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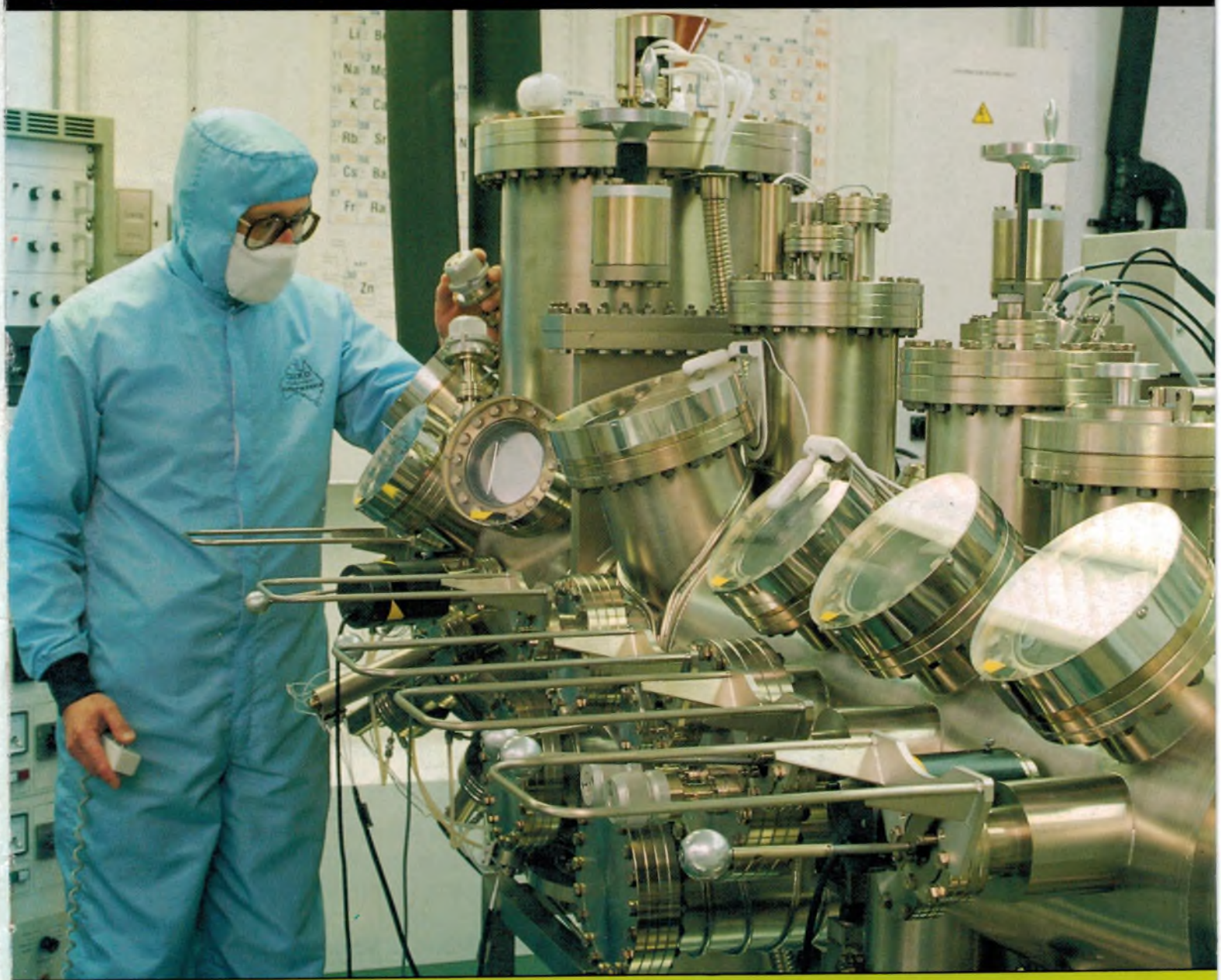

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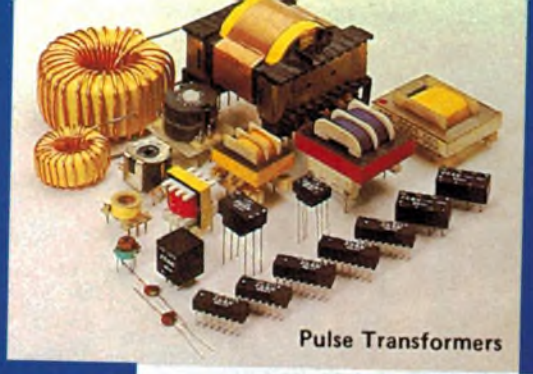
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PULSE TRANSFORMERS
DC-DC CONVERTERS
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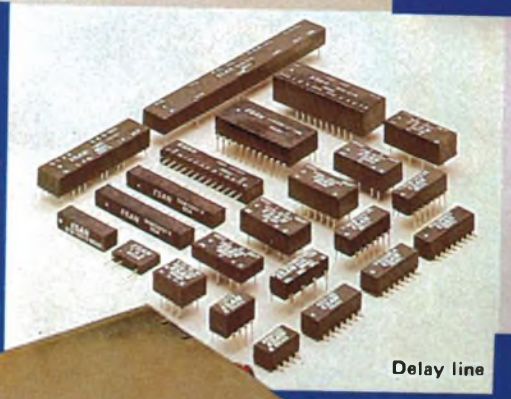
Delay line


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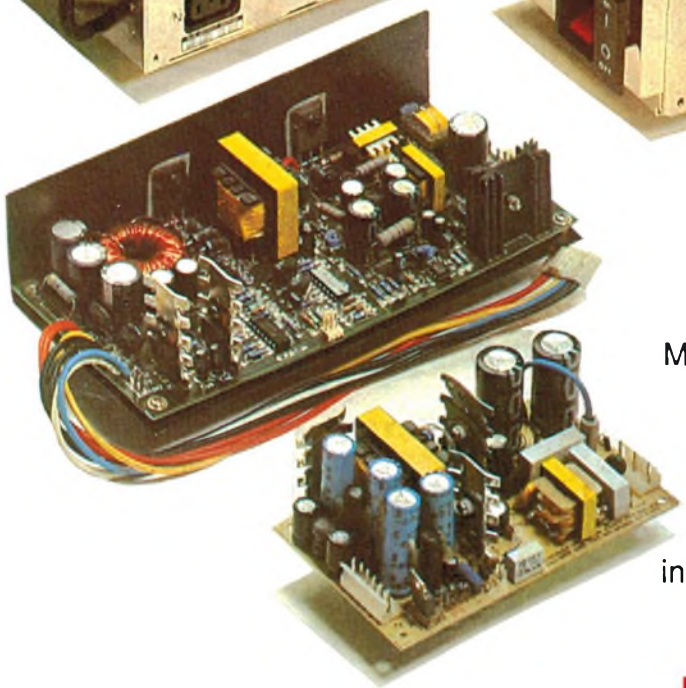

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Electronics Australia

Volume 51, No.10

October 1989

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

Timer/controller for garden sprinklers

Among our construction projects this month is an ingenious design for a unit to control your garden watering system. It mates with either one or two mechanical 'distributor taps', to achieve virtually the same result as commercial system costing many times more. Great for the armchair gardener! (See page 90)

DC voltage reference

Another of this month's projects is a simple unit which provides an accurately maintained source of 8.192V DC, to calibrate your DMMs and other meters. Much cheaper than sending your meter back for recalibration... (See page 100)

On the cover

A major tool used by CSIRO Radiophysics Division's pioneering Solid State Group is the MBE system, which grows gallium arsenide and other exotic semiconductor crystals one atomic layer at a time. It's shown here being driven by the Group's MBE expert, Dr Grant Griffiths. (See our feature story starting on page 42.)

Features

Entertainment Electronics

Projects and Technical

News and Comment

Departments

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Letters to the editor

Part wanted

I need a sine wave coil, AWA Part No. 52150, to build your project 'Shorted Turns Tester' as described in September 1972. I have tried to procure this coil through all normal channels, without any success.

I am hoping that one of your good readers might be able to help me with a coil.

If anyone out there has one, please advise me the price of coil and postage. It would be gratefully appreciated.

K. Bohan
14 Zambesi Drive, Greenfields, Mandurah, WA 6210

Superhet invention

In your issue for November 1988, page 6, under the heading 'Superhet inventor', you refer to a letter from Mr. Muscio which claims that Lucien Levy was the inventor of the superhet and not Edwin (Howard) Armstrong, and you comment that it is strange that the US patent authorities either did not know about Levy's patent, or chose to ignore it.

I don't find it at all strange. Firstly US patent law at that time allowed a US citizen domiciled in the USA to carry back for the purposes of novelty to the date of his actual invention, which could be well before the date of his patent application. Secondly US law required absolute novelty in the USA (and we must assume that this criterion was met) and no *printed* publication anywhere in the world.

Was Levy's French patent specification printed by 8 February, 1919? Was it available to the US patent office?

If Levy's French patent is earlier than February 1919 (your article does not give its date), it would seem likely that it was granted during the first world war. In that case it would have been unlikely to have been available in the USA and it may not have been printed at all at that date. During the world wars distribution of patent specifications between the patent offices at war ceased and it was some time after the wars ended before distribution was resumed.

The letter above referred to claims that royalties in Australia for the use of the superhet invention were paid to STC. This would mean that there was an Australian patent corresponding to French patent 493660, since that French patent had no force outside France and its territories. Do you know its number?

Living in Launceston I no longer have ready access to early Australian patent specifications, and most of the notes I made when I was a patent examiner in the wireless section have been destroyed or lost, but the brief notes I have do not list any superhet patent. They do list No. 3107/17 for the Homodyne receiver, 7683/22 to Armstrong for super-regeneration and 13801/28 also to E.H. Armstrong for frequency modulation with amplitude limiting of the received signal.

I hope that the above will be of some interest.

G.H. Rance, B.Sc., FIPA
Riverside, Tasmania

Metric time

I was interested in the article by Peter Phillips regarding changes to the Metric system, and I have come up with a few more ideas for changes.

The first change I would like to make is the name for the unit of data transmission speed (Baud). I feel that this could have serious effects on the morale of staff in the computer industry, as continuous reference to this word may make the staff baud (bored), in the same way as continuous references to sickness can make some people feel sick. To overcome this problem, the name 'Surprise' could be used instead. For example you could tell your friend that you have a 9600 surprise modem.

My girlfriend Millie was unhappy to hear that her name was not liked, and she is planning on cancelling her subscription to your magazine. (She has been a subscriber for 49-1/2 years).

I would also like to make a short comment on the debate over which symbols to use in circuit diagrams. I do not like the square ones, they are quite confusing. I told you the comment would be short – but seriously, it is my opinion, and I think the current ones you use are easier to remember as they relate to the operation of the symbol.

Regarding the free energy enquiry made by Mr. Girvan, I do have a solu-

tion although the SCC may not like it. All that is required is to use a couple of short lengths of wire to bypass the Kiloemfcolpshour meter in your fuse box, and you will receive free energy. However I cannot advise you on how to avoid fines etc., if you get caught.

Leo Daly,
Lane Cove, NSW

Fire & capacitors

I have just caught up with the May edition and the article on electrical fires. While generally agreeing with the points made, I feel I must take issue with the rather generalised comments on the safety aspect of mains capacitors.

We are the largest manufacturer of power factor correction capacitors in Australia. These are used throughout Australia under the 'EC' brand and under our previous name, 'RIFA'.

Firstly, I should mention we have an enviable safety record with these capacitors and provided they are used within their voltage and temperature ratings, they are extremely reliable. However as a safety feature, all of these capacitors use a characteristic of the polypropylene dielectric material to provide an internal fuse. At around 105°C, polypropylene shrinks significantly. By careful design of one of the internal connections, the winding will pull away should external heat or excessive current overheat the capacitor.

This fail-safe design we believe, is unique in Australian manufactured capacitors.

The other points I wish to take up with you are those relating to interference suppression capacitors on the mains.

I certainly would not argue with you regarding the potential dangers of suppression capacitors, but I am concerned you are generalising too much in your criticism.

It is extremely important that correctly designed mains capacitors are used for suppression work on the mains. I can't help wondering about the quality of the suppressor capacitor used in the head demagnetiser.

Mains capacitors from reputible manufacturers are constructed to certain international quality standards, minimum IEC384-14 and ideally the more international approvals the better. They should also be designed to take high voltage transients, have good dV/dt ratings, be self-healing and have good ionisation resistance.

The suppression capacitors manufactured by RIFA in Sweden use multi-

(Continued on page 159)

Editorial Viewpoint

Another success story for Aussie high technology

Sometimes it's all too easy to get the impression that Australia is just a quiet little backwater when it comes to the cutting edge of science and technology – a bunch of consumers (and even companies) with a kind of 'cargo cult' mentality, waiting until the breakthroughs are made by someone else overseas and then shipped over here so we can buy them. Unfortunately in quite a few areas this isn't all that far from the truth, either.

But of course there *are* some notable areas where Australian scientists and technologists are very much in the forefront, and making as many breakthroughs as anyone else – if not more. I'm delighted to be able to run stories on these local achievements whenever we can, because I believe it helps make us all a bit more confident about what *can* be achieved here.

Who knows – it might also encourage others in our midst to 'go for the gold' in their area of expertise, too.

You'll find the latest of these 'good news' feature articles in this month's issue, starting on page 42. It's the story of how a group of scientists and engineers in our CSIRO's Division of Radiophysics have pulled into a leading position, in the world-wide race to use gallium arsenide technology to produce super-fast transistors, diodes and integrated circuits for use at microwave and millimetre-wave frequencies.

It's a story about all kinds of esoteric devices like MESFETs, HEMTs and MMICs, in many cases with active areas measuring considerably less than a micron. It's also about the technology used to make them – including the MBE process of building up extremely thin semiconductor layers, by literally 'spraying' atoms onto a wafer, one layer at a time. Intriguing stuff!

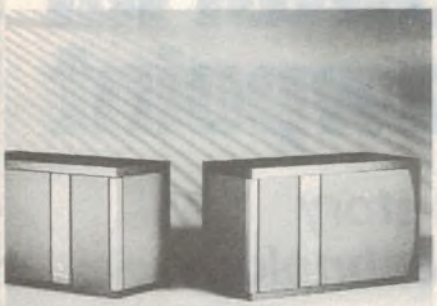
The devices that the CSIRO Group have developed to date already have a lot of export potential, because of the accelerating growth in satellite communications and direct broadcasting by satellite – especially in Europe. And the devices that they're continuing to develop have even more potential, making the work of great importance.

CSIRO itself is very aware of this potential, and has entered into a commercial partnership with Triune to boost the efforts towards its realisation. So all going well, it looks as if Australian technology and hi-tech industry may well take a leading role in this key area. Thanks to the CSIRO team, we certainly seem to be in the right position for this to happen.

In order to get the background for this story I was able to visit the Division of Radiophysics, to look over the kind of equipment that is used to produce the new devices and talk with the scientists concerned. Frankly it was fascinating – a real glimpse of the future. I hope at least some of the excitement and optimism that I sensed comes through to you in the article.

Jim Rowe

What's New In Entertainment Electronics



Loudspeaker designed for 'commercial' environment

British speaker manufacturer Wharfedale has just launched a new model to operate in a commercial environment. The model 'Programme 2180' has been designed to overcome the loss of treble performance caused by high frequency absorption in a crowded room.

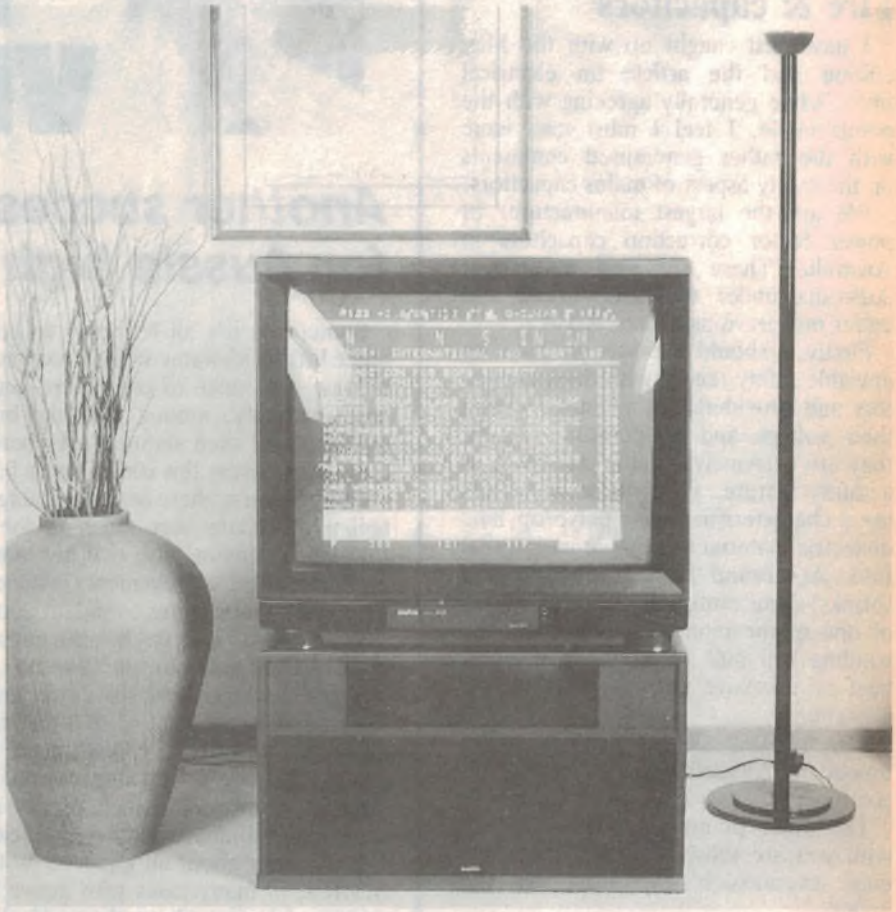
The system overcomes the loss of high frequency response by adding an extra treble unit, to give a unique 180° dispersion of sound within the room. Wharfedale says excellent sound penetration and tonal quality are achieved whether at high or low volume, and even after prolonged heavy usage.

The system comes with special brackets for easy mounting almost anywhere; and to ensure long term reliability, the 2180 is fitted with a thermal overload protection system.

Design aesthetics have been beautifully met with a vented enclosure and grille combination created by one of London's leading design agencies.

On the technical side, the Programme 2180 is a 3 driver 2-way system incorporating a 200mm low frequency driver and two 19mm hard dome tweeters. With its high efficiency and power handling capacity of 100 watts, the Programme 2180 is said to deliver outstanding performance.

For further information contact NZ Marketing, 8 Tengah Cres Mona Vale 2103 or phone (02) 997 4666.



Sanyo releases Super-VHS VCR, 80cm TV

Sanyo has launched a Super VHS Video Recorder and Large Screen Digital Super VHS Television System. Combined, the two are said to deliver up to 50% better picture quality from tape and incorporate the very latest in consumer electronics technology.

