feature broad spectral response, wide resistance change and very low power dissipation. These unique features make them suitable for a wide range of applications in street lamp switching, dimmers, exposure meters, active filters and volume controls. A wide range of encapsulations is available to suit industrial and commercial use.
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Obituary to Bill Moore, VK2HZ

Bill Moore, VK2HZ.

Well known radio amateur William (Bill) McInnes Moore, VK2HZ, passed away at his Springwood home on March 28, 1985. For many years, his amateur radio notes were a part of this magazine.

by PHILIP WATSON

Older readers will remember Bill as the amateur notes contributor to the forerunners of this magazine; "Wireless Weekly", "Radio and Hobbies", and "Radio Television and Hobbies". In the latter years these appeared under the heading "Amateur Bands with Bill Moore". It was a long association, commencing in 1933 and, with the exception of the war years, continuing until 1963.

Bill was born in 1911 at Crows Nest, NSW, the eldest of three children. He was educated at the Suspension Bridge Primary School, and a junior technical school where he obtained his Intermediate Certificate. A tertiary education had been planned but his father's death when Bill was 19 meant that he became the sole support of his mother, brother, and sister.

Having obtained his Junior Technical School Certificate he joined Metropolitan Water Sewerage & Drainage Board as an apprentice fitter and turner. He remained with the Board until he retired, 42 years later, as Chief Inspector, Testing and Inspection.

During his early teens Bill developed an avid interest in the then relatively new technology of wireless and in 1929, he joined the Wireless Institute of Australia. He obtained his amateur licence in July 1931 and in 1934 was elected federal president of the WIA, a position he held until 1938.

This interest in radio, which started purely as a hobby, was to assume a major importance in the years ahead. It not only aided him in his primary career — he conducted radio communication experiments for the Board in 1936 — but became the basis of his career in the RAAF with the outbreak of war.

Bill was a typical old-school amateur, brought up in an era when specialised amateur components were scarce and expensive, and the money to buy them even more limited. So Bill, along with most of his contemporaries, learned to improvise and make do with whatever was available. Little did anyone realise the role this hard won experience was to play in the nation's war effort.

In 1934 Bill met Doreen Ashton at a social gathering at Wollongong. Fifteen months later, on April 13, 1935, they were married at St Michael's Church, Wollongong. Bill and Doreen would have celebrated their 50th wedding anniversary just 10 days after his death. Their son John was born in August, 1936.

In 1938 Bill joined the RAAF Wireless Reserve. On the outbreak of war on September 3, 1939 he was called up, and commenced duties on September 6, as an aircrew wireless operator. He embarked for Singapore on August 10, 1940 where he was attached to No. 8 Squadron in Northern Malaya. Early in 1941 he was seconded to the Royal Air Force and attached to their pioneering radar installation and maintenance unit.

Bill was responsible for the erection of radar stations throughout Northern Malaya. In April 1941 he was commissioned as a Pilot Officer and, in October, promoted to Flying Officer. As the Japanese advanced, he was responsible for destroying the radar stations he had installed. Still attached to the RAF, he was evacuated from Singapore to Java in February 1942. He was captured in March and held for three-and-a-half years in eight different prisoner-of-war camps. He returned home on September 30, 1945.

But it was while he was a prisoner of war that Bill's technical expertise and courage were to be fully demonstrated. Bill's exploits have been mentioned in a number of books covering the Singapore campaign and the Java prisoner of war camps. Typical is a quotation from "Saga of Achievement", by Group Captain D. R. Hall (retired).

"In March, 1942, all Air Force personnel remaining in Southern Java were assembled at Tasik aerodrome, prior to being moved as prisoners of war to barracks in Batavia. Flying Officer W. M. Moore, an RAAF radar officer, removed some command receiving equipment from Kittyhawk aircraft, a number of which were scattered about the aerodrome, either in a new or crashed condition. This receiving equipment was then smuggled into the camp in Batavia, where it was modified for operation from torch batteries.

"The radio was concealed in a hole in the floor of the barracks, formed by removing two tiles and excavating earth and replacing the tiles in position to give the impression of an undisturbed floor. While operating the set after dark, a tile was removed and an aerial was run up and connected to a wire strung across the room and used to support a mosquito net.

"Headphones were removed from the hole and Moore received the news bulletins from All India Radio, Delhi. Later, bulletins were received from the ABC and the BBC. Next morning the news bulletins were passed to a senior officer, who secretly disseminated the news to other prisoners of war.

"When batteries became scarce, small transformers were manufactured and the unit was rebuilt to fit into the bottom of two standard issue water bottles. A false bottom was installed in each water bottle to allow four inches of water and space below for the parts of the radio. This radio was used for 18 months, carried from camp to camp, and survived numerous searches by Japanese guards.

"In 1944 all water bottles held by prisoners of war were seized by the Japanese for use by native troops, so a new place of concealment had to be found for the radio. The final receiver was built into the heels of a pair of wooden clogs, which were standard footwear for prisoners of war. It was with this receiver that news was received of the atomic bomb and the capitulation of the Japanese."

This was not only an extremely ingenious operation; it was also a very dangerous one. The Japanese would have taken less than kindly to the exercise and, had it been discovered, punishment would almost certainly have been severe. For this ingenious and couragous action Bill earned a "Mention in Despatches" and received on Oakleaf Emblem.

After the war Bill slipped quietly back into civilian life, resuming his job with the Water Board, his amateur activities, and his role as amateur correspondent for "Radio and Hobbies". Bill and Doreen had two more children; a daughter Lucile born in 1946 but who survived only a few days, and Bill born in 1949.

He continued to be actively interested in the WIA and was state president of the NSW Division for 1947 and 1948. In 1958 he was instrumental in forming the Blue Mountains Branch of the WIA and was secretary for its first decade and president for another four years until 1972.

Bill was a cheerful, quiet, unassuming bloke. Significantly, very few people outside his family and immediate friends knew of his colourful exploits as a POW; he was content to simply pick up where he had left off. While his original amateur interest had been on the HF bands he moved with the times and became a keen VHF operator, particularly on six metres. His quiet voice was instantly recognisable, and he was always ready to offer a word of advice or encouragement to those who needed it.

He was an active member of Legacy, and assisted many war widows through financial and personal crises over the years. He also played an active role in the local RSL sub-branch and, first as treasurer and then as president, helped pull it through a period of crisis.

And so, while it is primarily as an amateur that readers of this magazine will remember Bill, we should also think of him as a devoted family man, a brave soldier, and a community-minded individual ever ready to help those less fortunate than himself. Bill wouldn't have put it that way, but that is how others saw him.

Both amateur radio, and the community at large are the poorer for Bill's passing. He is survived by his wife Doreen, his brother John, and his sons John and Bill, to whom we extend our sincere sympathy. (PGW)

(Much of the above material, particularly the facts and dates of Bill's war service, were kindly supplied by his sons John and Bill, which we gratefully acknowledge.)

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The Daisywriter computer printer

For most computer applications there are only two choices of printer: Dot-matrix for speed and graphic capability or Daisywheel for letter quality. The Daisywriter reviewed here blurs that simple generalisation by being able to produce graphics output and by being quite fast, especially on columnar data.

by LEO SIMPSON

While there are now a number of relatively cheap Daisywheel printers on the market, the person or business who is interested in a new printer should consider those higher up the scale before making a purchase. One such printer which deserves consideration is the Daisywriter, made by the US firm, Computers International Inc. It offers the letter quality printout of a typical Daisywheel printer but incorporates many additional features to justify its higher price.

Certainly, it is quite an imposing unit compared to lower-priced Daisywheel and Dot-matrix printers. It is quite heavy too. Overall dimensions are 614mm wide, including the platen knobs, 374mm deep, not including the protruding data plug, and 260mm high with the standard single sheet plastic support. If a sheet feeder, is used, it becomes more bulky again. Weight is 16kg.