The new stereo VHRD4890 Super VHS video recorder is heavily featured and includes PIP (picture in picture). This allows you to watch both a television broadcast and a taped programme. In addition, with the digital memory still/recall function, you can store a live television frame or a recorded frame for future display.

Sanyo has also incorporated into the new recorder an 'Instant Start Loading System'. This high speed loading technology which takes about 1.5 seconds from start to play-back provides a significant increase in speed.

A Digital Auto Tracking system adopts the optimum tracking position so that regardless of the machine from which a tape was recorded, all video tapes are played back with maximum clarity and minimum of noise.

The new CPP 3359TX television receiver has an 80cm, tinted, FST screen as well as the new PIP capability. The two-way, four speaker sound system delivers a full 15 watts per channel and users can access 99 channels with 30 pre-set memory channels.

A four page memory enables you to access hundreds of pages of teletext information and tuning is made easy by the frequency synthesiser tuner, which provides access to a full range of UHF and VHF channels.

'Video surround' amplifier from Pioneer

Pioneer Electronics has released two video amplifiers designed not only to put 'armchair' ease back into the home audio and video system, but to add significantly to its enjoyment.

The Video Surround Amplifiers VSA1000 and VSA500 become the heart of the home entertainment system, controlling all functions either manually or by remote control.

The VSA1000 has the capability to accept and control 7 video inputs and 6 audio inputs (the VSA500 can take 4 video and 5 audio). This could give an envisaged video configuration of CDV, Laser Disc, 2 VCR's and additional monitors when required.

The VSA1000 also has up-to-the-minute facility for 'S' video. The facility of 'Super' video encompasses splitting the video signal to the monitor for high definition pictures from pre-produced videos offering this quality.

The VSA1000 has a Multi-Room Remote control which allows the system to be operated in other parts of the home.

It also features Pro-Logic Surround Sound giving a dramatic 'cinema' like experience to videos – adding excitement and enjoyment.

The vivid hifi sound, giving the 3 dimensional surround effect, is reproduced through its front speakers (100 watt per channel) accompanied by a variational delay through the rear speakers (30 attper channel). The VSA1000 is also equipped with a central channel for a fifth speaker which isolates the dialogue from the sound effects to give a 'life like' experience.

Although only the VSA1000 has Pro-Logic Surround and the central fifth speaker channel, both amplifiers have Dolby, Stadium, Studio and Simulated Surround Sound (the VSA500 has 50 watt front speakers and 15 watt rear).

The VSA1000's additional features include accoustic memory, sound field memory (programming uyp to five memory pre-sets of tone and surround settings for instant recall), simulated stereo, VCR audio noise filter, sleep timer, pre-amp out and pre-amp in terminals and on screen display.

New Sennheiser headphones

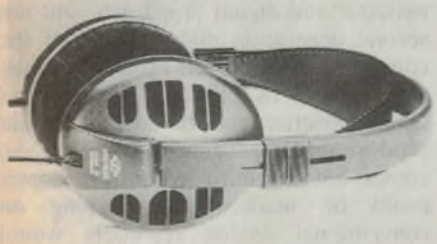
Sennheiser Electronic has added two new models to its 'Sound and Styling' range of hifi headphones.

The first models in the range, the HD450 and HD480, were inexpensive starter models in the hifi class, while the new HD520 and HD530 models implement the latest findings in acoustics research to meet more sophisticated demands.

One of the advances these new models incorporate is the material neodymium, the most strongly magnetic material currently known to science.

Both the HD 520 and HD 530 are dynamic wideband systems with large driver coils. Their oval shaped earmuffs completely enclose the ear and the optimal fit damps the formation of standing waves within the housing.

The HD520 headphone has driver coils made of copper, which 'tunes' the system deeper and gives a warm, well balanced tone with a full bass foundation.



The HD 530, on the other hand, has aluminium driver coils which are half the weight of conventional copper coils. This weight reduction allows the extremely lightweight membrane system to follow electrical pulses much more rapidly, so that even the finest details of a recording can be heard. The tonal colour of the HD530 is described as 'airy' and transparent, reminiscent of reproduction of electrostatic headphones.

Setting aside their differences, both models are of 600 ohm impedance and are designed for use with a Hi-Fi amplifier but are sufficiently sensitive to be connected directly to a component, such as a CD player, and provide adequate volume.

For further information contact the Australian distributor, Syntec International, 60 Gibbes Street, Chatswood 2067 or phone (02) 406 4700.

Broadcast standard portable tape recorder

Lyrec of Denmark has unveiled the FRIDA - a fully portable, yet fully comprehensive tape recorder specifically designed for broadcast operations.

Distributor Amber Technology said that despite its compact size, this 2-channel, 3-speed recorder is equipped with all the features of a larger studio machine.

Weighing only 12.5kg and just 8cm high, the FRIDA will accommodate spools up to 30.4cm without external adaptors.

The professional editing capability includes a 'dump' mode and a built-in tape cutter. A precision tape timer gives a true readout for each of the 3 speeds, and can be temporarily suspended during editing. A 'search' function allows the tape to be returned automatically to zero or to the last position where play started.

For further information contact Amber Technology, PO Box 942, Brookvale 2100 or phone, (02)975 1211.

Entertainment

New cassette decks from Marantz

Audiophiles and music lowers are the target market for two new tape cassette decks from Marantz. The Marantz SD35 and SD45II models are high-quality two-head machines which emphasise superb sonic performance at affordable prices, according to Mr. John Wiseman, Marantz Australia's National Sales Manager.

The SD35 and SD45II join the widely-hailed SD55 three-head deck, flagship of the Marantz cassette deck range. Extensive use of customised components audibly improves sonic performance.

Both decks feature Marantz's Super Hard Metal Alloy (SHMA) record/playback heads, together with a powerful dual-gap erase head.

Quiet, precise performance with negligible wow and flutter is assured by computer-controlled tape mechanism with separate motors for flywheel drive and tape take-up.

Both recorders feature Dolby B and C noise reduction circuits to further improve sound quality on both pre-recorded tapes and home recordings.

In the case of the SD45II, a discrete amplifier with high slew rate further improves sound quality and signal-to-noise ratio. This model also has an electronic counter with memory-stop for extra precision and recording-time management.

The Marantz SD35 is priced at a recommended $499, the SD45II at $599. Both models carry a full two-year warranty.

Low cost CD for car stereos

An ingenious little adapter 'cassette', produced by Philips, links any portable CD player to a car's tape cassette deck. This means that your favourite compact disc music can be enjoyed through the car's audio amplifier and speaker system.

No permanent wiring is necessary. The Philips SBC 3555 adaptor 'cassette' is simply inserted into the tape deck and the cable connected to the adapter plugged into the portable CD player's headphone socket. This cable is 1.5 metres long, which allows the CD player itself to be put into any safe and convenient place while in use – in the central console, the glove box or even the back seat.

The sound signal is transferred from the cassette adapter to the cassette deck head by electromagnetic induction, and without any wear to the head.

To conserve the compact disc player's batteries, Philips also includes in the kit a power connector which plugs into the car cigarette lighter.

The complete CD adaptor 'cassette' kit, which has a recommended retail price of just $49.95, can also be used with most caravan and boat stereo systems.

SOLID STATE MESSAGE RECORDER

As seen on 'Beyond 2000'

A device which records messages on a Memory Chip. It can be replayed many times by moving past the sensor, it can also be interfaced to existing circuitry and triggered by any desired function, it will instantaneously return to the start once replayed. It records messages up to 16 sec, operates from a 9V battery or any appropriate DC Plugpack. Ideal for the Alarm industry, Museum Etc.

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Wholesalers/Manufacturer enquiries are welcome.

Agreement reached on DAT

Leaders of the international recording and consumer electronics industries have reached an agreement on a joint recommendation to governments for a new system applicable to Digital Audio Tape recorders (DAT). Unlike the current generation of DAT machines, which do not permit digital to digital copying of pre-recorded music, the new system allows such copying but limits the subsequent reproduction of those copies. In announcing the new 'Serial Copy Management System (SCMS)', industry leaders emphasised that achieving this agreement, which recognises the mutual interdependence of these industries, as a major breakthrough for creators, consumers and industry.

The system essentially allows first generation digital copies of music to be made from CD's, pre-recorded DAT cassettes and digital broadcasts, but not second generation digital copies of the copies. Music recorded on DAT analog sources such as LP's and conventional audio cassettes and broadcasts, would produce up to two generations of digital copies but no third generation copies could be made. Home taping on conventional analog recorders would not be affected.

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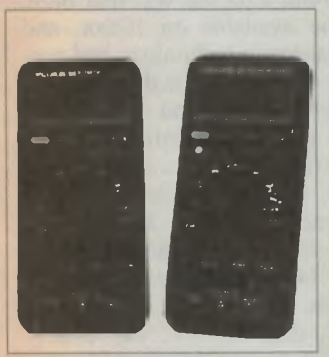

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- Touch Hold™ function
- Two year warranty

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- As 25 but adds
- Relative (difference) mode
- Min/Max recording mode

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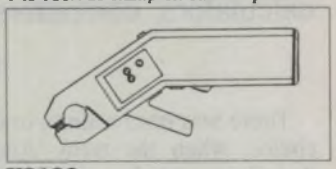

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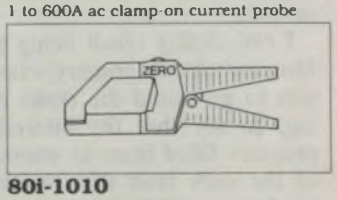

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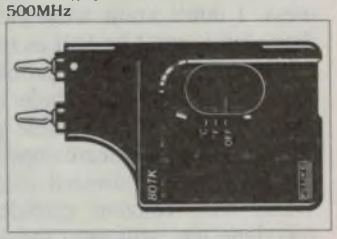

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A whimsical look at

Electronics in Education

When the author went to school, the only electronics available to assist the educative process was a public address system. But since then things have changed quite a bit – schools are now bristling with TV, radio, audio and video tape recorders, calculators, computers and electronic musical instruments.

by JIM LAWLER

There was once a time, in educational circles, when the term 'Audio Visual' described a teacher standing in front of the class, talking about a photograph in a textbook.

There are those of us, and this writer is one, who can remember school in the 1930's and 1940's, when all pens had steel nibs and pencils were either 'lead' or 'slate'.

I can clearly recall being an 'Inkwell Monitor' at one primary school. My job was to go round the desks each morning, to see that the inkwells were all properly filled from an enormous bottle of the dark fluid that was kept in the teacher's carefully locked cupboard.

I remember that it was considered a ton of fun to drop a piece of calcium carbide into the inkwell of someone you didn't like. The foul smelling, brilliant blue eruption from his inkwell was something to be admired from afar. It also took him a week to clean up the mess. I don't know what kids do these days, but it can't be half as much fun.

(Anyone under 50 probably won't know what calcium carbide was. It was used to produce a flamable gas for use in bicycle and car headlamps, before the days of battery powered electric lights. When wet, calcium carbide produces acetylene gas, still used today for welding, but now supplied in steel bottles rather than made on the spot in the 'do-it-yourself' gas producers of 50 years ago.)

In those far-off days there was no inkling (sorry about that) of electronics in the classroom. The nearest thing to electronics was the electric light. My first primary school didn't even have an electric bell to signal the end of classes.

(The bell was a great clanger in a tower on the roof, and it was rung by pulling on a rope in the Headmaster's office. The honour of ringing the bell was much sought after, because the Head usually gave the lucky student a sweet biscuit – a great luxury in those post-depression days.)

My secondary schooling took place during the war, at what was then the Caulfield Technical School. One might have expected a technical school to be properly equipped with the latest technology, but the nearest thing to electronic training aids that I can recall from those distant days was the PA system that was piped into every classroom.

The production of training films took great strides between 1939 and 1945. All the big Hollywood studios made films on all manner of subjects, needed to train people for the war effort.

The armed services tended to make their own 'gun' and 'bomb' films on 16mm film, but the studios did all of the 'screwdriver' epics on 35mm stock. I remember being marched off to the local cinema to see a Walt Disney film featuring Donald Duck doing everything one should NOT do in a machine shop. That 10-minute rendezvous with Donald taught me safe workshop practices that have stayed with me for over 40 years.

It wasn't until after the war that these films became available on 16mm, and by then advances in technology had rendered many of them out of date.

I left school in 1945 and had no further contact with the educational system until the sixties, when I was employed by the ABC to write publicity material for radio and television. It was only then that I realised just how involved schools had become with electronics in the classroom.

The ABC, then as now, was closely associated with State Education Departments in the presentation of study materials. In the few years (well, alright – 18 years!) since I had left school, electronic teaching aids had advanced from nothing at all to at least a radio in every classroom, and a television set in most.

Twelve years of pocket calculator development! The 1975 model Hanimex BC999B on the left has only 8 maths functions. It measures 135 x 83 x 24mm. By comparison, the 1987 Canon F-73 has more than 48 maths and scientific functions, and measures only 135 x 70 x 9mm.

Just some of the electronic equipment to be found in a typical school music laboratory these days. Multiple keyboards, sequencers, digital delay lines, mixers and multichannel recorders all play a part in developing a student's musical appreciation.

The most recent development in school music is the linking of computers to electronic instruments. Students now use their knowledge of computer programming to create (compose?) their own music. The notes can be displayed on a monitor screen, printed as sheet music or they can be saved as digital signals on floppy discs.

At about that time tape recorders also became available, and many teachers began to explore the possibilities of making personalised audio teaching aids.

When the compact cassette came on the scene, the use of audio recordings in education exploded. Cassettes were used by both teachers and students, who seemed to compete with each other in finding new applications for the technology.

The linking of audio cassettes with photographic slides or filmstrips was the first common application of what became known as 'audio-visual' teaching aids. These were simple enough for local production, and many teachers had sufficient skill to make their own materials.

Unfortunately, visual aids in the form of movie films were too expensive and too complicated for individual schools to attempt. Nevertheless many local productions were made, using commercial facilities and Government funds.

By the late sixties, most schools had a 16mm film projector, and anyone who went to school at that time will remember sitting in a darkened room while the clattering projector flung its sometimes boring message onto the screen.

In the early seventies the first videotape recorders came on the market. Education authorities wasted no time in applying the new machines to the art of teaching, but black and white images and open reel operation prevented the first generation VTR's from becoming as popular as their audio equivalents already were.

As it had been with audio tape recording, the Philips organisation was responsible for the next great leap in audio-visual technology. The NV1500 Video Cassette Recorder offered a one hour video recording, in colour, and with cassette convenience.

The Philips VCR paid the price of being first in the field. It was heavy and clumsy, expensive, unreliable and limited to one hour tapes. Although longer tapes arrived later, the NV1500 was doomed from the start. Even so, many thousands of them were sold to schools, and some are still in service today.

The Philips VCR showed how audio-visual techniques can benefit teachers and students, and today, there is not a classroom in the nation that does not have its VCR and TV, nor a school that does not have at least some kind of a library of video and audio tapes.

But audio-visuals are only one application of electronics in the field of

education. The electronic miracle that has changed education beyond all recognition is the pocket calculator. At first teachers were opposed to them being used in the classroom, as in a previous era they had been opposed to the ball point pen. But experience changed opposition to approval and now calculators are as much a part of every student's kit as is the ball point pen.

My sons have sometimes annoyed me by asking "Hey, Dad! what's six times eight?" (or some other equally simple question). They can work out the answer, but they do not know it instinctively, as I do. In my day we studied a subject called 'Mental Arithmetic', and had to know our 'times tables' off parrot fashion or else suffer an often physical punishment.

Today, my boys studied Advanced Maths at a level that was five years above me at an equivalent age. There is no possible way they could reach this level without the simple plus and minus abilities of the calculator. The electronic tool looks after the number crunching, while the student worries about the principles behind his procedures.

A typical college AV workroom. The equipment in this system includes two VHS recorders, a Philips NV1500 and an old Sony AV 3670-CE monochrome machine. All units are still in use, although the Philips and the Sony are only used for playback these days.

Part of the videotape and video cassette library at a senior secondary college. The shelves hold 5- and 7- inch reels of monochrome tape, Philips NV1500 and VHS cassettes.

So what if the batteries do go flat? A new set of batteries is a small price to pay for a mastery of maths that often exceeds what was found at degree level 50 years ago.

Then about 10 years ago the microprocessor heralded another revolution in the classroom. Computer technology had always been recognised as a powerful educational tool, but the enormous cost of the early computers had prevented them from being used in general education.

The microprocessor changed all that. In no time at all the microcomputer appeared in schools, and students quickly gained extensive programming skills. In fact, young people mastered the subject so rapidly that teachers often found themselves being taught by some of their more advanced students.

Microcomputers can be used in almost every facet of education. Not just in the obvious subjects of mathematics and science, but also in literature, the humanities, arts and sports. The versatility of the micro, and the relative ease with which new programs can be devised, ensures that the computer remains among the most important teaching aids available to modern teachers.

School music is another field where electronics has made great headway. I remember music classes at my primary

The BBC model B microcomputer was designed specially for educational use and this picture shows a typical college computer studies room. Networking was part of the Model B's initial design specification, and since then thousands of LAN specialists have cut their teeth on BBC's and 'Econet'.

school, where the only musical instrument available was a tuning fork. The school had one piano, but that was in the assembly hall and was not available for ordinary music lessons.

In more recent years, money has been made available to schools for many and varied musical instruments. But without doubt, the most popular instruments have been electronic in one way or another.

Pop groups have inspired most young people to try their hand at the electric guitar, and the often discordant clanging and twanging can be heard from most school music departments whenever school is in.

More recently, electronic keyboards have become readily available, and more and more students are using synthesisers and other electronic instruments to express themselves musically, in a way that was inconceivable only 10 years ago. Few of these students may go on to become serious musicians, but all of them leave school with an appreciation of music much deeper than that of students who left school before the days of general music studies.

And so, today, teachers have an enormous range of electronic tools and accessories to choose from. Most teachers and all of their students enthusiastically adopt the electronic approach to almost every facet of learning. Education has become dependent on electronics and students would be totally lost if all the little electrons stopped circulating.

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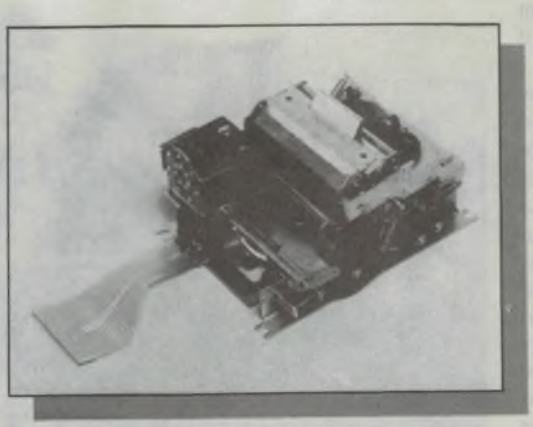

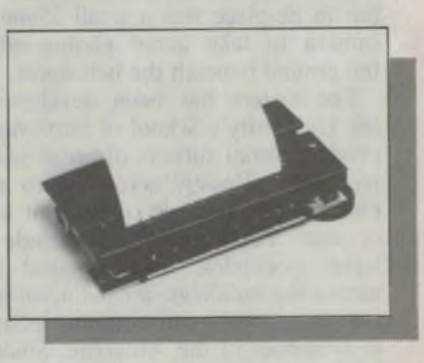

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Tasmania's University develops novel

Radio controlled model helicopter

Ever wished you could have your own 'spy' helicopter, able to take bird's-eye-view photographs wherever you wanted? A team at the University of Tasmania has done just that, and is using the tiny radio-controlled chopper for making aerial surveys...

by TOM MOFFAT

A few days ago my son came home from the video shop with a science fiction film called *Identified Flying Object*. The star of this little bit of fantasy was a miniature helicopter, that zoomed around shooting rays at people and doing good deeds. The chopper had a TV camera up front, that transmitted pictures back to the 'pilot' on the ground, flying it by remote control. A TV monitor provided a pilot's eye view.