The unit has a rugged but stylish plastic case in what now appears to be the mandatory off-white colour used by the IBM PC. If you're going to use this printer right next to an IBM though, you will need a large desk.

The basic printer mechanism is the same as used in the Brother HR-1 printer and EM-2 electronic typewriter. One of the interesting features of the mechanism is the linear induction motor used to propel the print-wheel and ribbon cartridge assembly along the platen. The linear motor consists of a fixed heavy steel rectangular section bar with a series of tiny slots milled across its underside. A coil assembly, supported underneath the bar and attached to the printer head and ribbon carrier assembly, induces the travelling field into the bar. Power to the linear motor, printwheel motor and solenoid are carried via two flexible printed circuit cables.

How a Daisywheel printer works

For those not familiar with this sort of printer, they are similar in principle to the children's typewriters of many years ago. These had a printwheel containing all the characters. It was rotated by hand until the appropriate character was in place and then a single lever was struck to print it. The modern Daisywheel is about 75mm in diameter and has up to 96 "petals", each carrying one print character. It is rapidly rotated to select each character in accordance with the standard ASCII (American National Standard Code for Information Interchange) code. When each character is in position, a solenoid-driven hammer thumps the petal and ribbon onto the paper, printing it out.

The petals are rather fragile and easily broken off so a recent refinement in the Daisywriter model under review is the printwheel cassette which protects the wheel from damage during handling.

Two user features which are sure to appeal are the fact that it uses the same ribbon cartridge as the IBM Selectric typewriter (which should always be readily available) and the easily loaded print-wheel which is protected in an integral see-through plastic cassette. Changing print-wheels while partway through a print-run is dead easy: just lift the plastic top-cover of the printer, press a grey lever near the print solenoid and the printwheel is simply lifted out. Drop the new wheel in, push the lever back, lower the top-cover and printing can resume. It can all take place in a few seconds.

The 96-character print-wheels are available in 25 languages and 25 font styles with printing pitch (dependent on the selected wheel) of 10, 12 or 15 characters to the inch. The print-wheels are rated for a minimum of 25 million impressions. That is equivalent to about 4000 1000-word documents.

The reason that the Daisywriter is claimed to have such a high print throughput is that it has no less than four Z-80 microprocessors. Three of these are used to control the page movement, to allow the machine to perform vector and dot graphics, since it can print 120 dots per inch (dpi) horizontally and 48 dpi vertically. The fourth processor is used to look ahead at data in the buffer, to anticipate white space, such as margins, tab stops, extra line spacing and so on. When these occur, the printer accelerates through the empty space, at an effective speed of 200cps, resulting in a significant increase in printing speed.

Printer buffer

The incorporation of a printer buffer also increases the printing speed, as well as freeing single-task computers such as the IBM PC for other jobs while printing is in progress. The maximum buffer capacity for the Daisywriter is 48K which sounds like a lot but long reports or articles can soon gobble it up. For example, the article on the Bridge

The Daisywheel printer offers a wide range of features, including subscript and superscript commands, bold or shadow printing and underlining. It is good value for money.

Adaptor on page 86 of this issue is about 2800 words and occupied just over 15K as a Wordstar file. On that basis, a 9500 word report would just about fill the buffer. Still, the Daisywriter would take about three-quarters of an hour to print out such a report. This is a long time for the computer to be tied up, which would be the case if the machine did not have such a large buffer.

However, the printer buffer does not always allow you to go on with other tasks. The problem is the noise of the printer itself, although this is not out of the ordinary as far as Daisywheel machines go. The first time I printed out a file and almost immediately got the message on screen telling me that as far as the computer was concerned, printing was finished. I thought, "beauty, I can get on with something else." But with the printer still belting through the text which had been loaded with such alacrity into its buffer, I could hardly hear myself think. I could not use the computer effectively. To make really effective use of the printer buffer, you would have to install the printer in another room or in a noise-proof enclosure.

It is also possible to reprint the contents of the printer buffer, using either a routine involving the Ready/Test and Top-of-Form buttons on the control panel or under software control. The buffer can be automatically reprinted up to 255 times under software control, which could be a handy feature where multiple original copies of documents are required.

The Daisywriter has a variety of hardware and software settings. Controls on the front panel let the user select default settings for line spacing, page length (up to 109 lines) and pitch (10, 12 or 15, to suit the selected print-wheel).

By way of explanation, default settings are those employed by the printer unless instructed under software control to do otherwise. For example, under software control, it is possible to set page length up to 255 lines.

In addition, 24 DIP switches, hidden behind a small door, give the user control over a host of parameters. The switches select for continuous or single sheet feed paper, six or eight lines per inch, 16 different languages, baud rate, printer interface, auto line feed and eight different protocols. These allow the unit to emulate printers by NEC, Diablo, Qume, Centronics and IBM, as well as three different Daisywriter protocols.

The Daisywriter has subscript and superscript commands, as well as underlining, bold or shadow printing, and selection of black or red ribbon. Of course, to use these features your word-processing program must either already be capable of doing these by expecting an appropriate printer emulation provided by the Daisywriter, or by having the appropriate routines "patched in".

Most printers have only one interface, either serial or parallel, with one alternative interface usually available as an option. The Daisywriter is fitted with four: Centronics eight-bit parallel, IEEE-488, RS-232C and 20mA current loop. For the serial modes, bit rates are automatically selected from 50 to 19,200 baud, or selectable by front panel DIP switch or software.

Speed

The makers of Daisywriter point out that specs for printer speed in characters per second (cps) do not necessarily bear any relationship to actual throughput. On short documents I found the Daisywriter was comparable in speed to some nominally much faster dot-matrix printers, as it was when printing columnar data such as the table and spec panel of the Bridge Adaptor article referred to earlier. In fact, the manufacturers state that on this sort of printout the effective throughput of the Daisywriter can be as high as 40 cps.

It was only on long documents that the Daisywriter was noticeably slower than a typical dot matrix unit, but even so it was reasonable, at about 20 cps.

While I did not try it, the Daisywriter can also be used to plot charts and graphs. It does this by using selected petals (such as the "full stop") on the Daisywheel and by effectively moving the paper around to accomplish drawing. This would be very intriguing to watch but it would probably lead to premature wear on the selected Daisywheel petals.

Cut-sheet feeder

The Daisywheel has two optional-sheet feeders, one of which is suitable only for A4 or smaller paper sizes (Easifeed 230) or the other which is able to handle wide paper sizes (Easifeed 235). Both are available with a paper-out sensor. I tried the former model. I found it a little fiddly to set up as it has quite a lot of mechanical adjustments. Once set up though, using the helpful instruction booklet, it seemed to be quite reliable.

I should also note that the instruction book for the printer itself is very comprehensive and has helpful print exercises, plus good explanations of the error modes (indicated by a beeper) and control panel procedures. The section on the software commands is long and comprehensive.

Conclusion

The Daisywriter is an impressive product which would enable the best results to be obtained from most word-processors. Its overall quality and range of features make it good value for money.

Price of the Daisywriter with 48K buffer, universal interface and interface cable (available to suit a large range of computers) is $1986 including sales tax. When supplied with the Easifeed 230 the price is $2220 or $2140 with the optional tractor feed mechanism.

For further information, contact PSI Daisywriter Products, 1-3 Atchison St, St Leonards, NSW 2065. Phone (02) 439 8086. (L.D.S.)

REVIEWS OF RECENT

Records & Tapes

CLASSICAL • POPULAR • SPECIAL INTEREST

RAVEL & CHAUSSON

Piano Trio in A Minor. Piano Trio in G Minor. Beaux Arts Trio. Philips Digital Disc 411-141/1.

The first thing about this record to strike one is the nice broad tone of the piano, unlike the usual sharpish sound of a French instrument — at any rate those of an earlier generation. The next thing is the digital range which is much too wide for chamber music. A normal fortissimo means a whispered pianissimo.