Fantastic? Not any more. Earlier that week I saw the same thing in real life, demonstrated over the football oval at the University of Tasmania. All the bits were there; the remote control, the TV camera. There was no 'good-deed ray', but in its place was a small 35mm film camera to take aerial photographs of the ground beneath the helicopter.

The system has been developed by the University's School of Surveying, to produce aerial surveys of areas and objects not normally accessible to aerial photography because of difficult access or cost. Potential targets include material stockpiles, archacological sites, measuring buildings, air pollution measurements, and even counting penguins in rookeries in the Antarctic. Since the helicopter is small and portable, it can be carried to difficult sites – where it can then take off from an area the size of a table top.

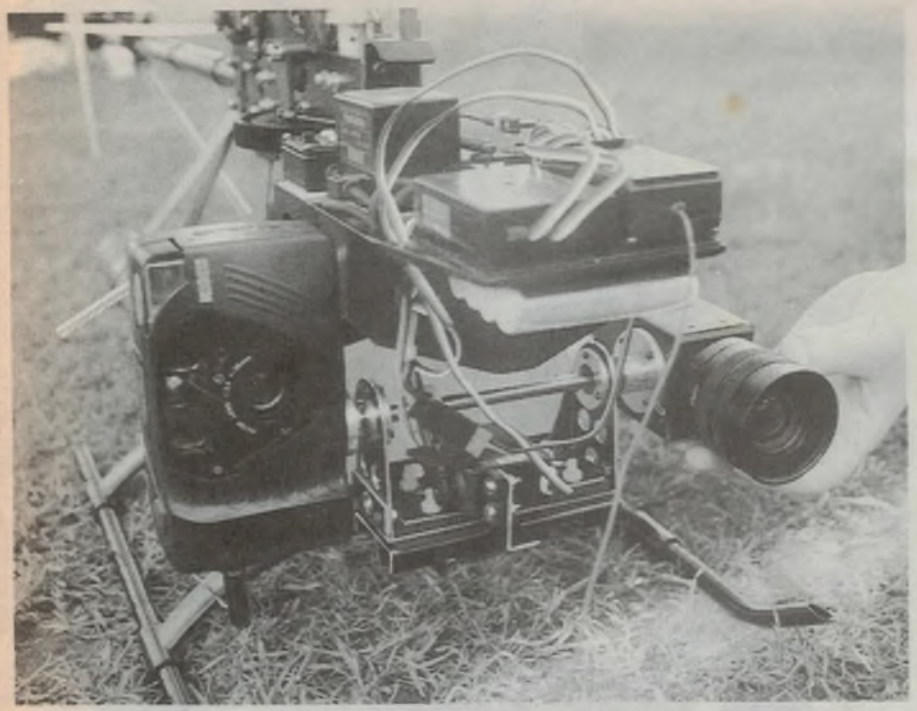
The miniature helicopter itself began life as a kit which was built up by Dr. Tony Sprent, a Senior Lecturer in the School of Surveying. The University then designed a special mounting near the front of the machine to carry a small Ricoh automatic 35mm camera on one side, and a tiny CCD (charge coupled device) TV camera on the other. Both cameras are mechanically coupled, so that they look in the same direction. They can be tilted by remote control to look at any angle between forward and straight down.

The helicopter is flown by a fairly sophisticated seven-channel radio control system, operating on 36MHz. Five of the channels are involved with flying the aircraft itself, controlling such things as cyclic and collective pitch of the main rotor, the thrust of the tail rotor, and the throttle. Many of these functions are interlinked and further assisted by a device called a 'rate gyro'. Without this help the machine would be unflyable, even by an expert pilot.

In helicopter terminology, the 'cyclic pitch' control varies the pitch of one side of the main rotor in relation to the other, providing directional control similar to that provided by the ailerons on a fixed-wing aircraft. 'Collective pitch' varies the pitch of the main rotor blades all at once, and can be loosely considered as the up and down control. The thrust of the tail rotor is controlled by the foot pedals in a full sized machine, and it rotates the helicopter about its vertical axis.

Flying a helicopter, even a miniature version, isn't a job for the faint-hearted. Pilots say it's like patting your head and

Flying the model helicopter isn't easy – pilots say it's like patting your head and rubbing your belly at the same time!



On the front of the chopper are 35mm and video cameras, on a tilting head. This is controlled remotely via one of the seven R/C channels.

rubbing your belly while standing on one foot on top of a ball. The Tasmanian project has enlisted the help of an aircraft engineer, Mark Lucas, from an operations company called Helicopter Resources. Mark has been building and flying model helicopters for years, and during the demonstration he put on a pretty good show.

The project's developers say the difficulty of learning to fly the machine limits its usefulness to casual buyers – you can't just buy it today and fly it tomorrow! But they're working on a three-axis rate gyro system that could simplify the piloting task to simple joystick movements for up-down, left-right, and forward-backward.

Back to the remote control system, the two remaining control channels have been assigned to the camera package. One channel tilts the two cameras up and down (panning is accomplished by simply turning the helicopter), and the other channel triggers the shutter on the 35mm film camera.

The helicopter hasn't actually transmitted pictures over the air yet, because of some problems with Australia's radio communications regulations. The developers would like to transmit on an unused UHF television broadcasting channel, but this appears unsatisfactory to the Department of Transport and Communications. They would prefer that the pictures be transmitted on a 10GHz microwave link channel. But the project developers say microwave technology would be much too directional for the job at hand, as well as being very costly (about $6000). Negotiations are continuing...

Accurate surveys

Although the miniature helicopter will have many uses, the most valuable application will be producing very accurate surveys of relatively small areas, such as archaeological digs. Remote control of the aircraft is possible to a distance of 200-300 metres, and an altitude of around 100 metres. The distance is limited by the need for the pilot to properly see the aircraft, in order to fly it. (The TV camera is only used for aiming the film camera)

Lecturer in Surveying Jon Osborn, another team member, describes an aerial survey example using the University's football oval. If the helicopter does a survey of the whole oval, it can determine the location of an object on it to an accuracy of 50mm, or say half the width of a human hand. The process requires the clever use of mathematics, optics, and computers.

Before a survey can begin it is necessary to establish at least three 'ground control points' on the oval, which can be clearly seen in photographs taken from the helicopter. These can either be existing features or specially installed markers. Either way, the distances between them must be carefully measured, probably with a good old-fashioned tape measure. For maximum accuracy, five or ten ground control points may be used – the more the merrier.

Then the helicopter flies over the area and takes at least two photographs. This can be done as it flies a straight course, click – pause – click. The two different

Preparing the machine for a flight. As you can see it is quite compact, and capable of being maneuvred into confined spaces.

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Dr Tony Sprent holding the chopper aloft.

viewpoints add perspective into the scene and make it possible to determine the height of objects on the ground, as well as the X and Y positions.

Once the photos are taken the helicopter lands, the negatives are developed, and then they are subjected to 'analytical solution'. This process produces an actual three-dimensional image of whatever was in the camera's view. In earlier times this was done optically with a stereo plotter – many fine contour maps have been produced in this way.

But nowadays optics are out, and computers are in. Each 35mm negative is submitted to an X-Y digitiser that can measure positions of points to within four or five microns. This is in the order of the grain size of the film itself.

First the ground control points are digitised into the computer from each negative. Obviously since the camera was in a different position for each negative, the pattern of control points will appear slightly different on each one. And this is the basis of the whole mathematical analysis process – the camera can only be in ONE position to produce a given pattern of control points on the negative.

With the two sets of control points set into the computer, it can then do some number crunching and work out exactly where in space the camera was for each of the two photographs. Knowing those two camera positions, it's then a simple matter to work out the position of ANY object on the ground which is visible in both photographs.

With more ground control points, it is possible to accurately calculate the focal length of the camera's lens, as well as determine any distortions that may exist in the lens. When these are known, they can be taken into account when calculating unknown ground positions, further increasing the accuracy.

Future uses

So what's the future of the helicopter aerial survey project? The development team says it's done the project basically as a service to the community. They've had some help with the project's $5000 cost from the Electrolytic Zinc Company (interested in stockpiles) and Tasmania's Hydro Electric Commission.

The group would like to hear from anyone else, anywhere, who might have an application for aerial surveys by the miniature helicopter. First point of contact would be Dr. Tony Sprent at the School of Surveying, University of Tasmania in Hobart. EA

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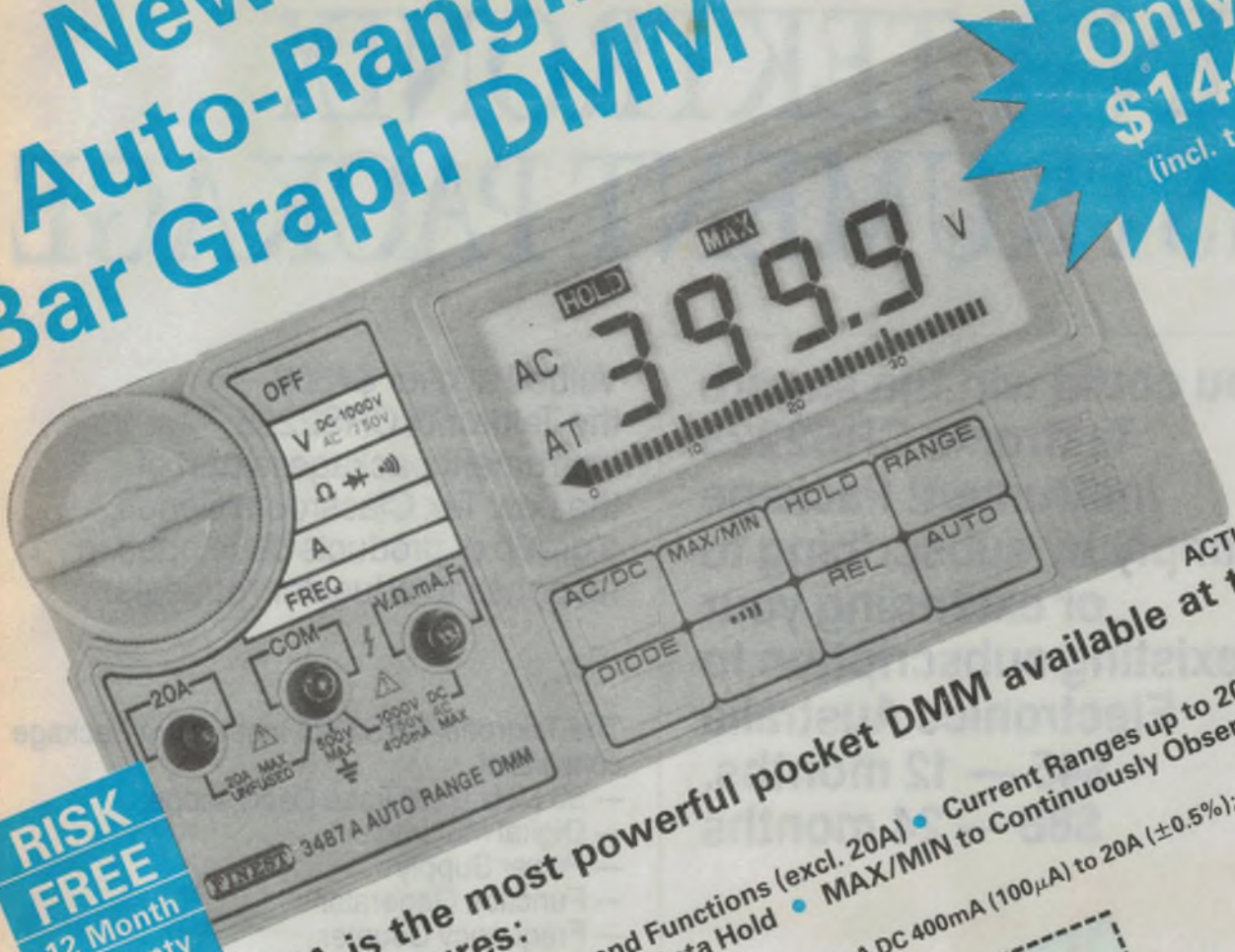

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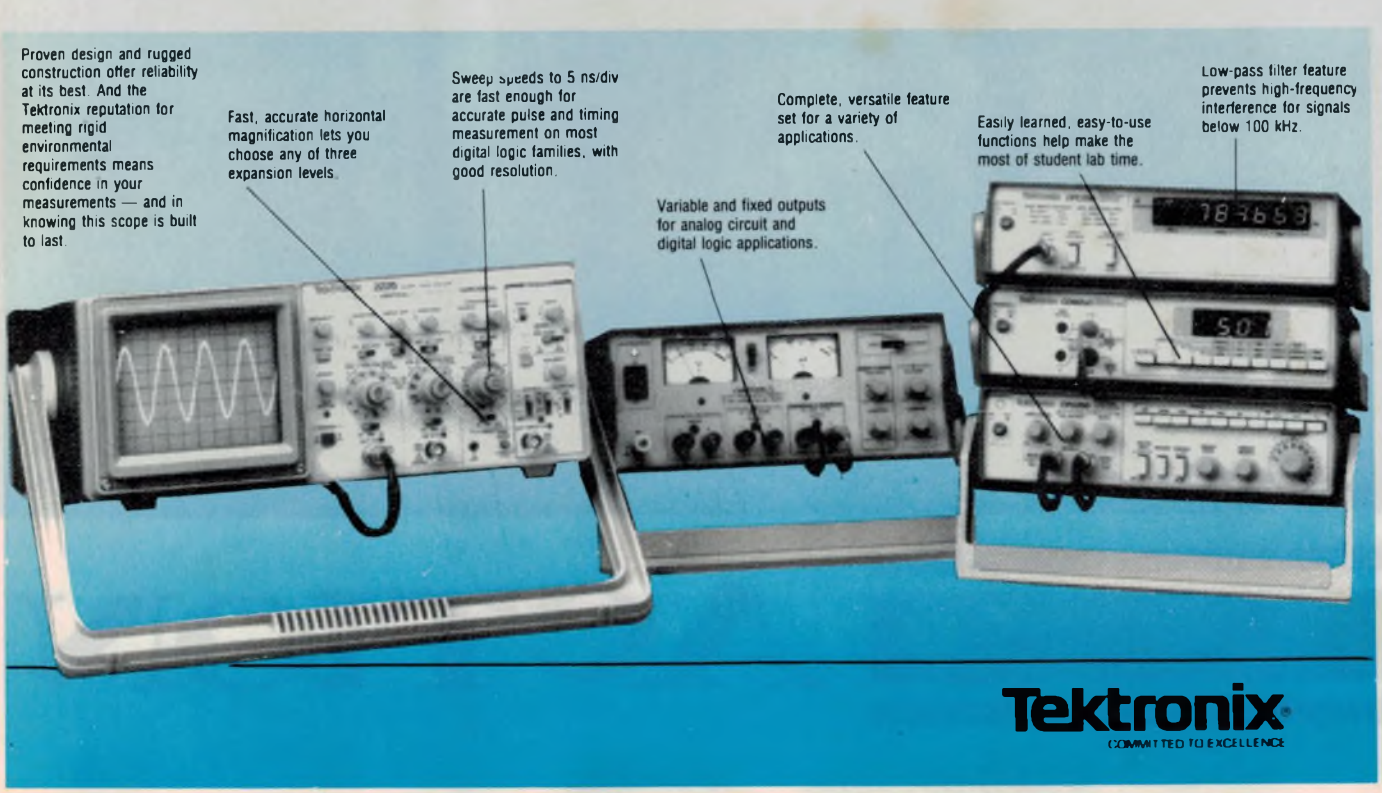
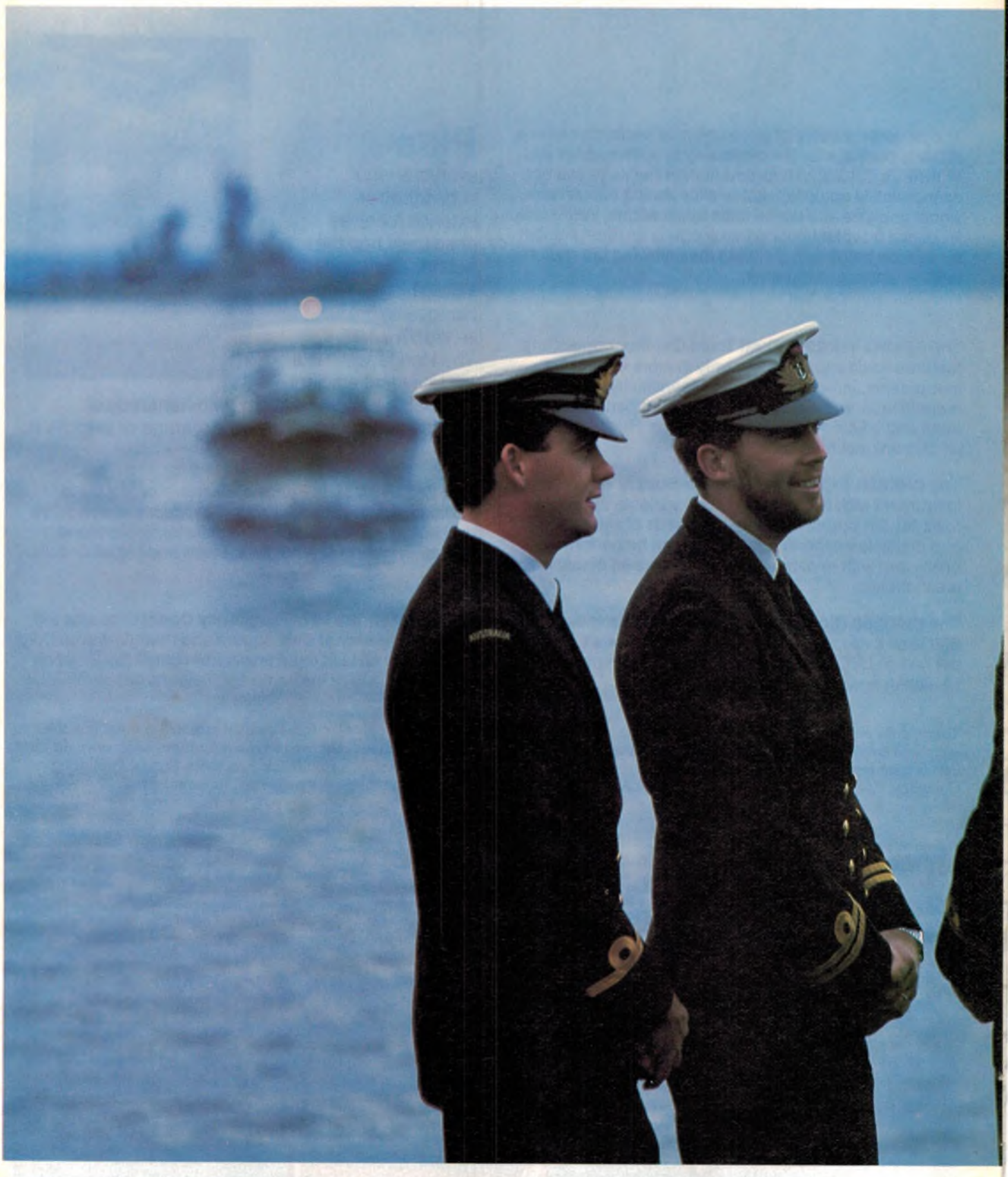




ACTION

Authorised by Dept. of Defence.

A beautiful sunrise, late nights, long hours, the sun rising over the horizon, bringing a great new day. A feeling every sailor knows.

STATIONS

NE0029 SPC 119/1

Navy Electronic

THE ELECT WHO WHEN

GETTING TO KNOW THE FEEL OF COMMAND.

The Royal Australian Navy trains its young officers to develop their own natural abilities and increase their qualities of leadership, integrity and initiative.

This is achieved at the Navy's two major training establishments. ONE, The Australian Defence Force Academy in Canberra. TWO, The Royal Australian Naval College, HMAS Creswell at Jervis Bay.

Today's Naval Officer not only requires courage, dedication and integrity but also the ability to cope with the academic and technical advances that are part of the Navy's rapidly changing world.

GETTING A START ON YOUR FIRST STRIPES.

One: Entering the Navy as an Electronics Engineering Officer via the Australian Defence Force Academy means you will have already qualified for admission to an approved degree course at an accepted university. Rank on entry to ADFA is as Midshipman.

Two: Joining the Navy as an Engineering Officer means you are already part way through your engineering course at one of Australia's major universities or you may have already earned your degree.

In Navy terms this means you are a Direct Entry, D.E., Officer and enter the Navy as a Lieutenant or Sub-Lieutenant according to your qualifications and experience.

D.E. Electronics Engineers go through a Junior Naval Officer's Course at HMAS Creswell for a 24 week period. This brings them up to speed on Navy customs and practices.

Weapons Electrical Engineering Officers (WEEO) participate in a 20 week familiarisation course to bring them up to date with Naval Weapons Systems.

On completion of these phases, Electronics Engineering Officers are sent to the fleet and their role in the Navy encompasses professional command and management of the wide range of electrical and electronic surveillance and communications systems.

And all the electronic weapons systems – missile loading, arming and firing circuits.

COMMAND. A RESPONSIBILITY NOT LIGHTLY GIVEN.

You may have heard that discipline in the Navy is rigid and unbending. Quite the contrary.

Personal initiative and leadership by example is positively encouraged and the hallmarks of those officers who will grow to full command.

Responsibility for the lives of men and women in the Navy is not lightly given and the codes by

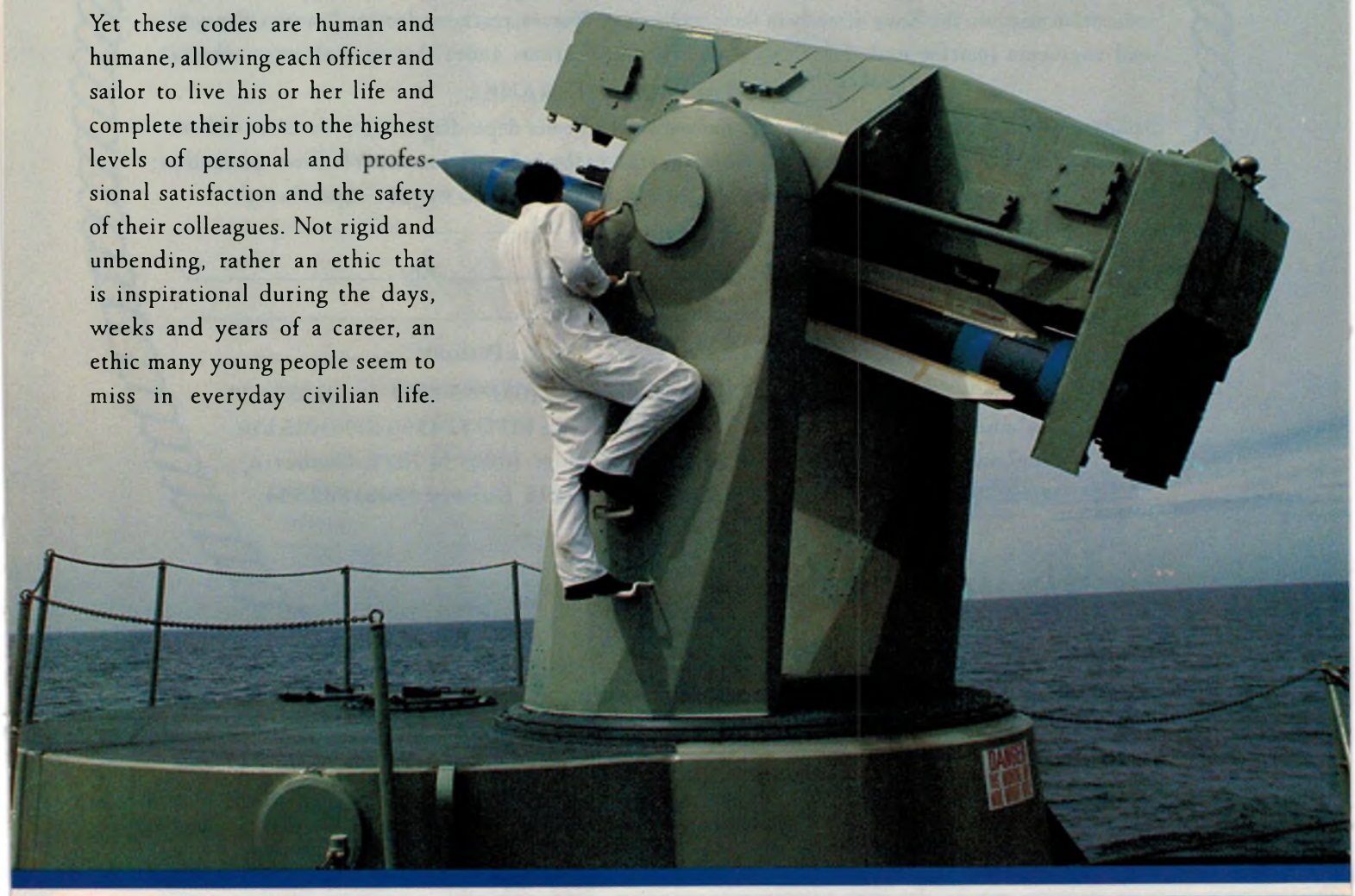
Authorised by Dept. of Defence.

Engineering Officers have their fingers on the very latest triggers

ONLY SENIOR RONICS EXPERTS ARE HAPPY THINGS BLOW UP.

which Naval Officers live their daily lives are steeped in a tradition that has been proved under stress and conflict over centuries.

Yet these codes are human and humane, allowing each officer and sailor to live his or her life and complete their jobs to the highest levels of personal and professional satisfaction and the safety of their colleagues. Not rigid and unbending, rather an ethic that is inspirational during the days, weeks and years of a career, an ethic many young people seem to miss in everyday civilian life.



NAVY OFFICER

LEADING THE PRIDE OF THE FLEET

NE0029.5PC.119/2

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AUSTRALIAN DEFENCE FORCE ACADEMY.

This is where officer cadets of all three services are educated in academic, technical and military matters. Navy Midshipmen study for either their Bachelor of Arts (BA), Bachelor of Science (BSc) or Bachelor of Engineering (BE) degrees.

These Officers, when they graduate, are designated as General List Officers (GL). Applicants must be over 17 years of age and under 20 years of age on 31st January of the year of entry, and have qualified for admission to an approved degree course at an acceptable university. Application is open to both males and females.*

DIRECT ENTRY OFFICERS.

Men and women who have completed or who are completing (undergraduates) their tertiary education may join the Navy directly in their professions. Nurses, teachers, doctors, lawyers, dentists and engineers (marine and electrical) may make applications under this special entry scheme.

PROMOTION FROM THE RANKS.

Sailors may be selected for officer's training under several schemes depending on age, education and rank.

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(062) 57 2311 Perth (09) 325 6222 (008) 199 018 Darwin (008) 888 554

*Females cannot be employed in combat or combat related duties.

P.A./OCT

NAVY OFFICER

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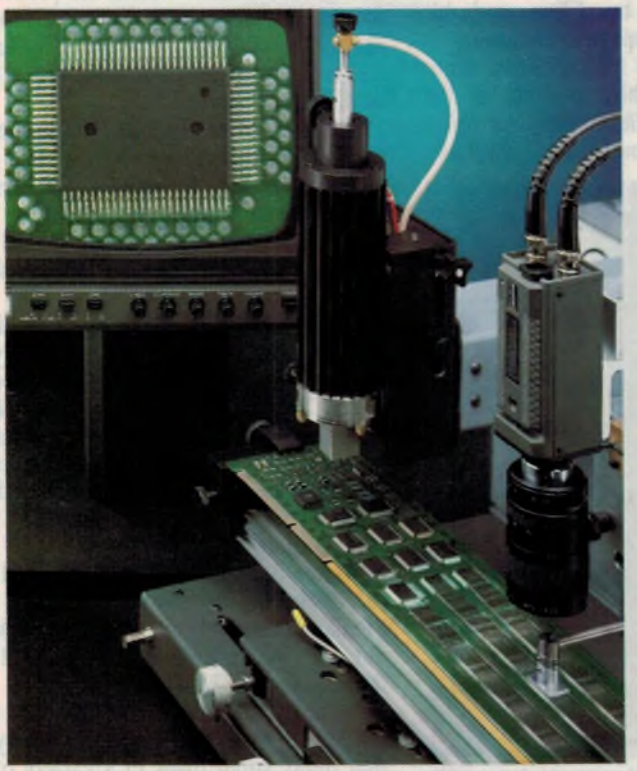

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Systems for Development, Production and Repair of Electronic Assemblies

New electronic kit designer/supplier:

AT&M - catering for the 'serious' kit user

No doubt many of our readers have noticed the recent appearance of a new firm supplying a range of kits for a wide range of functional modules. The driving force behind Australian Test and Measurement is Clive Chamberlain, who is focussing his efforts on meeting the needs of industrial and educational users as well as the more 'serious' enthusiast.

by JIM ROWE

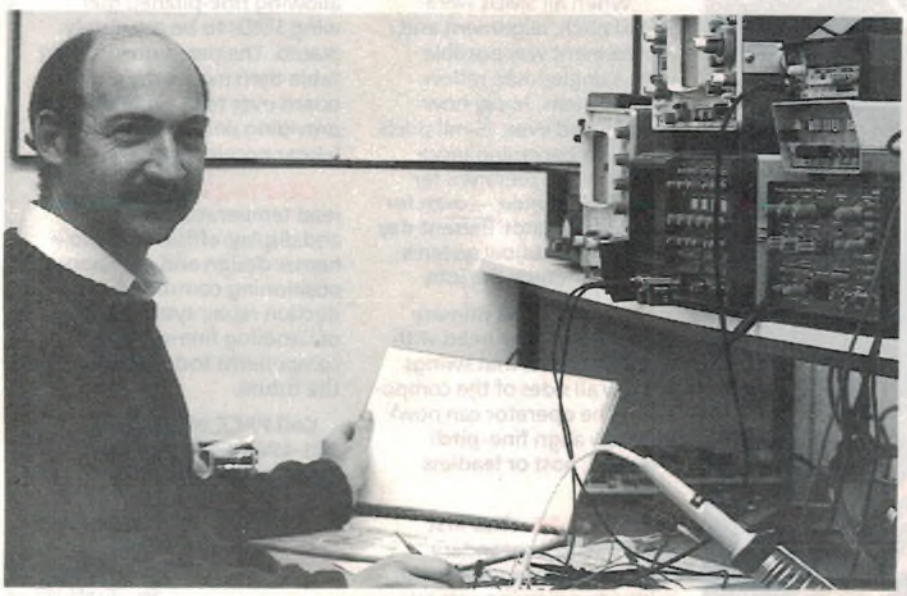
Clive Chamberlain is well known in the Sydney electronics industry, having built up and run the component supply firm Promark Electronics very successfully for about 12 years. But he dropped quietly from view about 18 months ago, after selling that business to the Electron House Group.

I guess most of us thought he'd taken an early retirement, to lead a well-earned life of leisure. And apparently he did – for a few months at least. But before long he jumped back into the fray, setting up another electronics company to develop and market a range of self assembly kits.

After a year of so of quiet and careful development work, AT&M's initial range of about 20 kits was released a couple of months ago. And as soon as they appeared, it became clear that Clive's approach was going to be somewhat different from that of existing kit suppliers.

All of the kits were for what one would describe as 'functional modules' for industrial and educational use – counters, timebases, regulators, timers, signal converters, transcoders, isolators and so on. And all of them had been designed in-house by Clive and his team, to perform a specific function.

Unlike most other kit suppliers, there were no kits for hobby projects, of the type described in *Electronics Australia* and similar magazines. The emphasis was not on the lowest possible price, either, but on the use of professional grade components and techniques – in order to achieve top performance and reliability.



Engineer Ron Koenig pictured at work in the AT&M development lab, with some of his test instruments.

In short, AT&M was obviously aiming to be a rather different kind of kit supplier from those with which we're all fairly familiar.

What's the story behind Clive's setting-up of AT&M? Why tackle the 'industrial' kit market, to the exclusion of the hobby market? These and similar questions occurred to me as soon as I saw his first advertisements, and I felt sure the answers would interest a lot of our readers as well. So shortly afterwards I contacted the urbane and energetic Mr Chamberlain, who said he'd be happy to explain.

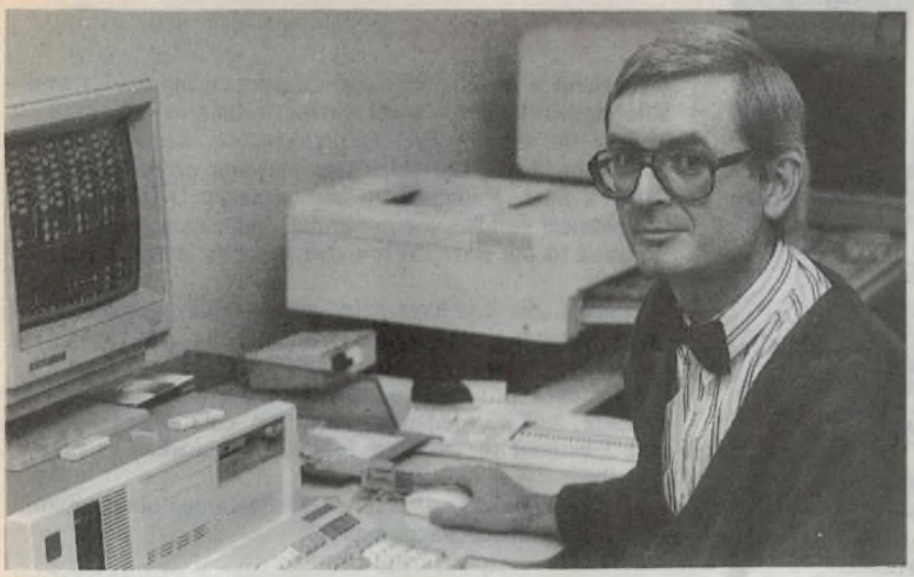
Things were a bit hectic at the time, though, as AT&M was in the process of moving to larger premises. As soon as the move was over, I would be welcome to drop in for an interview and a look at AT&M's facilities.

A couple of weeks later I took him up on this invitation, and was at last able to hear the story for myself. Needless to say I was particularly keen to hear why he started the new company, and the reasons for its 'go it alone' market strategy.

"Well, after I sold Promark it didn't take long for me to realise that early retirement was not my bag. I nearly went nuts!" he admitted. "I guess I'm basically a workaholic – never really happy unless I'm testing myself all the time. So I decided that I had to set myself another goal, and throw myself into achieving it."

"After a good deal of thought, I decided to set up Australian Test and Measurement with the idea of tackling not one, but three linked projects. I call them Stages 1, 2 and 3."

"One of the things I've noticed, during my many years in the industry, is that many small firms in a variety of industries need to build up their own pro-



Clive Chamberlain himself, at one of AT&M's three PC-AT CAD workstations.

cess control and monitoring equipment. They often can't afford to buy ready-made systems, like the big corporations, but they have much the same needs. Generally the job of building up the gear they need falls on their maintenance engineer or technician, who may not have the time or even the training to design it all from scratch."

"What they really need is a range of standard functional modules, in kit form. Modules designed to do important 'building block' functions, enabling them to be used to build complete systems. And modules designed for performance and reliability in an industrial environment – not designed down to a price, by cutting corners and using cheap parts."

"None of the existing kit suppliers seemed to be catering for this market, so this became my goal for Stage 1: to produce a range of kits for the 'serious' industrial user, which might also be of interest to colleges and other educational establishments for training, and perhaps by the more advanced enthusiasts."

It's taken a little over 12 months, and an investment of well over $100,000, but Stage 1 is now well under way. AT&M can now offer just on 20 functional module kits, from a simple 3-digit counter to a full duplex fibre-optic modem able to transmit data at up to 500 kilobaud over 1mm plastic fibre up to 25m long. And new kits are being added to the range at the rate of about three each month.

The goal is to have a 'floating pool' of 50-odd kits by the middle of next year, dropping those which become dated or otherwise lose appeal, and adding new designs as needs arise.

Design and development of all the modules has been carried out both by Clive Chamberlain himself and his experienced design engineer Ron Koenig – formerly with Netcomm, Medtel and AWA. They've set up an impressive development lab, with all the instruments needed to fully test and analyse module operation: various oscilloscopes (including a Philips 4-channel 400MHz model), an H-P spectrum analyser, a 125MHz/1ns pulse generator, function and signal generators, frequency counters, power supplies and so on.