(Permit me here the aside that the latest compact discs are showing a peculiarity in their sales. The makers' haste to establish a big market by putting out a torrent of mostly reprocessed issues has resulted in many new CD discs being offered by retailers at considerably less than the recommended price.) But back to the review.

The first movement of the Trio has hints of Ravel's justifiedly popular quartet and also his Daphnis and Chloe which was composed soon after. But the Trio is a mature work built on a strong formal chassis. Yet with all its many merits I do not find it among one of Ravel's most attractive compositions. The second movement is dainty with a strangely lurching gait strongly reminiscent of one of the movements in Daphnis and Chloe. Uneven bar lines are much in evidence.

Everywhere the piano is dominant often too much so. It is not until the third movement that the pianist's low notes start to disappear into silence with the cello following it. The music is an adaption of a Malayan poem ingeniously transcribed. And here the round-noted piano shows up to full advantage. Towards the end of the movement with a normal dynamic gain setting there is much ear-stringing.

There are fountains of notes in the attractive, fast finale with the piano sometimes having things much too much its way.

The Chausson, composed a quarter of a century before the Ravel, reminds one of what happened to music in that comparatively short time. It reminds us that Chausson was strongly influenced by his teacher, Cesar Franck. The first movement is all very tuneful and elegant. The second is a dainty scherzo.

The third movement features a most beautiful cello solo though the piano again gets more than its full share of the production. Indeed the pianist adopts the air of a bully in some passages. But after many tries the music finally enters silence at the end of the movement.

The Finale follows, nicely flowing and fresh-minded. The piano again acts as soloist, leaving only scraps for the other players. Cyclic form — a la Franck is again dominant. By this time I had grown so fed up with the pianist that I felt inclined to tell him to shut-up. It is fitting that the picture on the record sleeve shows a gigantic piano keyboard with three tiny tail-suited musicians sitting on it. Throughout the trio the piano is either much too forwardly recorded or else played by an insensitive artist. I prefer to think the former. (J.R.)

WAGNER

Lohengrin. Complete opera. Peter Hofmann (tenor), Karen Armstrong (soprano) Leif Roar (baritone), Elizabeth Connell (mezzo-soprano) and others with the Bayreuth Festival Chorus and orchestra conducted by Woldemar Nelson. Five digitally recorded discs, CBS Masterworks 78503.

I like Lohengrin less than every other Wagnerian stage work except Rienzi. Wagner wrote it with an eye to instant popularity. He was at the time comfortably ensconced in a regular job in a provincial German opera house and decided he liked it that way. But his subconscious must have made him uncomfortable by recalling thoughts of work that remained to him in developing music drama, and facing up to the gigantic task of getting on with the architecture of The Ring.

Removal from his sinecure was urgent. That is the only plausible explanation for his dangerous friendship with the anarchist Bakunin which led to his flight from Germany to Switzerland to avoid arrest by German police. There he settled down to the composition of The Rhinegold, in which opera took an entirely new direction.

Lohengrin has a ridiculously sentimental story even by operatic standards. A knight in shining armour arrives in the nick of time to save a maiden in distress and after a romantic interlude is forced to desert her, to her dismay and death. During the evening he sings sentimental songs to a big bird and subdues two evil plotters before returning to his mysterious country of origin.

The opera is often tuneful but without true dramatic significance. The plot makes frequent references to the Holy Grail — the cup or bowl out of which Christ drank at the Last Supper. Indeed the sugary prologue depicts the Grail's descent to earth and its return to heaven. To Wagner's atheistic mind it was like some large object that comes down to earth, arrives to the accompaniment of a couple of cymbal crashes and takes off again like a miraculous yo-yo.

This lip service to piety occurs often in the hypocritical course of the opera. All the ingredients of popularity are there, arias sprinkled throughout, an exciting prelude to the third act and a wedding march still used in Christian wedding ceremonies. To even as convinced a Wagnerian as myself it is much too much.

The present recording was made live in Baureuth in 1981 and the sound is good with only inconsiderable evidence of an audience's presence. Orchestra and choir are fine and the balance admirable. There is also, alas, the too wide dynamic range of digital recording that makes "pps" inaudible and "ffs" unbearable.

The soloists are less rewarding. The heroine, Karen Armstrong emits a pump-like vibrato reminiscent of an Eastern European soprano and the tenor, Peter Hofmann, matches her in unsteadiness of production. There are many audiences to whom the magic of Wagner's name makes the work tolerable, but they need generosity to accommodate the poor standard of the soloists while still having the rest of the production first rate enough to compensate.

MOZART

Piano Concerto in B Flat Major, K. 450
Piano Concerto in D Major, K. 451.
Murray Perahia (piano) with the English Chamber Orchestra CBS Masterworks Digital Disc D37824.

There is an alternative issue by Ashjenazy which differs widely in its reading. Each has its own attractions. That I prefer the Perahia should in no way effect your choice. To make things easier I recommend both.

Perahia gives a transfixing classical performance of both sonatas. In the K. 450 Mozart frees the woodwind to give it its own important personality, though it is perhaps thematically ever so slightly inferior to its successor. Every bar of both concertos holds the attention. The relative importance of each performance is always questionable, the two differ so much from each other.

DEBUSSY & RAVEL

String Quartet in G Minor. String Quartet in F Major.
The Melos Quartet DGG Analog Disc 2531 203.

This is an elegant beautifully balanced performance of both quartets. What I write about the Debussy, despite its superlatives, might well be suited to the Ravel.

The first movement of the Debussy is freely expressed but never gusty. The players' firm tone is immaculately reproduced. It slows down the tiniest bit sentimentally in the middle but quite without banality. And the ensemble is everywhere beautifully balanced.

The ensuing movement with its sharp pizzicatos is delightfully crisp and the following violin legato melody is taken pianissimo, instead of self-assertingly forte. Its high pitch gives it the necessary delicious prominence. The players' continuing unanimity proceeds uninterrupted. The rest of the work goes on in the same persuasive fashion. The listener need do nothing but relax and enjoy it.

A notable performance recorded in analog with a splendid dynamic range — full but never exaggerated, and exactly right for chamber music.

In the Ravel see above for the recording and performance. Do not judge the worth of this issue by the shortness of the notice. After having lauded its perfection what else is left to say?

"MESSIAH" ON CD

Handel, Messiah: Favourite choruses and arias. The Atlanta Symphony Orchestra and Chamber Chorus, with Layton James, harpsichord. Conducted by Robert Shaw. Telarc compact disc CD-80103. [From P. C. Stereo Pty Ltd, PO Box 272, Mt Gravatt, Qld 4122. Phone (07) 343 1612]

Although this review appears rather belatedly, I first heard this disc, very appropriately, on Easter Sunday, when the events that inspired it were fresh in mind.

Booklet notes point out that, circa 1730/40, Handel's fortunes had fallen to a low ebb in London, especially with the failure of the Composer's Italian opera company. In consequence, he had turned to writing oratorios, in English, for stage rather than church presentation, using a mix of recitatives, arias, choruses and instrumental items.

"Messiah", his ninth "commercial" oratorio, was written in just over three weeks and taken to Dublin for presentation, although Handel deliberately delayed the first performance for six months, anticipating (correctly) a build-up in public interest. Dubliners received it with great enthusiasm, but it took 10 years or more before gaining popularity in London.

As originally conceived, "Messiah" called for 40 singers and 40 instruments but, over the years, the number of performers has risen, on occasions, to hundreds and even thousands, providing a devotional, if not a musical "spectacular".

For this recording, Robert Shaw uses resources of more Handellian proportions, better able to provide clarity of sound: 40 instruments, organ and 60 voices. Included are Karen Erickson and Syliva McNair (soprano). Alfreda

Hodgson (contralto), Jon Humphrey (tenor) and Richard Stilwell (baritone) — all American singers of note.

Telarc indicates in the notes that the complete work is available on two-set CD and LP albums but this single disc contains 22 "favourite choruses and arias", edited unobtrusively into a composite 60-minute performance that certainly captures the traditional spirit of the work.

Helpfully, the scripture texts which form the basis of each item are listed in the notes.

The sound quality is generally excellent, although with just a touch of edginess on some of the more complex vocal passages. But my hunch is that those who buy this disc will do so for the content rather than ultimate technical perfection. (W.N.W.)

TRUMPET CONCERTOS

Classical Trumpet Concertos. Ludwig Guttler, with the Neues Bachisches Collegium Musicum Leipzig, conducted by Max Pommer. Compact disc, Capriccio 10010 [From P. C. Stereo Pty Ltd, PO Box 272, Mt Gravatt, Qld 4122. Phone (07) 343 1612]

Digitally recorded in Leipzig in 1981, this recital was released last year on compact disc by Capriccio — a label relatively new to Australia. It carries trumpet concertos by Leopold Mozart, Johann Melchoir Molter, "Anonymous" (an unidentified contemporary) and Joseph Haydn.

Composed in 1762, Mozart's "Concerto for trumpet, two Horns, Strings and Basso continuo in D-major" contains two movements totalling 11'12". Consistent with trumpets and the baroque writing of the period, it is pitched almost entirely in the clarino (high) register, posing considerable difficulty for the soloist, even without the "singing" quality and specified slurs, which the work demands.

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Records & Tapes

"Concerto for Trumpet, Violin, Strings and Basso continuo in E-flat major" (12′ 30″) has three movements: allegro, andante, allegro. While the composer is unknown, it typifies various mid 18th century compositions and, presumably in Guttler's view, "proceeds with good breeding and charm."

Molter's "Concerto No. 1 for Trumpet, Strings, and Basso continuo in D-major" (9′ 13″) also has three movements and would appear to have been composed in the mid 1740s, following the composer's return to Mannheim from Rome. Certainly, the Italian influence is evident.

As distinct from the three earlier concertos, Haydn's "Concerto for Trumpet and Orchestra in E-flat Major" (15′ 12″) took advantage of Weidinger's then new and improved trumpet, with its extended useable range, particularly in the lower register. With it came the demand and the opportunity for playing skills of quite a different kind: nimbleness and, as in the Adagio, the opportunity to convey real emotion.

Curiously, the work was neglected after Haydn's death but was revived by the noted British trumpeter George Eskdale in the late 1920s. A version for the modern valve trumpet has become one of the most popular works ever for a brass instrument. It certainly provides a fitting — and a welcome — climax after the earlier emphasis on clarino baroque.

Ludwig Gutler, by the way, is currently professor at the Academy of Music in Dresden, has travelled as soloist with the Bach Orchestra and the Berlin Chamber Orchestra and, since 1969, has been resident trumpet soloist with the Dresden Philharmonic.

Manufactured by Sanyo in Japan, the recording itself provides clean, well balanced sound, with the trumpet always in the spotlight. It is not — nor should it be — an audio spectacular but it will appeal to those partial to small or chamber groups and, of course, to anyone interested in solo orchestral trumpet. (W.N.W.)

MORE OLD/NEW JAZZ

The Legendary Jazzmen, Vol. 4. Digitally re-mastered stereo and simulated stereo LP, double album. RCA VJL-20425.

Such has been the reception accorded the earlier three volumes in the "Legendary Jazzmen" series, that RCA have now released volume 4, a double-album set. And it certainly doesn't let the series down, despite the mounting problem of locating further suitable (and available) originals from the archives and from private record collections.

As with the earlier re-mastered old-time jazz recordings, reviewed in these columns during the past few months, the man responsible for the technical — and musical — resurrection of this latest set is broadcaster and recording engineer Robert Parker. With the aid of a Packburn de-noiser to get rid of surface clicks, skilful panel work to recapture the original dynamic range, a reverb unit, an Orban Parasound stereo synthesiser and a Sony digital recorder, he creates a new master and recordings which would almost certainly sound far better than even pristine pressings of the day.

And they are startlingly good. "Sugar" (side 3, track 1) featuring Adrian Rollini on sax, was recorded in 1927 but it certainly doesn't sound that way; and much the same remark applies to other tracks from the same era.

For orderly presentation, the contents of the volume, amounting to 30 tracks in all, are arranged and presented under four headings: The Brass, The Reeds, The Rhythm and The Arrangers.

About half the tracks come from '78s from the late '20s and '30s, with the odd tape in stereo from the '60s. Others in between are from unidentified originals but all have had the "Parker" treatment, ensuring a surprising consistency in balance from track to track.

The personnel involved are listed for each item; in addition, there are biographies and, in most cases, pictures of the featured artists. With so many tracks, it is not practical to list the titles but few would be likely to question the joint judgment of recordist Robert Parker and producer Ron Wills.

Well worth the purchase price if you're into jazz! (W.N.W.).

COUNTRY GOSPEL

Just a closer walk. Alan Hawking. Stereo LP album, RCA Victor VPL1-0473.

With his brother Russell, since deceased, Alan Hawking made his debut on disc in 1955, featuring the Hawking Brothers. About the same time, he was a member of the "Trailblazers", an early Melbourne concert group. Since then, he has performed at venues ranging from the Sydney Opera to the Grand Ole Opry (USA), has toured with top-line American artists, and twice represented Australia at the International Show of the American Country Music Association at Nashville.

As might be expected, this whole album is presented in simple, relaxed, country style, with lead vocal, harmony, drums, bass, guitars, harp and banjo.

What is surprising is that, apart from some high harmony by Jane Hawking on one track, everything from the arrangements to the vocals and instrumental support was provided by Alan Hawking himself, using multi-recording.

There are 12 tracks, all with Gospel themes well known on the C&W scene: Just a Closer Walk — It Is No Secret — The Three Bells — One Day at a Time — The Old Rugged Cross — Amazing Grace (instrumental) — How Great Thou Art — Just For Today — Scarlet Ribbons — In His Hands — Where I'm Going — Gospel Train (instrumental).

The whole presentation is notably tuneful and restful, with excellent diction and with a lot of potential appeal to anyone who just likes to relax and listen to this sort of middle-age Gospel music. Even if you do doze a little, the final track "Gospel Train" will wake you up again with a spot of very adept one-man blue-grass rhythm.

The technical quality is good and I'd be surprised if Alan Hawking didn't make quite a few new friends with this one. (W.N.W.)

ROCK DEVOTIONAL

MetroBand Live. Directed By Thurlow Spurr. Stereo LP album, Light LS-5842. (From Word Records Aust, 18-26 Canterbury Rd, Heathmont, Vic 3135. Phone (03) 729 3777).

Whatever other claims to fame the MetroChurch (Edmond, Oklahoma, USA) may have, they can certainly be proud of the church band, featured on this album. "It is equally at home", says the jacket, "playing Count Basie style Big Band, Pete Fountain New Orleans Dixieland, or a reasonable facsimile of a Salvation Army street band."

In this "live" concert performance, they set out in a very professional manner to demonstrate that the claim is justified. Listening to the solos in a couple of the tracks, I was reminded of a Sydney jazz trumpeter friend who explained to me one day that: "you lose your job if anyone, during your solo, gets to recognise the melody!"

In a wide variety of arrangements, some by members of the band, they present eleven tracks based mainly on traditional hymns:

I Go to the Rock — Leaning on the Everlasting Arms — He Lives — Jesus Saves — We Will Stand — When the Roll is Called up Yonder — There is Power — When We All Get to Heaven — Love Lifted Me — Victory in Jesus — Jesus Medley.

The sound quality is excellent and the album should appeal strongly to anyone interested in orchestral gospel arrangements. I'm not quite so sure about the elderly lady whom the compere imagines might be discovered, late at night, enjoying these grand old hymns of the church. Unless she's been raised on a diet of big band dixieland, she mightn't even recognise some of them!

But, for what it is, it's good (W.N.W.)

"BIG BAND" GOSPEL

Straight Ahead. Amy Grant. Stereo LP album, Myrrh SPCN-7-01-675706-4. [From Word records Aust, 18-26 Canterbury Rd, Heathmont, Vic 3135. Phone (03) 729 3777.]