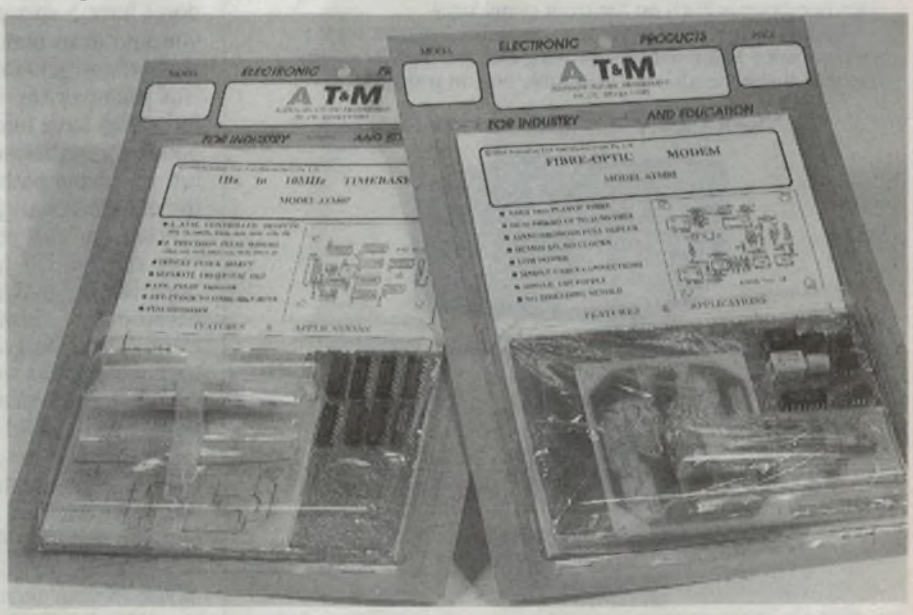
To assist with design work and production of things like PCB patterns and kit manuals, there are also no less than three PC-AT based workstations, the latest using an 80386 with co-processor running at 20MHz. For PCB design work Clive has invested in the Protel suite of design software, developed in Tasmania. Finished PCB artwork is printed out via a laser printer, giving excellent quality.

Kit manuals are prepared using the Ventura Publisher desktop publishing package, and printed out initially on the same laser printer. They are then replicated using one of the latest Minolta EP4102 four-colour copiers. "It cost almost $10,000 – but it was worth every penny!" said Clive, "It's virtually a high-quality print shop in a desk-top case..."

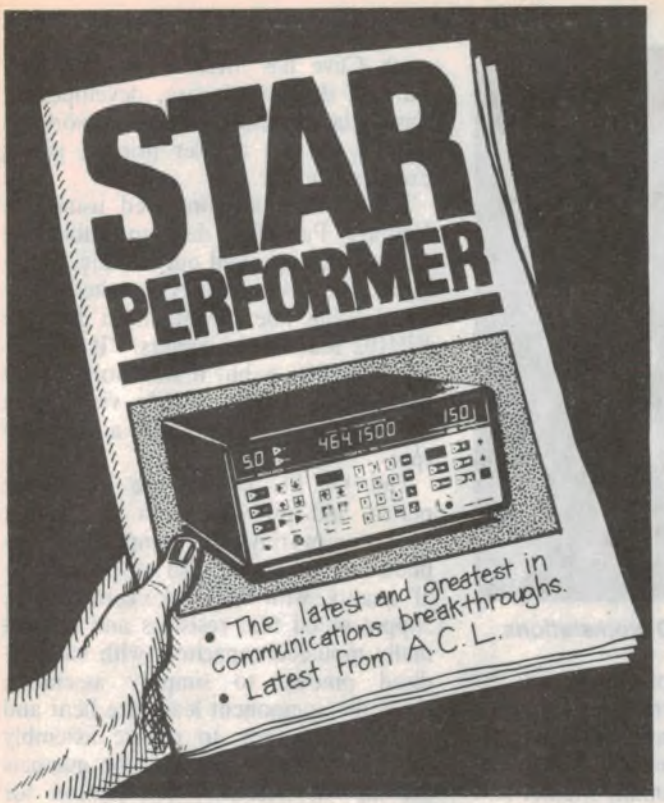
The kit PC boards are all solder plated and provided with component mounting overlays. All components supplied in the kits are also of 'professional' quality, with things like cermet pots, 50ppm metal film resistors and conformally moulded capacitors with standardised pinouts to simplify assembly. Even the component leads are bent and pre-cut to length, to reduce assembly time. And needless to say, the manuals provide all necessary information for both construction and setting up of the module concerned – including circuit schematic, overlay, key waveforms, fully itemised parts list and so on.

Each kit is packaged in an attractive standardised 'bubble pack', with stout backing card and a transparent plastic bubble enclosing the manual and kit. The bubble moulding is even carefully designed so that you can always read the top half of the manual's first page, listing the kit's salient features.

By the way, Clive is particularly proud of the overall design philosophy embodied in these kits. The emphasis



Samples of the first batch of AT&M kits – carefully designed, nicely packaged and using high grade components.



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Ten resident programmable memories, full frequency coverage from 100 KHz to almost 1 GHz and a very wide calibrated output from -127 dBm all the way up to + 7 dBm with AM and FM modulation functions, means you are always in total control.

And the amazing automatic memory exchange key allows operators to switch between frequencies or level settings without having your fingers perform something that resembles Beethoven's Fifth on the front panel keys!

Like all ACL products you can be assured of exacting performance and reliability; proving that the best RF equipment available needn't put a sizeable hole in your pocket.

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AT & M kits

throughout is on simplicity and elegance, using readily available standard parts. Novel circuit techniques are used to achieve the desired level of performance, without dependance upon exotic LSI chips that may not be around in six month's time. Rather than rely on fancy (and expensive) thumbwheel switches for presetting counters, the circuits are designed to use standard low cost 'form-A' pushbuttons, for example.

In short, the kits have been very carefully designed, and basically seem to provide everything that a professional or industrial user would expect.

Clive even provided us with a couple of sample kits to evaluate, and we tried wiring them up 'cold'. They went together without the slightest trouble, and worked exactly as described – very nice indeed!

So AT&M's 'Stage 1' is now bubbling along quite smoothly. But what about Stages 2 and 3?

I'll let Clive explain these himself:

"When the kits are fully up and running, Stage 2 will be to develop some innovative packaging systems. Many of the existing boxes and cases are either too expensive, or not really suitable for making professional-looking equipment. I've been toying with some ideas along these lines, and I think we can come up with something quite different and cost-effective."

"Then a little further down the track, Stage 3 will be to produce fully assembled and tested instruments. These will mainly be for export, because of the limited size of the local market."

"For some time now it's been a personal goal of mine to export Australian designed and manufactured products into niche markets overseas – probably the UK and Germany, because they're the markets I'm most familiar with. I've travelled quite a bit in these countries, and I know that the firms operating there don't have a fixed mortgage on their home markets. There are plenty of opportunities for Australian firms, if we develop the right products and use the right strategy."

"Unfortunately not many local firms seem to be prepared to tackle these markets. Sometimes I think it's because we don't have a strong design-manufacture-export ethos here, as you find in so many other countries, and despite the fact that Australians generally are educated to a relatively high level. But whatever the reason, a small number of firms in various industries have bucked the trend, and are quietly doing quite good export business. I'm determined that AT&M will follow this same path and prove again that it can be done – in the electronics area."

From my visit to AT&M and my talks with Clive, I'll be very surprised if he doesn't achieve these goals. I certainly hope that he and his AT&M team do succeed, too, not just because they seem to be doing all the right things, but because it will be great encouragement for other Aussie firms to 'have a go' as well.

For the moment, though, AT&M is concentrating on producing a solid range of quality kits.

Details of many of the new kits are given in AT&M's recent advertisements. However a brochure giving details of all the kits released to date is available from AT&M, 28 Hotham Parade, Artarmon 2064, by phoning them on (02) 906 2333 or fax (02) 438 4219. Clive and his team can also advise of your nearest stockist, as they've now set up a country-wide distribution network to augment their own direct-mail service.

NEW

A T&M

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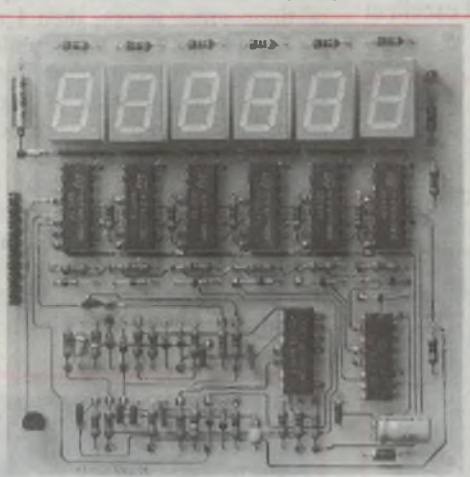
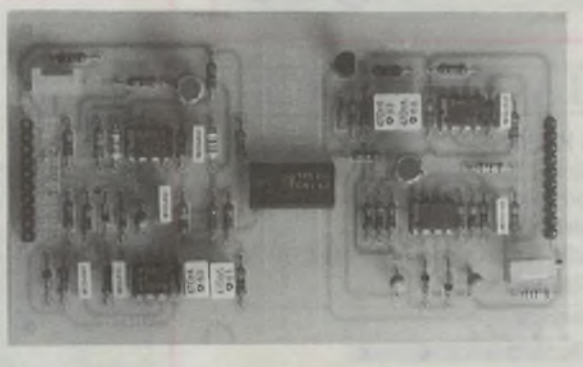
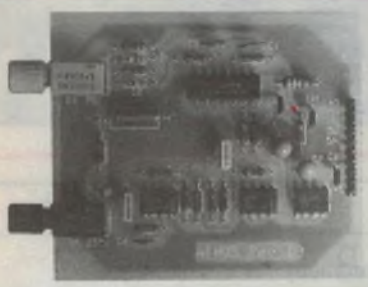


ATM12 PRESETABLE 6 DIGIT COUNTER
Pre-load with 2 push button switches from 1 to 999999, press START and counts down to Zero from external pulses,ie flowmeter,microswitch etc. On board 500mA/50V output turns off at "0"Bright Orange 1/2" Displays counts to 50KHz.Single + 5V supply @120mA *PRICE* **$62.50**

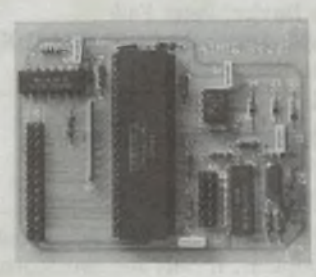


ATM16 10KV ANALOGUE ISOLATOR
Precision V/F/V converters separated by UL & VDE approved 10kV opto coupler. 0 to 1V in, 0 to 5V out, transfer accuracy 0.05%, currentdrain ≈5mA each side.
+ 12V supply each side.
PRICE **$54.50**

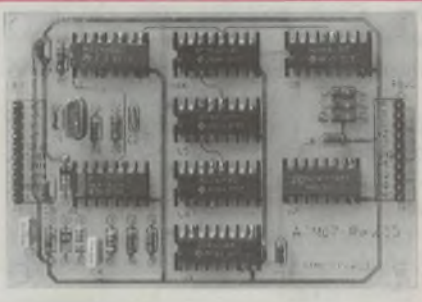


ATM05 Fibre optic Modem, full duplex DC to 500KBaud using low cost plastic cable, single + 5V @ 15mA easy connections.

PRICE **$62.50** CABLE **$1.80**/Metre



ATM18 2 independent Parallel to serial & Serial to Parallel data transceivers (UART) XTAL controlled Baud rates of 9600, 4800, 2400, 1200, 600, 300 TTL & RS232 compatible + 5V @ 10mA *PRICE* **$42.00**



ATM07 Universal Timebase, 8 Xtal outputs-10MHz, 1MHz, 100KHz, 10KHz, 1KHz, 100Hz, 10Hz, 1Hz also synchronised outputs of 100nSec, 1μSec,10μSec,100μSec,1mSec10mSec, 100mSec, 1Sec. *PRICE* **$38.00**

AT&M KIT STOCKISTS

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Compact Disc Reviews

by RON COOPER

SLAVONIC DANCE

Royal Philharmonic Orchestra,
Conducted by Frank Shipway
London Festival Orhestra,
Conducted by Alfred Scholz
Duetsche Austrophon DC 74432 DDD
Playing time: 62.58

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Another disc from this new budget label – Digital Classic, and in similar vein to the Wedding March disc. This one though is more expensive – $9.99!) Again, the selections of this type of disc, which probably suits the more casual listener, are excellent and are:

Antonin Dvorak: Slavonic Dances Op46 Nos 1, 3, 4 and 6, Op72 No2
Franz Liszt: Valse Oubliee
Johannes Brahms: Hungarian Dances Nos 1, 3, 10 and 17
Peter I. Tchaikovsky: Czardas (Schwanensee), Waltz in A Flat Major, Russian Dance Op71a (Nutcracker)
Johann Strauss: Russian March Op426
Frederic Chopin: Prelude Op28/6
Georges Bizet: Danse Boheme (Carmen)
Bedrich (Friedrich) Smetana: Polka, Furiant (Bartered Bride)

With the exception of track 2 (which sounded somewhat 'woody'), they are all digital recordings with very quiet background and clean, well-balanced sound. Tracks 5,9,14,17 of Slavonic Dances are brilliantly played on the piano and expertly recorded, whereas the opening Slavonic Dance is played by an orchestra. I would prefer one or the other on the same disc.

There is a difference though, in the playing on the orchestral tracks. I was somewhat disappointed with track 13 yet the Smetana tracks (15 and 16) are quite brilliant. On reading the fine print, the Smetana is played by the Berlin Festspielorchester, whereas the Bizet is played by the London Festival Orchestra.

On the whole, this is a very fine disc, with many excellent tracks and excellent value.

WEDDING MARCH

Various Orchestras,
Conductors Alfred Scholz,
Eugen Duvier, Peter Falk
Deutsche Austrophon DC74431 DDD
Playing time: 62.09

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

Here is a disc which I feel should be very popular, if only for two reasons – its selections and price. For $8 ($7.99) you get 62 minutes of excellent music as follows:

Felix Mendelssohn Bartholdy: Wedding March Op61
Johann Sebastian Bach: Concerto for Two Violins and Orchestra in D minor
Wolfgang Amadeus Mozart: The Abduction from the Seraglio Overture
Ludwig van Beethoven: Fidelio Overture
Richard Wagner: Tannhauser Overture
Peter I. Tchaikovsky: Wedding March Mazurka Op20a
Johann Strauss (Sen): Emperor Waltz Op37

This new (1988) all-digital disc is well recorded, with a fair amount of ambience in the acoustics and does tend to favour the strings and percussion at some expense of woodwind and brass. However, these faults are not objectionable and in view of the price, if it is able to give more people a taste of these great works, then I am all for it. It is not an audiophile quality recording, nor is it promoted as one, but it is not a re-hash of poorer older recordings to keep the price down.

While the artists are relatively unknown, there is no real complaint from me on this either. There are odd spots where I would prefer a different interpretation from some of the winds, but this is minor and partly due to the recording balance. Well worth the price.

TCHAIKOVSKY

Symphony No 6 'Pathetique'
Concertgebouw Orchestra, Amsterdam
Conductor Semyon Bychkov
Phillips Classics 420 925-2 DDD
Playing time 48.04

PERFORMANCE
1 2 3 4 5 6 7 8 9 10

SOUND QUALITY
1 2 3 4 5 6 7 8 9 10

The programme notes on this disc refer to this work as a Symphony of suffering, yet to the serious listener the joy and pleasure attainable from this work is, I feel, indescribable.

(Continued on page 159)

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Silicon Valley NEWSLETTER . . .

Seagate buys Imprimis

Silicon Valley disk drive maker Seagate Technology has made a dramatic move to become the world's undisputed leading disk drive vendor, as the company agreed to pay US$450 million in cash and stock for Control Data's 'Imprimis Technology' disk drive subsidiary.

Imprimis had 1988 sales of US$1.2 billion, and has large share of the market for 8" disk drives which are popular in minicomputer and high-end workstation markets. Combined with Seagate's revenues of US$1.2 billion, the new operation will have sales of at least US$2.5 billion, leaving its nearest competitor far behind in total sales volume.

In terms of marketshare, the combined company will control a towering 71% of the overall worldwide 5.25" and 3.5" disk drive market.

"This acquisition makes Seagate a huge, one-stop place to buy disk drives. It just makes the company a tougher competitor, particularly with the Japanese," commented Dataquest analyst Linda Shalew.

US Memories 'not a trust'

The announcement of the formation of US Memories received an enthusiastic reception with industry analysts, government officials, and legal experts who said they expect the joint DRAM venture to quickly be cleared of any violations of the US anti-trust law.

According to Sanford Kane, the newly appointed president of US Memories, the anti-trust clearance will be based in large part on the fact that even if all US semiconductor companies would combine their DRAM operations, they would still not be in any position to influence the pricing structure of the DRAM market, at least not as long as Japanese chip producers control the lion's share of the booming market.

Also, the cost of setting up new DRAM manufacturing operations is so prohibitive, it is highly unlikely that any new individual US DRAM companies will emerge. "There has been a phenomenal reluctance on the part of established companies, because of the huge investment required."

Meanwhile, in Washington, the formation of US Memories picked up key support in the Bush Administration, as Commerce Secretary Robert Mosbacher said he supported the chip venture plan.

Industry analysts said that in order to raise the necessary US$500 million to $1 billion in start-up capital, at least 14 major companies will need to become equity partners in the venture. So far, seven firms have signed up as equity partners in US Memories.

Intel predicts 100M transistor chip

You were impressed with the 80386, a chip with contained 275,000 transistors on a single chip. Perhaps you were astonished with the recently introduced 486 which packs a whopping 2 million transistors on the same small piece of silicon real estate.

How about 4 million transistors, or even 100 million?

Intel microprocessor chief David House, while addressing the PC Expo Show in New York recently said his company is currently working hard on the 80586 processors which will contain an estimated 4 million transistors. The 586 should be ready for introduction around 1993. Beyond that, House predicted that Intel will be able to introduce a microprocessor with close to 100 million transistors before the end of this century.

$4.6 billion market seen for ISDN

Integrated Services Digital Network (ISDN) is now gaining momentum as a viable market, and industry-wide annual sales of terminals and adapters will grow from the 1989 level of about US$12 million to more than US$4.5 billion by 1993, according to the latest forecast from Able Telecommunications Inc.

Already a number of vendors have emerged selling a variety of terminals and terminal adapters. But because of the lack of ISDN standards, chosing terminals and adapters can be a difficult task for users installing the first generation ISDN networks.

"Companies will need to gain a better understanding of the factors and trends that drive the developments of ISDN terminal products. They need to be aware of the market size and timing for ISDN products," said George Chow, president of Able Telecommunications.

Currently ISDN terminal prices average around US$2,300. Through next year, those prices are expected to continue to decline to the US$2,000 range. After that, a second generation of terminals with new features and capabilities will raise the average price from US$2,100 in 1991 to US$2,300 in 1993.

The key year for ISDN terminal market growth is expected to be 1992, as terminal sales will jump seven-fold from US$85 million to US$650 million. That growth rate will continue into 1993 when sales will reach close to US$4.6 billion. That year, no less than 2 million ISDN terminals are expected to be shipped.

Japan bows to US, opens cellular market

Facing the threat of a new round of high-tech trade sanctions, Japan has agreed to open its lucrative cellular phone market to foreign suppliers.