This is very much an album for the "now" generation, or at least for that section of it that's turned on by the sound of Gospel rock music. One generation on, and churchgoers tend to be less enamoured by rock rhythm,

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especially as delivered by over-powered amplifiers and accompanied by lyrics, identified as "devotional" mainly by the title!

These remarks are not meant to detract in any way from the evident talent or the dedication of Amy Brown and the musicians supporting her in this new album. They are very capable and undoubtedly very sincere but, as I said, their music will appeal primarily to the younger generation of Gospel record buyers.

Diction is about average for this kind of performance but, to forestall any doubts on this score, the inner jacket carries the lyrics in full, plus the credits for each track. Amy Grant's name appears several times against words and/or music — a further indication of her talents.

The track titles: Where Do You Hide Your Heart? — Jehovah — Angels — Straight Ahead — Thy Word — It's Not a Song — Open Arms — Doubly Good to You — Tomorrow — The Now and the Not Yet.

The sound quality of the album is well up to standard and, if Amy Grant happens to be your pin-up favourite among Gospel vocalists, you will find a signed, eye-catching full-colour portrait inside, to go with the music! (W.N.W.)

FLAWLESS FLUTE

In the Pink. James Galway and Henry Mancini, with the National Philharmonic Orchestra. Stereo LP, Starcall SFL1-0117. Distributed by RCA.

One might be excused for concluding that, as a musician and entertainer, James Galway can't put a foot wrong — or maybe, can't put a lip wrong! Whether faced with a classical or a popular program, he always manages to live up to expectations.

This disc is no exception and will certainly not disappoint James Galway's many fans.

It opens with the jaunty "Pink Panther" theme, followed by "Maggie's Theme", the latter marked by Galway's superbly controlled sound. At the other extreme is the dazzling virtuosity displayed in "Speedy Gonzales". "Pennywhistle Jig" and "Pie in the Face Polka" provide their own brands of rhythm, while "Baby Elephant Walk" is different again, played on a penny-whistle!

Other track titles include: Breakfast at Tiffany's — Crazy World — "Thorn Birds" Theme — Two For the Road — "The Molly Maguires" Theme — Mancini/Mercer Medley — Cameo for Flute.

Henry Mancini, composer (or joint composer) arranger and conductor provides a backing that complements but never competes with Galway's flute. The technical quality is excellent and, all told, it adds up to a very tuneful and listenable album. Recommended (W.N.W.)

VOCAL DUO

Only You. Renee & Renato. Stereo LP album, Starcall SFL10111. (Distributed by RCA).

As with their earlier recording "Just One" (reviewed by GS in March '84) this latest album is again virtually devoid of jacket notes. Yes, it was recorded in Hollywood in 1984 for the Hollywood label and is distributed by Starcall/RCA — but the orchestra, chorus and conductor receive not a mention.

From the names, accents and a couple of pleasant but modest cover pictures, one might conclude that Renee is English, with a touch of French. Renato presumably has an Italian background and a penchant for the Italian operatic style, which he uses to good effect.

Undoubtedly, the European touch adds its own appeal to this further album of middle-of-the-road romantic songs, rounded off by what is probably a "message" track: "Jesus Loves Us All". The remaining titles are:

Volare — Come Prima — Love Letters — Anniversary Waltz — Blue Serenade — Only You — Save Your Love — Falling in Love — If Love Is Not the Reason — I Wanna Give You Love.

Technically, the sound is good and, overall, the album should have a ready appeal to those who prefer middle of the road popular music (W.N.W.)

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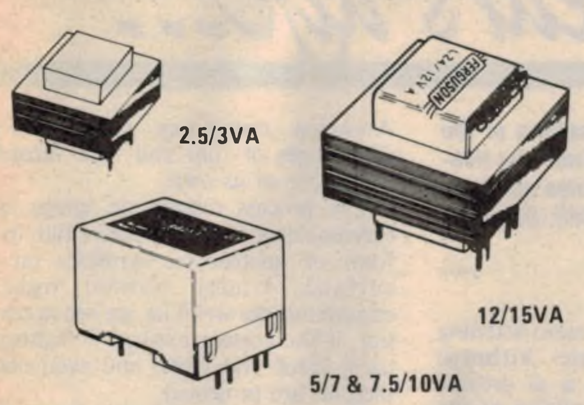

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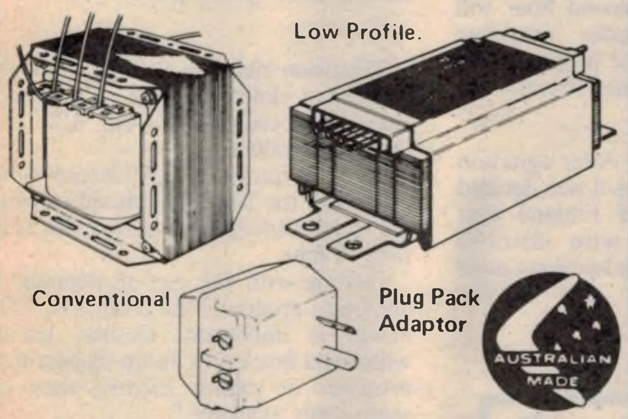

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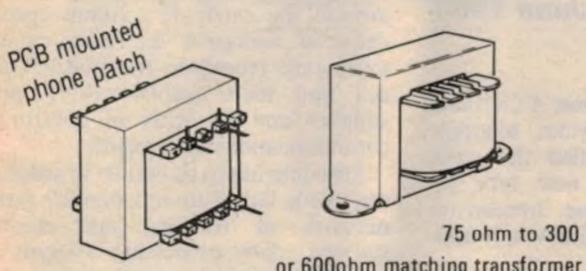

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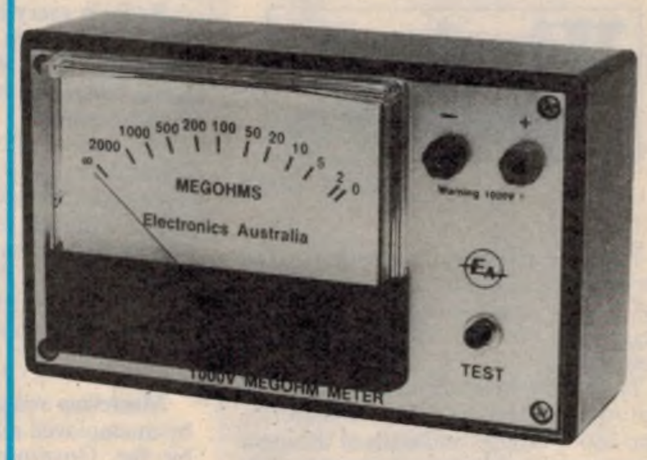

Megohm Meter

Featuring an in-built transistor inverter power supply, this Megohm Meter tests at 1000V and covers the range from 2MΩ to 2000MΩ. It is particularly handy for checking electrical wiring. Details in July *Electronics Australia.*

Infrared Remote Control

Next month, we intend to describe an infrared remote control for the Dick Smith Teletext Decoder. It requires very few extra parts, is easy to build and duplicates all the control keys on the original wired unit.

Surface Mounted Components

Don't miss our exclusive article on surface mounted technology. Our article looks at the various component types and describes how they are mounted onto PC boards.

Hifi Reviews

We take a look at the Luxman L-215 stereo amplifier and the Spectrum V1.2 loudspeaker system.

**Although these articles have been prepared for publication, circumstances may change the final content.*

50 and 25 years ago...

"Electronics Australia" is one of the longest running technical publications in the world. We started as "Wireless Weekly" in August 1922 and became "Radio and Hobbies in Australia" in April 1939. The title was changed to "Radio, Television and Hobbies" in February 1955 and finally, to "Electronics Australia" in April 1965. Below we feature some items from past issues.

Wireless Weekly 3d

June 1935

Perfect silence impossible: The impossibility of producing perfect silence has been demonstrated recently by engineers at the General Electric Company.

The engineers constructed a small box-like room inside one of the laboratories. The floors, ceilings and walls of the inner room were suspended on springs. This room was then padded inside and out with sound absorbing materials.

When the room was completed, a sensitive meter placed inside it detected sounds averaging about 14dB.

Egg lark: Engineers at station WOR, New Jersey, found a lark in a nearby meadow which had built a nest in a discarded coil of wires; while the 50kW transmitter was working, the lark went about other business, leaving the eggs unattended.

The eggs hatched out all right because while the transmitter was working, the coil picked up just enough heat to keep the eggs warm, which may be just a lark, as may the bit about other larks who tried the same thing but selected coils with too much wire in them, so that the eggs were cooked.

Television standards: There appears to be a great deal of uneasiness in the trade in London regarding television. Whilst every manufacturer is hastily reassuring his clients that present day sets will still be of use three or four years hence, there is a feeling that this is more a hope than a statement of fact.

The BBC is at the moment in a state of change, their 38 line transmissions are coming to a close in the very near future. Germany works on the 180 line picture and English authorities will either go to this or increase the lineage to 240.

Radio in every room: A radio listening installation on a scale hitherto unattempted in Australia is at present being placed in the new building of the Hotel Australia.

By means of an AWA system of centralised radio reception, programs from eight Sydney metropolitan stations will be available to guests in every room. A radio room on the second floor will accommodate the master receiving apparatus from which the programs will be distributed to the guests' rooms.

Musicians redundant: After agitation by unemployed musicians it was decided by the Government of Finland that restaurant owners who dismiss orchestras and install loudspeakers must pay a fixed monthly sum to the Musicians' Union.

Radio Television and Hobbies 2/6

June 1960

Car engine without pistons: A German company making motorcycles, scooters and Prinz cars has startled the auto world with an entirely new type of internal combustion engine. Instead of pistons that shuttle up and down, it uses a tricky three lobed rotor.

A cross between the ordinary internal combustion engine and a turbine, it promises twice the power from the same weight and size as conventional engines.

The potent package is a rotary gasoline engine, an engineering will-o'-the-wisp that has eluded inventors for generations. It has apparently been captured at last by the NSU Werke.

Hot movies: A new thermoplastic recording process developed recently in the General Electric laboratories in America combines most of the advantages of film and tape recording with some of its own.

The process records an image on a thermoplastic layer on tape or film in the form of microscopic wrinkles on the surface. Under normal lighting conditions, the wrinkles are not apparent but, if the correct method of lighting is used, black and white and even colour pictures are projected.

The film consists of three layers. The thickest layer is the base material, which is about as thick as conventional movie films. Over this is coated a layer of conducting plastic, and finally the low melting point thermoplastic layer.

Television violence: Rules to limit the amount of violence shown on television have been codified by the BBC and issued to producers.

A large number of American series offered to the BBC are refused as being too brutal. Accepted cuts are made from time to time.

Dealing with the use of weapons in children's programs the code says: "The choice is important. Coshes, knives, whips and bottles are more suspect than revolvers or swords because they are more easily available."

Weather satellite: The United States weather satellite "Tiros" constitutes what is probably the most elaborate electronics package yet sent into orbit around the earth. It contains specially designed miniature television cameras, video tape recorders, transmitters, solar cell and rechargeable battery power supplies and an array of control and communications equipment.

Speeding along its course in space, the satellite is linked to an extensive ground network of tracking and receiving stations, data processing systems and programming and control centres.

Colour TV camera: A new EMI colour camera uses three vidicon tubes and an optical system — several times more efficient than relay lens systems — which has been designed so that the maximum amount of light falls on the photo-conductive surfaces of the vidicon.

The versatile design makes the system suitable for broadcasting and telecine transmissions, as well as for use in industry and medicine.

COMPUTER BOARDS

THE NEW ZRT-80 KIT

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BIG BOARD II

OVER 1,000 SOLD!

Jim Ferguson, designer of the "Big Board" distributed by Digital Research Computers, produced this stunning computer "Big Board II"

FEATURES...
- **4 MHz Z80 CPU AND PERIPHERALS CHIPS:** The Ferguson computer runs at 4MHz. Its monitor code is lean, uses Mode 2 interrupts, and makes good use of the Z80-A DMA chip
- **64K RAM + 4K STATIC CRT RAM 24K (E)PROM OR STATIC RAM:** "Big Board II" has the three memory banks. the first memory bank has eight 4164 RAM's that provide 60K of user space and 4K of monitor space. The second memory bank has two 2K and 8 SRAMs for the memory mapped CRT display and space for six 2732s or 2K x 8 static RAMS or pin compatible (E)PROMs, the third memory bank is for RAM or ROM added to the board via the STD bus. Whether bought as a bare board, a full Kit, or assembled and tested, it comes with a 450nS2732A EPROM containing the monitor
- **MULTIPLE DENSITY CONTROLLER FOR SS/DS FLOPPY DISKS:** The "Big Board II" computer has a multiple density disk controller. it can use 1793 or 8877 controller chips. The board has two connectors for disk signal with 34 pins for 5¼" drives, the other with 50 pins for 8" drives
- **VASTLY IMPROVED CRT DISPLAY:** The "Big Board II" computer uses a 6845S CRT controller and 8002 Video Attributes controller to produce a display that will rival the display of quality terminals. Characters are formed by a 5 x 7 dot matrix on 15.75 KHz monitors and a 7 x 9 dot matrix on 15.75 KHz monitors. The display is user programmable with the default display 24 lines of 80 characters
- **STD BUS CONNECTOR:** "Big Board II" brings its bus signals to a convenient place on the PC board where users can solder a STD socket, bus cards can be plugged directly into it, and it can as well be connected by bus cable to industry standard card cages
- **A Z80-A S10/0 = TWO ASYNCHRONOUS/SYNCHRONOUS SERIAL PORTS**
- **TWO Z80A CTCs = EIGHT PROGRAMMABLE COUNTERS/TIMERS:** The "Big Board II" has two Z80-A CTCs. One is used to clock data into and out of the Z80-A CTCs. One is used to clock data into and out of the Z80-A S10/0, while the other is for systems and application use
- **PROM PROGRAMMING CIRCUITRY AND SOFTWARE:** The "Big Board" computer has circuitry and drivers for programming 2716s, 2732(A)s, or pin-compatible (E)PROMS. (Software $25 extra)
- **CP/M CAPABILITY:** CP/M with Russell Smith's CBIOS for the "BIG BOARD II" is available (plus tax) $230

The CBIOS 5" or 8" is avail. separately (plus tax) $65

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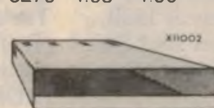

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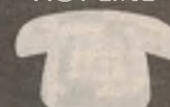

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Information centre

Substitute transistors for Playmaster 136

A few years ago, I constructed the Playmaster 136 amplifier (EA Dec 1972). It worked extremely well and I subsequently passed it on to one of my sons, while I went on to bigger things.

The amplifier has now developed a fault in the left output transistors, viz AY8171 and AY9171. The problem is that I cannot obtain these transistors anywhere, and nobody apparently can give me the equivalents. Can you help?

Recently, I also built the stereo synthesiser published in EA in December 1982. The 470pF capacitor across switch S3 had been devalued by the kit supplier from the 2kV specified to 1kV. On completion of the unit, a dreadful mains hum was present and the LED indicator light refused to go out. Needless to say it was the 470pF 1kV which was at fault.

My problem is that I cannot find the correct capacitor at the various outlets although I have tried.

I am looking forward to building your latest Playmaster Series 200, and I hope that I can purchase a kit exactly as you specify. (R.H., Carlingford, NSW).

● We suggest that you use a TIP31B for the AY8171 and a TIP32B for the AY9171. These TO-126 style transistors can be bolted directly to the top of the heatsinks and their emitter and base leads bent at right angles so that they pass through the appropriate holes.