The agreement was hailed in Washington as a clear victory for the US's tough new Trade Act, which mandates sanctions against countries that maintain unfair trade practices.

In June, when the US placed Japan on a list of unfair trading partners, Japanese officials vowed never to negotiate under the threat of sanctions.

In Washington, Commerce Secretary Robert Mosbacher said the agreement should "serve as a model for future negotiations. The resolution of this dispute illustrates the commitment of the Bush Administration to open markets and work cooperatively with our trading partners in preserving the free-trade system."

Although the agreement applies to all foreign cellular phone vendors, the main beneficiary, in the short-term will

James Fergason, chairman and CEO of Optical Shields Ltd in Menlo Park, admires one of his firm's LCD eye protection devices. Fergason is a prolific inventor, and holds many of the main LCD patents.

be Motorola which had initiated the trade complaint that led to the branding of Japan as an unfair trader.

In Japan, the dispute over the cellular market has been viewed by many business leaders as arrogance and impatience on the part of the Americans. They have suggested that Motorola was unwilling to alter its product to meet Japanese product specifications or wait until the next generation of Japanese phone standards bridges the technological gap between the Motorola phones and the Japanese radio transmission and receiving standards.

Because of the agreement, Motorola will be free to market a broad line of cellular products in Japan, including its new US$2,500 shirt-pocket phone, its private cellular radio network systems, such as those used by taxis, and its line of car telephones.

Apple expanding Irish operation

Apple Computer announced it is planning to start a US$60 million program this summer to expand the company's manufacturing facilities in Cork, Ireland. When completed, the expansion will more than double the size of the existing facility, which produces most of the company's computers and peripheral products for the European market.

Among other things, Apple will build a 200,000-square-foot extension of the current 140,000-square-feet of manufacturing space. A spokeswoman for Apple in Cupertino said the company needed to expand the plant to be able to accommodate the rapid growth of Apple's European business. She said Apple would not discuss to what extent the new facilities would boost the company's capacity.

During Apple's most recent fiscal year, the European market generated more than US$1 billion in sales for Apple, nearly 25% of the company's overall revenues. And Apple's sales growth in Europe has been outpacing that of any other geographic area, including the United States.

Apple said it expects its sales in Europe to increase three-fold by 1992. The company started manufacturing in Cork nine years ago, and the facility serves as the company's sole manufacturing site in Europe.

ESL to stay in valley

ESL, one of Silicon Valley's defence contractors, is not moving away from Silicon Valley after all.

Just last February, Sunnyvale-based ESL shocked much of the valley with the announcement that it was moving most of its operations to Livermore, about 20 miles east of Silicon Valley. At the time, ESL president Robert Kohler said he was fed up with the valley's housing prices and deteriorating quality of life. He also said that as defence contracts are shrinking in number and size, companies like ESL simply cannot afford to operate competitively in an expensive area like Silicon Valley. "We cannot afford to pay $1 million per acre just to lay asphalt to test our big vehicles," he noted.

Kohler's denunciation of Silicon Valley as a place to do business was all the more stunning since he had just been elected as chairman of the Santa Clara County Manufacturing Group, an organisation whose purpose is to promote the Valley and lobby for improvement in its infrastructure.

A few weeks ago, ESL said that after reviewing a detailed cost analysis of moving the company and most of its 2,600 workers to Livermore, the savings were much less than had been anticipated. The cost benefits were "not enough to justify the hardships of making that kind of move," according to a spokesman for the company.

Union warns Congress about fab hazards

Leaders of one of America's largest trade union have warned a Congressional panel that work in the US semiconductor industry is by far not as clean and safe as the industry's image as a 'light industry' suggests. The group then called for the federal government to launch a major investigation into the health hazards of working in the chip industry.

Barbara Easterling, executive vice president of the Communications Workers of America union, told members of Congress that people in the semiconductor industry work under " very dangerous conditions. The carnage in the semiconductor workplace is not scored in the spilled blood of wage earners or visible damage to their bodies. Instead, it is imposed on the invisible world of workers' chromosomes and tissues through the ingestion of hazardous substances."

Just last year, the semiconductor industry announced it was funding a 3-year, US$3.5 million study of occupational hazards in the semiconductor industry.

But Easterling and other union leaders say it is likely that the study will be biased towards management, and urged that the government takes control of the investigation.

Lee Neal, representing the industry, assured the panel that the study would be completely independent as it is conducted by an independent scientific advisory panel that includes representatives from the National Institute for Occupational Safety and Health.

DRAM chips 'disappear'

Last June 3, at the height of the DRAM crises, Samsung shipped 11 boxes of 1-megabit DRAMS to its Silicon Valley facility for distribution to a number of memory-starved customers.

Samsung used the American Airlines carrier to transport the boxes. Somewhere along the way, one box didn't make it all the way to Silicon Valley – at least not the legal way.

Now Samsung has filed a lawsuit against the airliner for losing one of the DRAM boxes, which contained some 8,000 chips. At the time, customers were paying Samsung as much as US$40 for a single 1-megabit DRAM, putting the value of the lost box at more than US$220,000.

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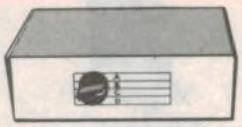

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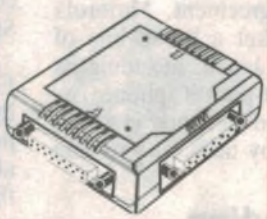

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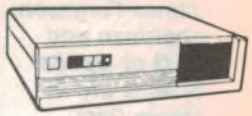

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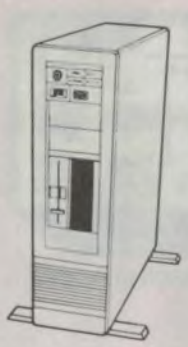

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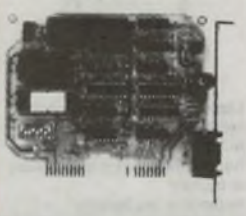

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X18090.....$700

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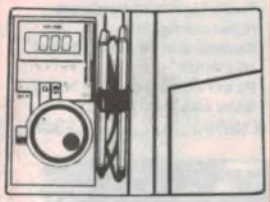
TEST EQUIPMENT



MULTIMETER (YF-100)

- Autoranging for DCV, ACV, OHM & continuity measurement
- AC DC 0 - 500 Volts
- 10mm thickness & 80g light weight for easy operation
- Dimension & weight = 108 x 54 x 8mm and 60g approx

Q11264.....$69

MULTIMETER (YF-3000)

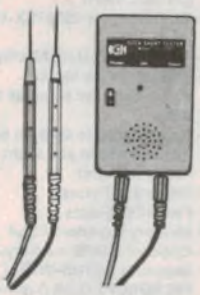
- Large display 3 1/2 digit 0.5" height LCD for easy readout
- AC DC 0 - 1000 Volts
- Auto/manual range select easy to operate
- Automatic low battery" - + " display for battery indication
- Memory-comparative function available for allowance within ±5% f.s
- Warning sound for overload and conductance
- Dimension & Weight = 170 x 80 x 33mm, 260gram approx
- Data hold function for easy readout

Q11268.....$110

MULTIMETER (YF-2100)

- Large display 4 1/2 dgt 0.5" height LCD with maximum reading of 19999
- AC DC 0 - 1000 Volts
- Automatic polarity."-" display for negative input
- High over-load protection for all ranges
- Over load display, the highest digit "1" or "-1" alone glows
- Power consumption 20mW approx.
- Dimension & weight = 162 x 86 x28mm and 200g approx

Q11266.....$199



SHORT TESTER

- Instantly shows the open/short position of PCB
- It can test whether PCB or solid wire open/short by Buzzer

Q11276.....$22.95

LOGIC PULSER (LP-540H)

- Can be used directly to inject a signal into logic circuits without removing IC
- Compatible with TTL, DTL, RTL HTL, MOS and CMOS

Q11274.....$42.95

DIGITAL METER (YF-120)

- Autoranging operation
- Data-hold for easy readout
- Full range protection
- 0-500 volts AC-DC
- 0-20 MΩ
- Dimension & weight =133 x 29 x 17mm and 60g approx

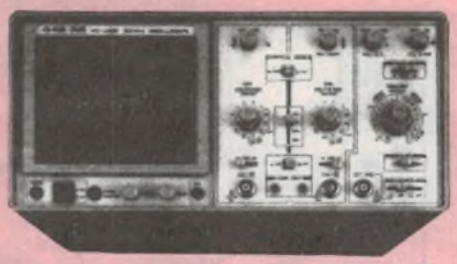
Q11270.....$98.95

LOGIC PROBE (LP-2800)

- Useful for TTL or CMOS has high and low indicator leds and also with pulse memory.
- This is a very handy tool for the hobbyist or serious technician for tracing those hard to find faults on logic boards.

Q11272.....$34.95

NEW CRO'S



20MHZ DUAL TRACE OSCILLOSCOPE

CRT DISPLAY
- 150mm rectangular

VERTICAL DEFLECTION
- Deflection Factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Bandwidth DC: DC to 20MHz (-3dB)
  AC: 10Hz to 20MHz (-3dB)
- Operating Modes: CH-A, CH-B, DUAL and ADD (ALT/CHOP L202 only)
- Chop Frequency: 200KHz Approx.
- Channel Separation: Better than 60dB at 1KHz

TIME BASE
- Type: Automatic and normal triggered in automatic mode, sweep is obtained without input signal
- Sweep Time: 0.2μ Sec to 0.5 Sec/ Div on 20 ranges in 1-2-5 step with fine control and X-Y
- Magnifier: X5 at all ranges

TRIGGERING
- Sensitivity Int: 1 Div or more
  Ext: 1Vp-p or more
- Source: INT, CH-B, LINE or EXT
- Triggering Level: Positive and Negative, continuously variable level; Pull for Auto
- Sync: AC, HF Rej, TV (each + or -) at TV Sync. TV-H (line) and TV-V (Frame) sync. are switched automatically by SWEEP TIME/Div switch.

HORIZONTAL DEFLECTION
- Deflection factor: 5mV to 20V/ Div on 12 ranges in 1-2-5 step with fine control
- Frequency Response: DC to MHz (-3dB)
- Max Input Voltage: 300V DC + AC Peak of 600Vp-p
- X-Y Operation: X-Y mode is selected by SWEEP TIME/ Div switch
- Intensity Modulation Z Axis: TTL Level (3Vp-p-50V) + bright, - dark

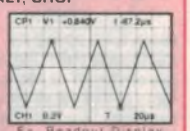
OTHER SPECIFICATIONS
- Weight: 7Kg Approx
- Dimensions: 162(H) x 294(W) x 352(D) mm

Q12105.....$695

40MHZ READ-OUT OSCILLOSCOPE

CRT DISPLAY
- 150mm rectangular

VERTICAL AMPLIFIER (CH1 and CH2 Identical)
- Operational Modes: CH1, CH2, ADD, DUAL, ALT, CHOP
- Sensitivity: 5mV-5V/ Div 3% in 1-2-5 steps
  1mV-1V/ Div x5% x5MAG
- Bandwidth DC: DC to 40MHz (-3dB)
  AC: 5Hz to 40MHz (-3dB)
- Rise Time: Less than 8.7nS



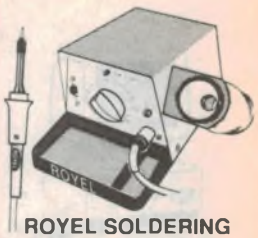
Ex. Readout Display

HORIZONTAL AMPLIFIER
- Operating Modes: X-Y operation CH1-X axis, CH2-Y axis
- Sensitivity: 5mV-5V/ Div± 3% in 1-2-5 steps
- Input Impedance: 1MΩ±2%, 25pF±3%
- Bandwidth DC: DC to 1MHz (-3dB)
  AC: 5Hz to 1MHz (-3dB)

TIME BASE
- Sweep Method: AUTO, NORM, SINGLE
- Sweep Time (A): 0.2μs-0.5S/ Div±3% in 1-2-5 steps (X1 only)
  (B): 0.2μS-0.5mS/ Div±3% in 1-2-5 steps (X1 only)
- Magnified Sweep: 10 times±5%, Max 20ns
- Linearity: ±3% or better

Q12107.....$1,695

SOLDERING IRON



ROYEL SOLDERING STATION

The all solid-state heat sensor and control unit allows the selection of the appropriate soldering tip idling temperature. The very high-powered element (relative to the size of the tool) will replenish heat drained from the tip during each soldering operation and will recover the tip tempreture moments after the tip is lifted.

- Zero voltage switching
- Zero tip potential
- Aux ground connection
- For soldering irons- CT6 (3mm Tip), CT7 (5mm Tip)

T12570.....$235

ADCOLA SOLDERING IRON RS30

(12 WATT)

- 3mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

T12625.....$39.95

ADCOLA SOLDERING IRON RS50

(16 WATT)

- 5mm tip
- 240V operation
- 3 months warranty
- Safety Standards Approved

T12630.....$36.50

ROYAL DUOTEMP SOLDERING IRONS

The DUOTEMP range are designed to idle with a normal tip temperature of 360°C, without its button depressed. In this mode they are ideal for delicate work such as printed circuit boards. With the button depressed, the power is doubled, allowing much heavier work to be completed, or a rapid temperature recovery from larger joins. A range of 6 long-life tips are available. Note: This mode cannot be used continuously.

ROYEL DR-30: 21 WATT

- 3mm tip
- 240V operation, no transformer required
- Safety Standards Approved
- 6 months Warranty

T12640.....$58.50

ROYEL DR-50: 30 WATT

- 5mm tip
- 240V operation, no transformer required
- Safety Standards Approved
- 6 months warranty

T12645.....$59.95

ROYEL DR-60: 60 WATT

- 6.5mm tip
- 240V operation, no transformer required
- Safety Standards Approved
- 6 months warranty

T12650.....$62.50

GENERAL TOOLS

PORTASOL PROFESSIONAL

- Four tools in one: Blow torch, Hot Blow or Hot Knife
- No Cords or batteries
- Heavy duty, tip temperature adjustable up to 400°C
- Equivalent to 10-60 watts
- Hard working. Average continuous use 90 minuters
- Refills in seconds
- Powered by standard butane gas lighter fuel
- Range of easily replaceable screw tips included
- Includes metal stand for the soldering iron when working
- Cap features bully-in flint for igniting Portasol tip
- Includes snap case for storage

T12639.....$89.95

PORTASOL PROFESSIONAL TIPS

4.8mm (T12610).....$12.50
3.2mm (T12612).....$12.50
2.4mm (T12614).....$12.50
1.0mm (T12616).....$12.50

ECONOMY ANTISTATIC SOLDER SUCKER

- Light Weight
- Sturdy construction
- Easy to remove tip
- Excellent value for money

T11281.....$13.95

SOLDER ROLLS

60/40 RESIN CORED

- 0.71mm, 250gm

T31000.....$8.95

- 0.71mm, 500gm

T31002.....$15.95

- 0.91mm, 250gm

T31010.....$7.95

- 0.91mm, 500gm

T31012.....$14.95

- 1.6mm, 250gm

T31020.....$7.50

- 1.6mm, 500gm

T31022.....$13.95

KITS • KITS • KITS • KITS • KITS

CAPACITANCE ADAPTOR FOR YOUR DMM

This clever adaptor circuit plugs into your digital multimeter and can measure capacitance up to 2.2 microfarads. (SC NOV 87)

K88119.....$24.99

PRINTER BUFFER

This external printer buffer will allow two computers to share one printer without the bother of swapping cables. Without dynamic ram (ETI 1620 FEB 89)

K56012.....$139.95

Dynamic Ram (extra).....$150

PCB SHORTS LOCATOR

Here is a simple circuit to help you locate shorted tracks on printed circuit boards, by means of a varying audio tone. It is easily built and will cost you a lot less than equivalent commercial units.(EA FEB 89)

K88015.....$22.95

WALK-AROUND THROTTLE FOR MODEL

This walk around throttle offers a host of features including pulse power, inertia (momentum), braking and full overload protection. (SC APRIL 88)

K88122.....$89

HANDS FREE SPEAKERPHONE

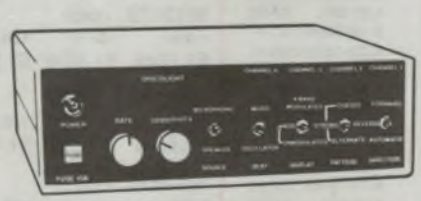
Here's a hands-free telephone that anyone can afford. With the speakerphone you can have relaxing conversations without the need to hold the phone to your ear. And if you are put on "hold" you can continue with you work while you wait. (SC SEP 88)

K88130.....$89

PC DRIVEN FUNCTION GENERATOR

Here's a simple and low cost little unit which lets you use your personal computer to generate signals with almost any conceivable waveform. It hooks up to the computer via a standard Centronics-type parallel printer port, making it compatible with almost any kind of computer. Building and using it will also give you valuable insight into the growing trend towards computer-driven test instruments, too! Software included. (EA JAN 89)

K88111.....$45



DISCOLIGHT SC

These days when you go to hear your favourite band or disco there is always a top light show. Now you can have many of these exciting light show effects - with the Discolight (SC AUG 88)

K88125.....$159

SALE ON KITS!

- Car Battery Monitor
K80100.....$9
- Sound Pressure Meter
K81053.....$29
- Audio Cassette Test Unit
K81101.....$49
- Slide Show Cross Fader
K81110.....$59
- Stand Alone Eprom Programmer
K82013.....$54
- Low Fuel Car Alarm
K82031.....$14
- Vocal Canceller
K82042.....$15
- Sub Woofer Amplifier
K82075.....$59
- Electric Fence
K82092.....$15
- Appliance Power Up Switch
K82110.....$19
- Boggle Goggles
K82124.....$5
- Super Siren
K82111.....$19
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K83080.....$8
- Electronic Watt Meter
K83083.....$59
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K83090.....$9
- Video Enhancer For VCR's
K83100.....$23
- Phone Minder/ Paser
K84021.....$23
- Ultrasonic Movement Detector
K84060.....$23
- Headphone Amplifier
K84111.....$23
- Sound Processor for VCR's
K84040.....$29
- Active Direct Injection Unit
K87110.....$49
- Screecher Burglar Alarm
K86090.....$24
- Two Tone Doorbell
K40440.....$6
- Simple Intercom
K40640.....$6
- Car Alarm
K40840.....$14
- Low OHMS Meter
K41580.....$29
- Op. Amp Tester
K41830.....$19
- Nicad Float Charger
K42680.....$9
- Car Headlight Delay
K43230.....$13
- Auto Electrical Tester
K43340.....$15
- Versitile Car Alarm
K43400.....$49
- Loudspeaker Protector
K44940.....$19
- Phone Bell Extender
K45470.....$19
- Sound Flash Trigger
K45680.....$29
- Parallel Printer Switch
K46660.....$49
- Parameter (Graphic) Equalizer
K54060.....$19
- Model Engine Ignition System
K55160.....$29
- Dual Speed Modem
K34600.....$129

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ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS

GENERAL COMPONENTS

BREAD BOARDS

This inexpensive rang of modular interlocking units enables a quick, easy way of experimenting with new circuits and ideas. There are two main units consisting of a terminal strip or distribution and a Central plug-in unit.

- 100 holes

P11000.....$2.75

- 640 + 100 holes

P11007.....$14.95

- 1280 + 100 holes

P11010.....$26.95

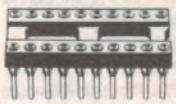
- 2560 + 700 holes

P11018.....$69.95

HEAT SHRINK TUBING

- Price per metre

PHS 25	25mm	$6.95
PHS 20	20mm	$5.00
PHS 16	16mm	$3.60
PHS 13	13mm	$3.30
PHS 10	10mm	$2.65
PHS 7	7mm	$2.15
PHS 5.5	5mm	$1.85
PHS 3.5	3.5mm	$1.70
PHS 2.5	2.5mm	$1.50
PHS 1.5	1.5mm	$1.30



GOLD INSERT LOW PROFILE IC SOCKETS

- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where field service components is required.

Cat.no.	Description	1-9	10+
P10620	8 pin	$1.20	$1.10
P10624	14 pin	$1.60	$1.40
P10626	16 pin	$1.90	$1.80
P10628	18 pin	$2.00	$1.90
P10630	20 pin	$2.20	$2.00
P10632	22 pin	$2.40	$2.20
P10634	24 pin	$2.60	$2.40
P10640	28 pin	$2.90	$2.70
P10644	40 pin	$2.95	$2.75

LOW PROFILE IC SOCKETS

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

Cat. No.	Description	1-9	10+
P10550	8 pin	$0.20	$0.18
P10560	14 pin	$0.25	$0.20
P10565	16 pin	$0.25	$0.20
P10567	18 pin	$0.40	$0.35
P10568	20 pin	$0.40	$0.35
P10569	22 pin	$0.40	$0.30
P10570	24 pin	$0.40	$0.30
P10572	28 pin	$0.50	$0.40
P10575	40 pin	$0.50	$0.40

CANNON TYPE CONNECTORS AT SPECIAL PRICES !!

Cat. no.	Description	Price
P10960	3 pin line male	$2.90
P10962	3 pin chassis male	$3.25
P10964	3 pin line female	$3.50
P10966	3 pin chassis female	$3.75

12V DC FANS

80 x 80 x 25.4mm
12V DC, 1.7 Watt, 0.14 Amps

T12469.....$12.95

10+ fans only $11.95 each

BALL BEARING FANS

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

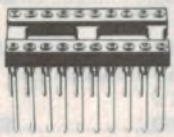
240V 4 5/8" T12461...$14.95

115V 4 5/8" T12463...$14.95

240V 3 1/2" T12465...$14.95

115V 3 1/2" T12467...$14.95

10+ fans (mixed) only $13.95 each



WIRE WRAP IC SOCKETS

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

Cat.no.	Description	1-9	10+
P10579	8 pin	$1.50	$1.20
P10580	14 pin	$2.50	$2.25
P10585	16 pin	$2.50	$2.25
P10587	18 pin	$2.95	$2.75
P10590	20 pin	$3.25	$2.95
P10592	22 pin	$3.25	$2.95
P10594	24 pin	$3.95	$3.65
P10596	28 pin	$4.50	$4.25
P10598	40 pin	$6.95	$6.50

JUMP WIRE KIT (KS-350)

Contains:
14 kinds of length from 0.1" to 5" with different colors

Q11278.....$19.95

FLASHING LEADS

- Red, 5mm

	1-10	10+
Z10159	$1.10	$1.00

WIRE WRAP WIRE

- Precut wire
- Pack of 100

W19002	Blue	3.0"	$4.75
W19022	Red	3.0"	$4.75
W19042	Yellow	3.0"	$4.75
W19062	Black	3.0"	$4.75
W12784	Green	3.0"	$4.75
W19026	Red	5.0"	$5.95
W19046	Yellow	5.0"	$5.95
W19066	Black	5.0"	$5.95
W12790	Green	5.0"	$5.95
W19006	Blue	5.0"	$5.95
W19016	Blue	10.0"	$10.50
W19036	Red	10.0"	$10.50
W19056	Yellow	10.0"	$10.50
W19076	Black	10.0"	$10.50
W12796	Green	10.0"	$10.50

- Spool wire

W19390	Green	50ft	$8.00
W19400	Blue	50ft	$8.00
W19406	Purple	50ft	$8.00
W19407	White	50ft	$8.00
W19408	Orange	50ft	$8.00
W19410	Yellow	50ft	$8.00
W19415	Black	50ft	$8.00
W19416	Green	100ft	$10.75
W19417	Brown	100ft	$10.75
W19420	Blue	100ft	$10.75
W19425	Red	100ft	$10.75
W19426	Purple	100ft	$10.75
W19427	White	100ft	$10.75
W19428	Orange	100ft	$10.75
W19430	Yellow	100ft	$10.75
W19435	Black	100ft	$10.75
W19460	Blue	500ft	$33.75
W19461	Green	500ft	$33.75
W19465	Red	500ft	$33.75
W19475	Black	500ft	$33.75

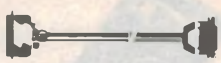
QUALITY LEDS

Cat. no.	Description	Price
Z10140	3mm Red	$0.15
Z10141	3mm Green	$0.20
Z10143	3mm Yellow	$0.20
Z10145	3mm Orange	$0.20
Z10150	5mm Red	$0.10
Z10151	5mm Green	$0.15
Z10152	5mm Orange	$0.15
Z10155	10mm Red	$1.00
Z10156	10mm Green	$1.00
Z10157	10mm Yellow	$1.00

CRYSTALS

Y11000	1MHz	$11.50
Y11003	1.8432MHz	$7.50
Y11005	2MHz	$6.90
Y11007	2.3040 MHz	$6.50
Y11008	2.4576 MHz	$6.50
Y11009	2.7648 MHz	$4.90
Y11010	3MHz	$4.90
Y11015	3.57954MHz	$3.00
Y11018	3.93216MHz	$4.90
Y11020	4.00 MHz	$4.90
Y11022	4.19430MHz	$3.90
Y11023	4.33618MHz	$4.90
Y11024	4.44 MHz	$4.90
Y11025	4.75 MHz	$4.90
Y11026	4.9152 MHz	$6.90
Y11027	4.9562 MHz	$4.90
Y11030	5MHz	$4.90
Y11033	5.0688MHz	$4.90
Y11042	6.144 MHz	$4.90
Y11050	8.00 MHz	$4.90
Y11055	8.86723MHz	$4.90
Y11070	12.00 MHz	$4.90
Y11072	14.318 MHz	$4.90
Y11080	16.00 MHz	$4.90
Y11085	18.432 MHz	$4.90
Y11090	20.00 MHz	$4.90

LEADS



PRINTER LEAD

- Suits IBM* PC/XT, compatibles
- 25 pin "D" plug (computer end) to Centronics 36 pin plug

- 1.8 metres

P19029.....$14.95

- 3 metres

P19030.....$19.95

- 10 metres

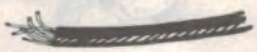
P19034.....$39.95

CABLES

FLAT GREY RIBBON CABLE

- Flat cable for IDC connectors
- m = metre

	1-9m.	10+m.	100+m.
W12614 - 14 way	$1.90m	$1.80m	$1.20m
W12616 - 16 way	$1.90m	$1.80m	$1.20m
W12620 - 20 way	$2.50m	$2.20m	$1.50m
W12624 - 24 way	$2.90m	$2.70m	$1.70m
W12626 - 26 way	$3.60m	$3.30m	$2.20m
W12634 - 34 way	$3.90m	$3.60m	$2.30m
W12636 - 36 way	$1.90m	$1.80m	$1.20m
W12640 - 40 way	$4.90m	$4.00m	$2.80m
W12650 - 50 way	$5.50m	$4.90m	$2.90m



COMPUTER CABLE

- Six conductor shielded computer interface cable
- m = metre

	1-9 m	10+ m	100+ m
W12670 - CIC6	$1.30m	$1.10m	$1.00m
W12672 - CIC9	$1.60m	$1.50m	$1.20m
W12674 - CIC12	$2.50m	$2.20m	$1.90m
W12676 - CIC16	$3.50m	$3.20m	$2.50m
W12678 - CIC25	$3.90m	$3.40m	$3.00m

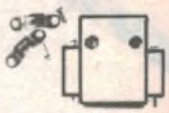
PLUGS & SOCKETS

D TYPE SOLDER PLUGS

	1-9	10+	100+
P10880 - DE9P	$5.95	$5.50	$0.80
P10890 - DA15P	$1.85	$1.55	$0.90
P10900 - DB25P	$1.95	$1.60	$0.90
P10910 - DC37P	$3.95	$3.75	$3.50
P10920 - DF50P	$5.95	$5.75	$4.95

D TYPE SOLDER SOCKETS

	1-9	10+	100+
P10881 - DE9S	$1.95	$1.75	$0.80
P10891 - DA15S	$1.95	$1.75	$0.90
P10901 - DB25S	$1.95	$1.75	$1.00
P10911 - DC37S	$3.90	$2.90	$2.70
P10921 - DF50S	$6.90	$5.90	$4.90



D TYPE SOLDER COVERS

	1-9+	10+
-DE9C P10882	$1.20	$1.00
-DA15C P10892	$1.25	$1.10
-DB25C P10902	$1.25	$1.10
-DC37C P10912	$5.50	$4.95
-DF50C P10922	$6.50	$5.95

CARD EDGE CONNECTORS

1" SPACING

		10+	100+
P12060	10 pin	$3.95	$3.50
P12062	20 pin	$4.25	$3.75
P12064	26 pin	$4.50	$3.95
P12066	34 pin	$4.95	$3.95
P12068	40 pin	$5.95	$4.95
P12070	50 pin	$6.95	$5.95

VIDEO ACCESSORIES

VIDEO DUBBING KIT VCK1

For European and Japanese machines. Packed in plastic tray for easy identification of parts and tidy storage.

CONTAINS:

Audio/ Video:
- 6 pin DIN plug to 6 pin DIN plug 1.5 metres
- 6 pin DIN socket to:
  (a) Video: RCA plug (16cm)
  (b) Audio: 5 pin DIN plug(16cm)

Video:
- 1 each plug adaptor
  - RCA socket to PL256 plug
  - RCA socket to BNC plug

Audio:
- 5 pin DIN socket to 2 RCA plugs (16cm length)
- 2 plug adaptors RCA socket to 3.5mm phone plug

P32190.....$16.95

VIDEO DUBBING KIT VDK2

All Japanese machines, old and new. Packed in plastic tray for easy identification of parts and tidy storage.

CONTAINS:

Video:
- RCA plug to RCA plug, 1.5 metre, 75 ohm
- 2 plug adaptors, RCA socket to BNC plug
- 2 plug adaptors, RCA socket to PL259 plug

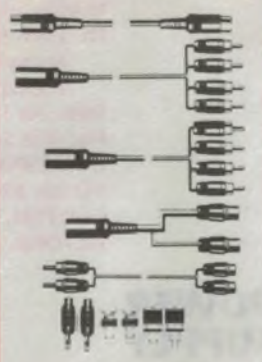
Audio:
- RCA plug to RCA plug, 1.5 metre, shielded cable
- 2 pcs 5 pin DIN plug to 2 RCA sockets (in/out) 16cm
- 2 plug adaptors, RCA socket to 3.5mm phone plug

P32192.....$26.95

VIDEO/ AUDIO TRANSMITTER

A small compact unit that allows transmission of video and audio signals (RF) to any TV set or VCR within a range of 30 metres (100"), simply by tuning in on Channel 11. Can be used as a transmitter for a video camera. With power on LED, on/ off switch, audio and video leads and supplied with and AC adaptor.
- Transmission: VHF, channel 11 (PAL)
- Video input: 75 ohms, 1V p-p
- Audio input: 600 ohms
- Output Control: Audio-video fine adjustment
- Power Sources: 9V battery or power adaptor
- Accessories:
  - RCA to RCA audio lead
  - RCA to BNC video lead
- Size: 70(W) x 85(D) x 28(H)mm
- Weight: 170 grams

A16150.....$95.95



VIDEO DUBBING KIT VDK3

Suits all Japanese machines, mono and stereo, old or new. Colour soded plugs and easy to follow instructions make it simple to use, even for the novice.

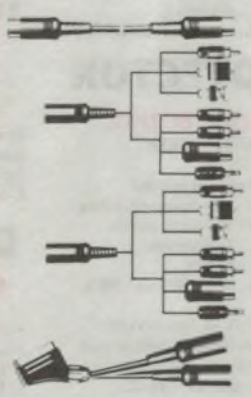
CONTAINS:

Audio/ Video -
- 1 x 6 pin DIN plug ot 6 pin DIN plug, 1.5 metres
- 2 x 6 pin DIN socket to 4 RCA plugs (20cm length)

Video:
- 2 x plug adaptors, PL259 plug to RCA socket
- 2 x plug adaptors, BNC plug to RCA socket

Audio:
- 2 x RCA sockets to 5 pin DIN plug (20cm length)
- 2 x plug adaptors, RCA socket to 3.5mm plug
- 2 x RCA sockets to 2 x RCA plugs

P32193.....$30.50



THE ULTIMATE DUBBING KIT - VDK4

With this dubbing kit you will be able to copy from mono to stereo from old to new Japanese and European machines, even those using the new SCART plugs system.

CONTAINS:

Audio/ Video -
- 6 pin DIN plug to 6 pin DIN plug, 1.5 metres
- 2 x 16cm leads with 6 pin DIN socket to colour coded connectors.
  (a) 5 pin DIN plug audio
  (b) PL259, BNC, RCA plugs for video
  (c) 2 x RCA, 3.5mm phone plugs for audio
  (d) SCART plug to 2 x 6 pin DIN sockets, 10cm for audio/ video R/P.

P32194.....$54.95

ANTENNAS

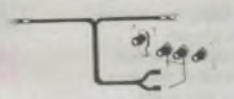
AUTOMATIC ANTENNA ROTATOR

- Fully automatic with with 50kg vertical load
- Suits most TV, FM, UHF & VHF antennas
- Energy Authority approval No.N1499

SPECIFICATION:

Rotation: 360° with mechanical stop
Rotation Time: 360° in 70 sec.
Mast size: 22mm to 44mm diameter
Loading: 50kg vertical - 0.25m2 wind
Weight: Drive Unit 3.1kg
Size: 152 x 375(H)mm

A12069.....$169.95



INDOOR ANTENNA

- 300 ohm
- With moulded ends for fitting to TV/ FM radio etc.

L15030.....$2.95

BAND 4 UHF ANTENNA

- UHF channels 28 - 34
- 75 ohm cable connects directly, doesn't require a masthead balun
- 10 elements with back reflectors ensures maximum gain with minimum ghosting
- Can be mounted in both vertical or horizontal position

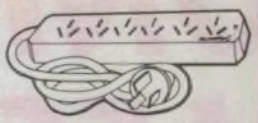
L15011.....$53.95

RADAR DESIGN UHF/VHF/FM INDOOR ANTENNA

- Built in UHF - VHF mixer
- Frequency band from 40 - 890MHz
- 900mm VHF dipoles
- UHF fine tuning with radar dish
- 75 ohm coaxial cable and plug

L15039.....$49.95

240 ACCESSORIES



SURGE BUSTER

6 PROTECTED POWER OUTLETS

Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players etc

SPECIFICATIONS:
- Electrical rating: 240V AC, 50Hz, 10A
- 3 x Metal Oxide Varistors (MOV)
- Maximum clamping Voltage: each MOV: 710 volts at 50 amps
- Response time: Less than 25 Nanoseconds.

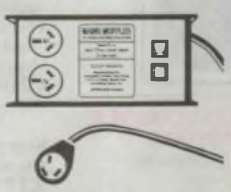
X10086.....$69.95

CPF CONTINUOUS POWER FILTER (SPIKE ARRESTOR)

The CPF Power Filter provides a protective electronic barrier for microcomputers, printers, telephone systems and modems electronic typewriters, audio and stereo systems and other sensitive electronic equipment. CPF' responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.

SPECIFICATIONS:
- Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
- Spike/ RFI Protection: 4,500 amps for 20m/ second pulses
- Maximum clamping voltage: 275V differential mode

X10088.....$69.95



MAINS MUFFLER

Sudden mains disturbances can seriously affect your computer equipment, and stored data. So why risk it when you can have a Mains Muffler, particularly when the cost of one failure is likely tl be greater than the purchase price!

SPECIFICATIONS:
- Maximum total load: 1000W, 4 AMP, 250V, 50 Hz
- Outlet Sockets: Attenuation: 150KHz-47dB, 500KHz-68dB, 10MHz-66dB
- Dual T Section: VDR Transient suppression. Surge capacity 200 Amp 8 x 20us

X10089 (2 Way).....$199
X10090 (4 Way).....$299

THE BUTTON SPIKE PROTECTOR

Simply plug the button into an outlet and it will protect all equipment plugged into adjacent outlets on the same branch circuit.