As far as the stereo synthesiser is concerned, we are surprised that the 1kV capacitor should fail. We suggest that you contact George Brown & Co Pty Ltd, 174 Parramatta Rd, Camperdown, NSW 2050. Phone (02) 519 5855.

Problem with tacho/dwell meter

I would appreciate any advice you can give me on these problems to do with the Tacho/Dwell Meter (EA, July 1983).

(1) The kit purchased from Jaycar did not include a voltage dependent resistor (VDR). The result of an enquiry to Jaycar was inconclusive and they had no VDR for sale. Dick Smith had two VDRs for sale. One was too large to fit in the case; I bought and fitted the smaller.

When the meter was switched to tacho mode and connected between the negative end of the coil and chassis earth, the engine stopped (possibly the resistance of the VDR with 5.5V across it went too low and virtually shorted the coil to earth). The VDR has since been removed. Can you tell me:

(a) the type number of the correct VDR; or

(b) the type number of an acceptable alternative; or

(c) the characteristics of an acceptable type and where to buy it.

(2) When used to measure resistance on the 20Ω range, the readings change in a random manner at intervals of about one second. A typical series of readings would be, when measuring a 10% resistor: 09.7, 10.1, 09.8, 10.2 etc. The soldered joints appear to be satisfactory, there are no bridges between tracks, diodes D5 and D6 have been checked (with an ohmmeter), and the thermistor appears to be satisfactory (it measured 1.06kΩ at room temperature, about 23°C) and the range resistors appear to be satisfactory.

As I have previously built the Capacitance Meter (EA, March 1982) and the 3½ Digit Multimeter (EA, March 1983), and both worked from the start, I would appreciate any advice you could give me. (T.C., Bexley North, NSW).

● An examination of previous tacho circuits published in EA shows that none have used a VDR and it is not really necessary. The circuit should work without it.

As far as the problem of measuring resistance is concerned, we suggest that you check that the four position slide switch has low contact resistance, as this can affect the readings.

Multi-sector burglar alarm

I recently built your Home Burglar Alarm (EA, January 1985) but encountered a few problems with the siren driver circuit. I would be glad for any advice you could give me.

The problems occur when the silent alarm switch is closed. With no load connected, the unit goes through the alarm and reset cycle correctly if triggered. However, after 10 seconds (the exit delay) the unit triggers again.

With a load connected, the alarm resets almost immediately and the siren gives a short "BLAT". When the test button is pressed the same result occurs — a short "BLAT" and also a flash of the sector LEDs.

The alarm LED remains steady when the silent alarm switch is open; when closed, it pulsates.

The circuit was tested with IC10 removed — IC7d and IC11a worked correctly.

IC10 appears in different places in the text as a 4001 and a 4011. A 4011 was used, although a 4001 was tried but without the desired results. The wiring diagram seems to conflict with the circuit diagram and I have altered the wiring. (K.H., Boya, WA).

● Firstly, the changes you have made to the wiring diagram are quite in order. The pin marked 32 on the printed circuit board was included due to an oversight, and should be ignored. The corrections that you have made to the wiring to S11 and S12 are necessary if the type of switches that you use have the common contacts in the centre rather than at one edge as in those used in the prototype.

IC10 should be a 4011. The parts list is correct but the circuit diagram is in error.

The problem that you have appears to be related to IC7, because it is common to both the alarm and the delay circuits. Check all the solder joints around this IC and associated components, watching out for short circuits in particular. Pay close attention to pins 2 and 3 of IC7 since the problem only occurs when S10 is closed.

Infrared remote control

I have built the Stereo Infrared Remote Control (EA, October 1979) which has been working well for 12 months. Recently, I decided to make the modification which appeared on page 116 of the January 1980 issue.

I have found that the "up", "down"

and "off" work very reliably from over 10 metres away. However, to switch on, I have to move to about one metre away and press the "up" button on the remote as many as five or 10 times, with a relay click now and then until it finally stays on.

I replaced the 10kΩ resistor on the base of the modified circuit with different values. I settled on 100Ω which gives me back the range, but now it goes straight to the second last or last maximum volume position (which to say the least is a bit startling to the unaware).

Can you give me some ideas on how to make this part more reliable? (M.K., Carlingford, NSW).

● First, we suggest that you restore the circuit to its original condition. If the circuit still fails to operate correctly, then it seems likely that one of the ICs has been damaged. Try IC5 and IC6.

It should not be necessary to reduce the 10kΩ resistor to the base of the BD263 Darlington transistor. Try replacing this component also.

Le Gong doorbell

I have built two Le Gong units (EA, March 81) and both have been triggered when switching on household lights or when using the ceiling fan speed controller. Both units have been run by inbuilt batteries, with no connection whatsoever to the AC mains. Can you suggest a cure?

I have been a reader of your journal since the old Wireless Weekly days of 1928 and have spent many happy years building many different projects including the 50W Mosfet Playmaster Stereo Amplifier (EA, Dec 1980). Now, at 72 years of age, I still like to tinker. (J.D., Tweed Heads, NSW).

● We suggest that you try bypassing the pushbutton leads with a 0.1μF capacitor. In addition, to keep interference to a minimum, we suggest that the leads be twisted together.

Interference to AM radio

Since moving into my new home some two years ago, I have experienced a very annoying "buzz" on the AM receivers around the house and parts of the backyard. It comes about when either of our Rank television sets are switched on, appearing about every 15kHz on the AM receivers.

Is there any way to cure this wretched problem. (M.M., Rye, Vic).

● Your radio is picking up the 15,625kHz harmonics generated by the line output stage of each TV receiver. The best way around this problem is to use an external aerial for the radio, with a shielded lead-in. This external aerial should be mounted as far away from the TV receivers as possible.

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Help wanted for scanner project

After looking around at various scanners, transceivers and CB rigs, I have decided to build my own. Although heavily into electronics, I lack the expertise necessary to devise my own plan. Can you help me? (A.M., Campsie, NSW).

● There is no way you could build a scanner with special features for less than the cost of a commercial unit. And the amount of design work necessary for the microprocessor and RF circuitry does not bear thinking about. No, we certainly cannot help on that one.

Looking for a CRO

I am a beginner come average hobbyist in electronics and I am looking to buy a CRO (say 10MHz or less) without too many features (single trace, z input, not very old and reliable) at about $150. I am not looking for a kit but a second hand oscilloscope or new one (up to $200).

Could you please advise me where and how I may purchase one as I have tried the newspaper classifieds, your EA Marketplace and cannot find any for sale. Many of the electronics stores have been tried (such as David Reid and Jaycar) but without success. (E. Misoyannis, 42 Haines Ave, Carlingford, NSW 2118).

● We have printed your full name and address so that any reader with a suitable CRO can contact you directly.

Waterlogged solar fountain

I have two problems that you may like to tackle in your Information Centre. First, I made up the Solar Fountain, putting in much time and effort to dig and cement a pond, and mount a fountain etc. The pump became waterlogged within two weeks of operation, so we fitted a second pump only to have a repeat performance. Is there any cure?

My second problem is with the Touch Lamp Dimmer (April, 1983). I made up two of these units. The first one works well but I placed the second one in a bedlamp with lots of metal for the touchplate and on humid days I have to remove the globe to stop the lamp from going through a continuous cycle. Can you help? (W.F., Carnarvon, WA).

● We have not heard of the problem with the Solar Fountain pump before and can only suggest that you take the matter up with the retailer concerned. The sensitivity of the Touch Lamp Dimmer can be reduced by reducing the 1MΩ resistor on pin 15. Try substituting a 470kΩ resistor initially, but be prepared to use a lower value if required.

Sub-woofer amplifier

After reading many reviews in your magazine I purchased a 100W Sub-Woofer Amplifier kit (EA, July 1982). I bought it about three months ago and have never been able to get it running.

I was very careful in constructing the amplifier but I was unable to get zero voltage at the output. I have installed the 5W 220Ω resistors across the fuse clips, the +50V rails are correct, and I was able to obtain 13V across the 220Ω resistors.

Now each Mosfet has about 14-16mV across each 0.56Ω/5W resistor. It is impossible to adjust the trimpot (VR2) to obtain zero voltage at the amplifier output — I always get about 40V.

I went right through the amplifier and replaced the trimpots and all transistors except for the Mosfets. The problem remains, even when the Mosfets are not connected.

Later on a friend had a look at it and found that the input signal got as far as the Q1 transistor, so the filter works well but that's all. I have spent a great deal of time on this thing and I hope that you can suggest something besides the garbage tin. (B.P., Coogee, NSW).

- Having read through your description of the symptoms, it is not possible to say what is wrong with the amplifier. Indeed it is possible that there is nothing wrong at all since the output stage appears to be biased correctly. Are you measuring the output voltage as depicted on the circuit diagram, ie, between the output and 0V terminals? The voltage here should be close to zero volts.

Trouble with Teletext Decoder

I have been trying unsuccessfully to get the Teletext Decoder working.

Basically it does not like going into the teletext mode. The self-starting crystal oscillator usually won't, but if it does start, Data and Clock signals come out of the VIP SAA5030 and into the TAC SAA5040 correctly; so too does the information from the remote control. During this time, a normal TV picture usually appears. Occasionally, for no apparent reason it will decide to function.

The picture has half good information and half corrupt (this is when L2 is tuned to the best possible position). When this happens, all the functions of the handset appear to function. Sometimes even pages can be selected, although they are still 50% corrupt. Occasionally, selection between television and teletext works normally but, more often, once television is pressed, it is impossible to get back into the teletext mode.

When the unit has been running for five minutes, the SAA5030 VIP gets too hot to touch. After 20 minutes, you can smell the heat of the plastic. This occurs in either mode. The 5V and 12V rails are correct.

The PO line functions as described — high for TV and low whenever a Teletext picture is displayed.

The decoder is totally incapable of displaying the large headers used on the index eg: MAGAZINE ONE, MAGAZINE TWO. The space where they should be is filled with seemingly random garbage as: "gggf Ggjj5 og gggggggggg8".

I really would appreciate any help or advice. (A.N., Campbell, ACT).

- We feel that the problems you are experiencing are all due to one of two things: either the signal which you are applying to the decoder is of insufficient amplitude or the signal source is not tuned correctly. It must be stressed that the Teletext Decoder requires the TV station to be tuned spot on. The video waveform should have an amplitude of between one and two volts peak to peak.

Since the clock generated in the SAA5030 is phase locked to the clock signal recovered from the incoming teletext data, insufficient level or mistuning could easily prevent this clock from running correctly. This clock then controls all the timing throughout the circuit, accounting for the problems that you are experiencing with the controls.

Once you have resolved the problems with the input to the circuit we feel that good results will be obtained after the setting up procedure has been followed. The SAA5030 does get quite hot under normal conditions.

Notes & Errata

HOME BURGLAR ALARM (February 1985, 3/MS/113): the leads to LED D33 are shown transposed on the wiring diagram on page 59. Similarly, the leads to switches S3 and S4 have also been transposed. Three pins marked "32" are shown instead of two — the one on the printed circuit board should be ignored.

The wiring for switches S11 and S12 is correct for the switches that we used. These switches have the common contact at one end rather than at the centre as with most popular types. The short length of wire soldered between these switches must connect to the common of the switches, so the wiring must be altered if centre common switches are to be used.

Finally, if the alarm time is longer than specified, reduce the 4.7μF timing capacitor on pin 5 of IC7c. If the alarm sounds soon after you have left the house, then the exit delay should be made longer.

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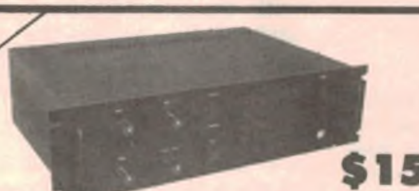

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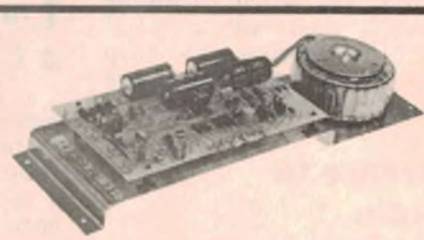

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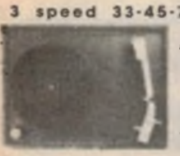

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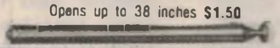

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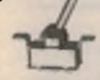

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Kenwood KX-780 cassette deck . . . from p41

not markedly affected by the bias changes which indicates that the machine is pretty well set up to begin with.

By far the best performance was obtained with metal tape, TDK MA C-60 (one of Kenwood's recommended types). At a recording level of −20VU, the −3dB point of the frequency response was 19kHz without Dolby, 16kHz with Dolby B and 15kHz with Dolby C.

At −10VU, and Dolby out, the frequency response was only 6.5dB down at 20kHz, for a medium bias setting. Signal-to-noise ratio was 50.5dB without Dolby, 56dB with Dolby B and 58dB with Dolby C. All signal to noise ratio figures are unweighted. At 0VU, harmonic distortion was around 1.5%, an excellent result. By pushing the maximum signal level a little over 0VU, a dynamic range in excess of 60dB is easily achieved.

With Nakamichi SC tape, the 20VU frequency response was 3dB down at 19kHz, without Dolby. With Dolby B, it was 17.4kHz and with Dolby C, 18kHz. At −10VU, the frequency response was 10dB down at 10kHz, although only 0.3dB down at 15kHz, again for a medium bias setting. Signal-to-noise ratio was 49.5dB with Dolby out, 54dB with Dolby B and 56dB with Dolby C. Harmonic distortion at 0VU and 1kHz was around 1.6% again, a very good result overall.

With Ferric tape, (DM Magnetics) the

continued on page 128

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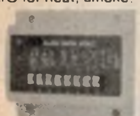

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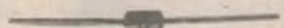

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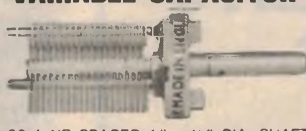

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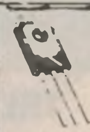

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245	Hi Fi Woofer	8 or 15 Ohms	30	30-5000	150	$111.00 or	$210.00
249	Hi Fi Twin Cone	8 or 15 Ohms	30	30-12000	150	$117.50 or	$223.00
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266	Disco etc	8 or 15 Ohms	50	40-14000	150	$175.00 or	$332.00
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236	Twin Cone Disco	8 or 15 Ohms	65	50-14000	60	$ 90.00 or	$170.00
241	P.A. etc	8 or 15 Ohms	65	50-8000	80	$ 94.50 or	$180.00
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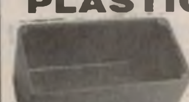

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Kenwood KX-780 cassette deck . . . from p126

−20VU frequency repsonse was 3dB down at 17kHz with and without Dolby B, and at around 19kHz with Dolby C, although note that the overall response was a good deal lumpier than with the previous two tapes.

At −10VU, the response at 20kHz was −9dB down and distortion at 0VU was 3.1%. All these figures for Ferric tape were taken with minimum bias setting, which gave the best overall results.

Separation between channels was −39.5dB at 100Hz, −40dB at 1kHz and −38dB at 10kHz. These are good results.

In fact, the overall results from this machine were very good and demonstrate just how far the cassette medium has evolved. There are few points worth complaining about, although the accuracy and resolution of the LED signal level could be improved.

In use, the unit performs very well and produces very good quality recordings.

Recommended retail price of the Kenwood KX-780 is $679.00. For further information on the Kenwood range of products, contact Trio-Kenwood (Australia) Pty Ltd, 4E Woodcock Place, Lane Cove, NSW 2066. (L.D.S.)

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