SPECIFICATIONS:
Voltage: 240V Nominal
Total Energy Rating: 150 joules
Response Time: 10ns
Protection Level: 350V peak

X10087.....$36.95

ROD IRVING ELECTRONICS

SYDNEY: 74 Parramatta Rd.
Stanmore 2048
Phone: (02) 519 3134
Fax: (02) 519 3868

MELBOURNE: 48 A'Beckett St
Phone: (03) 663 6151

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Phone: (03) 489 8866

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Order Hotline: 008 33 5757
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Inquiries: (03) 543 7877
Telex: AA 151938
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All sales tax exempt orders and wholesale inquiries to:
RITRONICS WHOLESALE -
56 Renver Road, Clayton.
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Fax: (03) 543 2648

ORDER HOTLINE
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STRICTLY ORDERS ONLY

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POSTAGE RATES:

$1 - $9.99	$2.00
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$25 - $49.99	$4.00
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The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

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ROD IRVING ELECTRONICS

RITRONICS WHOLESALE

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International- +61 3 543 7194
Telex: AA 151938
Fax: (03) 543 2648
CORRESPONDENCE:
P.O Box 620
CLAYTON, 3168
VICTORIA, AUSTRALIA

IBM* CARDS

G7 CGA/ MGP
X18007.....$75

MGP
X18003.....$70

HEGA
X18070.....$245

VGA
X18071.....$380

VGA 512k
X18072.....$560

RS232
X18026.....$32

RS232 & Clock
X18028.....$59

Clock
X18024.....$32

Printer
X18017.....$20

Games
X18019.....$22

Multi I/O
X18040.....$80

I/O Plus
X18045.....$75

2 M/Byte Ram
X18052.....$170

3 M/Byte Ram
X18056.....$200

Serial /Parallel /Games
X18151.....$75

Floppy Disk Drive
X18005.....$36

4 Way Drive Controller - 360K/ 720K/ 1.2M/ 1.44
X18006.....$99

XT* Hard Disk Controller
X18060.....$100

AT* Hard Disk Controller
X18140.....$210

IBM* PC/AT* DECODED I/O CARD

This card is designed for the IBM* PC/AT* expansion slot and includes data buffering and address selection. The wire wrap area features plated through holes. Extremely useful for R&D, it's address range is 0280H to 72 F7H. + -5V, + -12V fuse protection and has location for D type 37 pin or D type 25 pin connector.
H19125.....$70

INTELLIGENT 6 PORT I/O CARD

An intelligent front end communication adaptor featuring 6 asynchronous RS232C ports and communication co-processor. With many driver routines supported for various operating systems, this card lets your AT* (and compatibles) be connected with ASCII terminals, modems or other serial devices operating UNIX-V like systems (eg: M/S XENIX, SCO XENIX, Microport Unix) or DOS environment. With either Xenix/ Unix or DOS configurations, your AT* can be turned into a full scale super microcomputers that rivals or exceeds the performance of systems costing much more.
X18152.....$450

MONITORS

RITRON MULTISYNC VGA COLOUR MONITOR

Quality Auto VGA, EGA, CGA monitor without the excessive price tag!
Display Tube: 14 inch 90° deflection
P22 Non-glare, tint. 0.13mm dot pitch
Active Display Area: 245 x185mm
Resolution:
800 dots(H) x 600 lines(V)
Display Colour:
TTL input: 8/16/64 colours
Analog input: unlimited colours
X14528.....$700

RITRON CGA COLOUR MONITORS

Quality monitors without the exorborant price tag!
Display Tube: 14 inch 90° deflection
0.39mm Dots trio pitch. Dark face screen
Phosphor: P22
Resolution:640 dots (horizontal)
240 line (vertical)
X14526.....$350

RITRON EGA COLOUR MONITORS

Display Tube: 14 inch 90° deflection dot type black matrix. Standard persistence phosphor.
Active Display Area:
240mm x 180mm
Resolution:
64 Colour:720dots(H) x 350 lines
16 Colour:640dots(H) x 200 lines
X14527.....$465

KEYBOARD

KEYBOARD WITH SOLAR CALCULATOR

- Enhanced RT layout plus calculator function keys
- Size: 495 x 195mm (W x D)
- Custom mold logo tab
- FK-3002, 112 keys European version
- Big-caps calculator function Japan Alps Mechanical tactile"Click" keys

X12024.....$103

"IBM* XT* TYPE" KEYBOARD

- 100%IBM* PC*, XT* compatible
- 84 Keys, including function keys and a numeric keypad
- Low profile keyboard design
- Proper placement of shift keys with large key tops to suit professional typists
- 3 Step height/angle adjustment
- Curl lead plugs straight into IBM* PC/ XT*
- Status displays, Power, Cap lock and Numeric Lock

X12020.....$67

GENERAL

MINI VACUUM CLEANER

Use it to clean:
- Computer keyboards
- Printers & Video recorders
- Computer circuit boards

C21087.....$9.10

GRIP CLIP COPY HOLDER

- Attaches to the top of your monitor
- Put your copy right where you need it. Spring clip to hold paper
- Velcro at mount for easy removal

C21065.....$8.50

DUST COVER

Keep your computer and accesories free of dust and grime
XT* Cover Set
C21066.....$7

MOUSE

QUICK MOUSE MICROSOFT* COMPATIBLE

- Auto-selection and auto-transfer between mouse system PC mouse mode and Microsoft serial mouse mode
- Microsoft Serial Mouse and MouseSystem compatible
- Super high tracking speed: 600mm/sec
- Super high resolution: 200 DPI (0.12mm/dot)
- Silicon rubber coated ball
- Optical rotary encoder

X19955.....$55

POWER SUPPLY

150W SWITCH MODE POWER SUPPLY FOR IBM* PC/ XT* & COMPATIBLES

DC OUTPUT:
- +5/ 13A, -5V/ 0.5A
- +12V/ 4.5 - 12V/0.5A

X11096.....$105

180W SWITCH MODE POWER SUPPLY FOR BABY AT* COMPATIBLES

X11098.....$115

200W SWITCH MODE POWER SUPPLY FOR IBM* AT* & COMPATIBLE

DC OUTPUT:
+5/ 16A, -5V/ 0.5A
+12V/5A - 12V/ 0.5A
X11097.....$165

PROTECTOR

SURGE BUSTER

6 PROTECTED POWER OUTLETS
Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players etc
SPECIFICATIONS:
- Electrical rating: 240V AC, 50Hz, 10A
- 3 x Metal Oxide Varistors (MOV)
- Maximum clamping Voltage: each MOV: 710 volts at 50 amps
- Response time: Less than 25 Nanoseconds

X10086.....$49

CPF CONTINUOUS POWER FILTER (SPIKE ARRESTOR)

The CPF Power Filter provides a protective electronic barrier for microcomputers, printers, telephone systems, electronic typewriters, audio and stereo systems and other sensitive electronic equipment
CPF responds instantly to any potentially damaging over-voltage, ensuring safe trouble free operation.
SPECIFICATIONS:
- Electrical rating: 220-260 volts (AC) 50Hz 10 Amp
- Spike/ RFI Protection: 4,500 amps for 20m/ second pulses
- Maximum clamping voltage: 275V differential mode

X10088.....$54

SWITCH BOX

DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.
- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 Way RS232
X19120.....$27
4 Way RS232
X19125.....$35
2 Way Centronics
X19130.....$27
4 Way Centronics
X19135.....$33
RS232 2 X 2 Auto Switch
X19140.....$33
Centronics 2 x 2 Auto Switch
X19145.....$33

GENERAL

RIPPER STRIPPER

Remove ugly paper feed edges quickly and cleanly with this simple little gadget
C21085.....$6.65

DISK BOXES

5 1/4" DISK STORAGE BOX

- 100 x 5 1/4" disk capacity
- Smoked plastic hinged lid
- "Eclipse"

C16042.....$6.50

3 1/2" DISK STORAGE BOX

- 40 x 3 1/2" disk capacity
- Smoked plastic hinged lid
- "Eclipse"

C16040.....$6

Minumum order value is $100. Minimum post/pack $3.00. Minimum account post/pack $5.00. Comet Road Freight, bulky items and /or over 10kg is extra.
- **Wholesale orders only to approved resalers or tax exempt buyers.**
- **Prices do not include Tax.**

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Now you can buy absolute top quality disks that are also the cheapest in Australia! They even come with a lifetime warranty, which indicates the quality of these disks. So why pay 2-3 times the price for the same quality?
Packs of 10, D/S D/D without boxes, or brand name, just their whitepaper jacket, and index label (5 1/4" disks includes write protects)

5 1/4" 2S/2D "NO BRAND" DISKS

10+ DISKS	100+ DISKS	1,000+ DISKS
$4.75	$4.50	$4.00

3 1/2" 2S/2D "NO BRAND" DISKS

Suitable for IBM, PS/2, Macintosh, Atari, etc.
$21
(ALL PRICES PER 10 DISKS)

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(ALL PRICES PER BOX OF 10 DISKS)

DESCRIPTION	1-9 BOXES	10+ BOXES
3 1/2" 2S/2D	$27.95	$26.95
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5 1/4" 2S/2D	$19.95	$17.95
5 1/4" 2S/HD	$24.95	$22.95

VERBATIM DATALIFE PLUS. TEFLON COATED

5 1/4" 2S/2D	$23.95	$21.95
5 1/4" 2S/HD	$28.95	$25.95

CONNECTORS

COMPUTER CONNECTORS

		1-9	10+
P12200	36 Centronics Crimp Plug	$2.35	$1.95
P12201	36 Centronics Crimp socket	$2.40	$2.00
P12210	36 Centronics Solder Plug	$1.35	$1.20
P12213	36 Centronics Chassis Socket	$1.35	$1.20
P10901	DB 25 Solder Socket	$0.45	$0.40
P10900	DB 25 Solder Plug	$0.45	$0.40
P10902	25 Backshell Cover	$0.45	$0.40
P12170	DB 25 Crimp Plug	$2.40	$2.10
P12171	DB 25 Crimp Socket	$2.50	$2.20
P10880	DB 9 Solder Plug	$0.40	$0.30
P10881	DB 9 Solder Socket	$0.40	$0.30
P10882	DB 9 Cover	$0.35	$0.30
P10886	DB 15 High Density (VGA)	$2.10	$1.90
P12166	DB 9 Crimp Plug	$1.85	$1.65
P12168	DB 9 Crimp Socket	$1.85	$1.65

DIODES

	10+		10+		10+
IN4002	$0.04	IN4007	$0.10	IN5408	$0.20
IN4004	$0.05	IN5404	$0.18	IN5401	$0.20

VOLTAGE REGULATORS

	10+				
78L05	$0.50	7812KC	$0.50	7912KC	$1.80
7805UC	$0.43	79L05	$1.00	LM317T	$1.50
7805KC	$1.90	7905UC	$0.70	LM317K	$1.95
78L12	$0.50	7905KC	$1.50	LM350T	$5.00
7812UC	$0.50	79L12	$1.00	LM337T	$1.60
		7912UC	$1.00	LM338K	$7.50

DRIVES

Y.E. DATA 3.5" 1.44/ 1.2/ 720 DRIVE

C11911.....$150

COPAL 5 1/4" 360 DRIVE

C11901.....$105

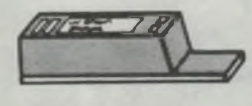
Y.E DATA 5 1/4" 1.2 DRIVE

C11906.....$125

CRYSTALS

		10+
Y11000	1MHz	$5.10
Y11003	1.8432MHz	$1.95
Y11005	2MHz	$1.30
Y11007	2.3040 MHz	$1.50
Y11008	2.4576 MHz	$1.15
Y11009	2.7648 MHz	$1.60
Y11010	3MHz	$1.30
Y11015	3.57954MHz	$0.75
Y11018	3.93216MHz	$1.30
Y11020	4.00 MHz	$0.85
Y11022	4.19430MHz	$0.95
Y11023	4.33618MHz	$1.00
Y11024	4.44 MHz	$1.40
Y11025	4.75 MHz	$1.40
Y11026	4.9152 MHz	$1.15
Y11027	4.9562 MHz	$1.20
Y11030	5MHz	$0.95
Y11033	5.0688MHz	$0.95
Y11042	6.144 MHz	$0.95
Y11050	8.00 MHz	$0.95
Y11055	8.86723MHz	$0.85
Y11070	12.00 MHz	$1.05
Y11072	14.318 MHz	$0.85
Y11080	16.00 MHz	$1.05
Y11085	18.432 MHz	$1.05
Y11090	20.00 MHz	$0.85

GENERAL



UV EPROM ERASER

Erase your EPROMs quickly and safely. This unit is the cost effective solution to your problems. It will erase up to 9 x 24 pin devices in complete safety, in about 40 minutes (less time for less chips)
SPECIFICATIONS:
- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineereed to prevent UV exposure
- Dimensions 217 x 80 x 68mm

Without timer
X14950.....$69

With built-in timer
X14955.....$102

METERS

MU SERIES PANEL METERS

DIMENSIONS LISTED BELOW

Q10500	MU45 0-1mA	$8.50
Q10502	MU45 50-0/50uA	$8.50
Q10504	MU45 0-100uA	$8.50
Q10505	MU45 0-50uA	$8.50
Q10510	MU45 0-5A	$8.50
Q10515	MU45 0-10A	$8.50
Q10516	MU45 0-20A	$8.50
Q10518	MU45 0-1A	$8.50
Q10520	MU45 0-20V	$8.50
Q10525	MU45 0-30V	$8.50
Q10530	MU52E 0-1A	$10.20
Q10533	MU52E 0-5A	$10.20
Q10535	MU45 VU Metre	$9.50
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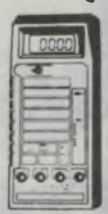

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Australian CSIRO scientists are now

Pushing the frontiers of GaAs technology

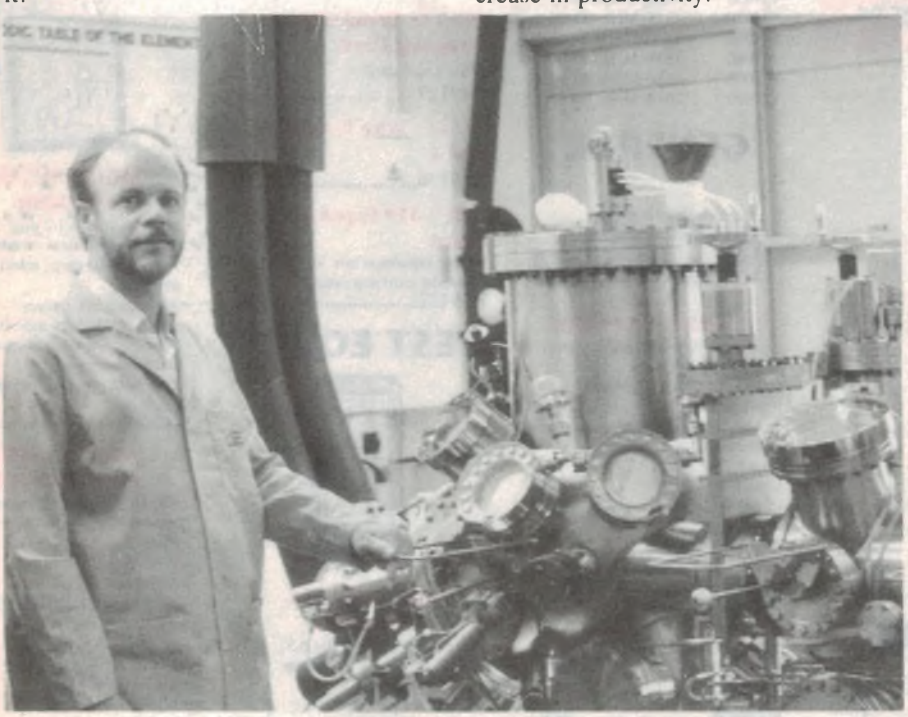
After years of painstaking research and development into microwave and millimetre-wave applications of gallium arsenide semicoductor technology, a team of scientists in the CSIRO's Division of Radiophysics has now produced devices and fabrication techniques which truly advance the state of the art. These achievements have great potential in terms of world markets, and CSIRO is now moving to realise this potential in conjunction with Triune, a commercial partner.

by JIM ROWE

Electronic circuits are a bit like racing cars and aircraft, at least in one respect: no matter how fast they can go, there's always pressure to make them go *faster*.

Mind you, this drive for ever-faster circuits isn't just a mindless pursuit of speed for its own sake. There are good economic and technical reasons behind it.

The faster a computer's circuits can work, for example, the more data it can crunch through in a given time – reducing the cost of processing. Or looking at it another way, the faster a computer can operate, the larger the number of users who are able to share its computing power at any one time, giving an increase in productivity.



Dr John Archer, leader of the CSIRO Solid State Group, pictured here with the MBE system – used to grow the very thin semiconductor layers.

Similarly in the area of communications, the faster information can be transferred reliably between its source and destination, the lower the transfer cost involved and the higher the overall productivity of those using the information. This explains the move towards higher data rates, higher bandwidths and – inevitably – higher RF carrier frequencies for radio communications. Incidentally it also explains the move to *optical* transmission, using lasers and fibre-optic cables.

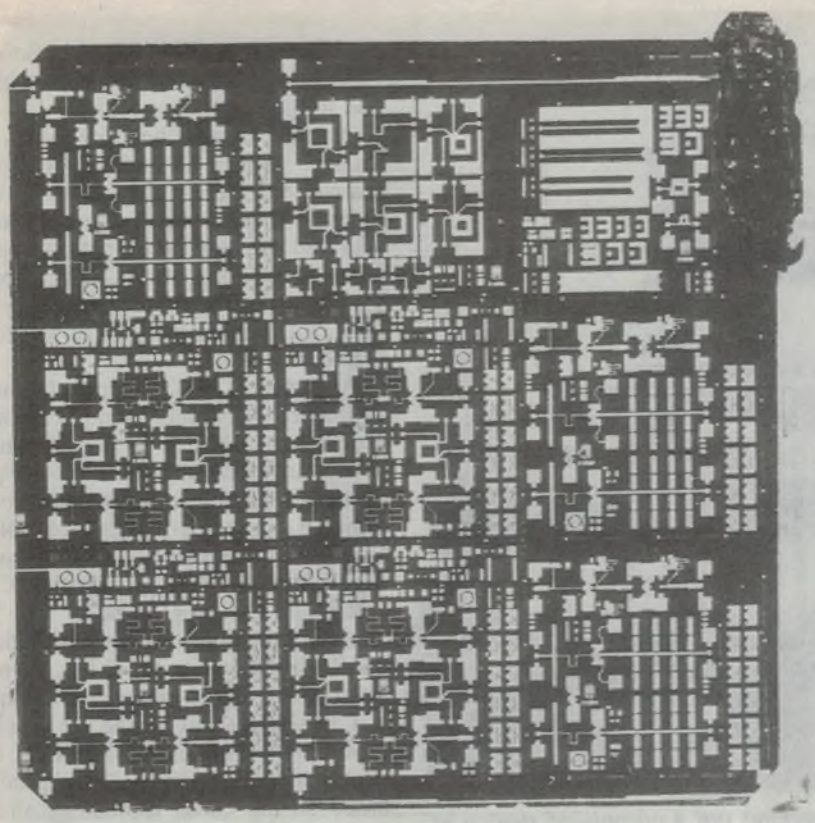
As part of this drive for higher speed and higher frequency operation, researchers around the world have been putting a lot of effort in the last few years into coming up with faster transistors, integrated circuits and other solid-state devices. And one very promising area which has received a good deal of attention is devices based on *gallium arsenide* (GaAs) and related materials, as opposed to the more familiar silicon and germanium devices.

What's the attraction of GaAs? In a nutshell, this 'compound' semiconductor has an energy-band structure which gives a significantly higher *carrier mobility* than for 'elementary' semiconductors like silicon or germanium. For a given applied voltage, conduction electrons achieve considerably higher drift velocities.

Put simply, conduction electrons are able to move about FIVE times faster in GaAs than in silicon, and almost twice as fast as in germanium.

So GaAs devices have the potential to operate at considerably higher speeds and frequencies than those made from silicon. The only problem is that the technology to make GaAs devices is rather trickier than for either silicon or germanium, and has taken rather longer to develop.

Most of the GaAs research work that has been carried out around the world over the last 8-10 years has concen-



A blow-up shot of one of the Group's MMIC test chips, with a number of GaAs circuits based around MESFETs, HEMTs and planar Schottky diodes.

trated on digital applications: producing faster logic gates, gate arrays and processor chips for computers. And of course that remains a major thrust of GaAs technology.

However the other major thrust is in the area of communications, where GaAs devices have the potential to allow operation at extremely high frequencies – well into the hundreds of gigahertz, and probably into the terahertz region as well. In other words, it is basically GaAs that is likely to allow us to bridge the current gap between conventional 'radio' and 'optical' technologies.

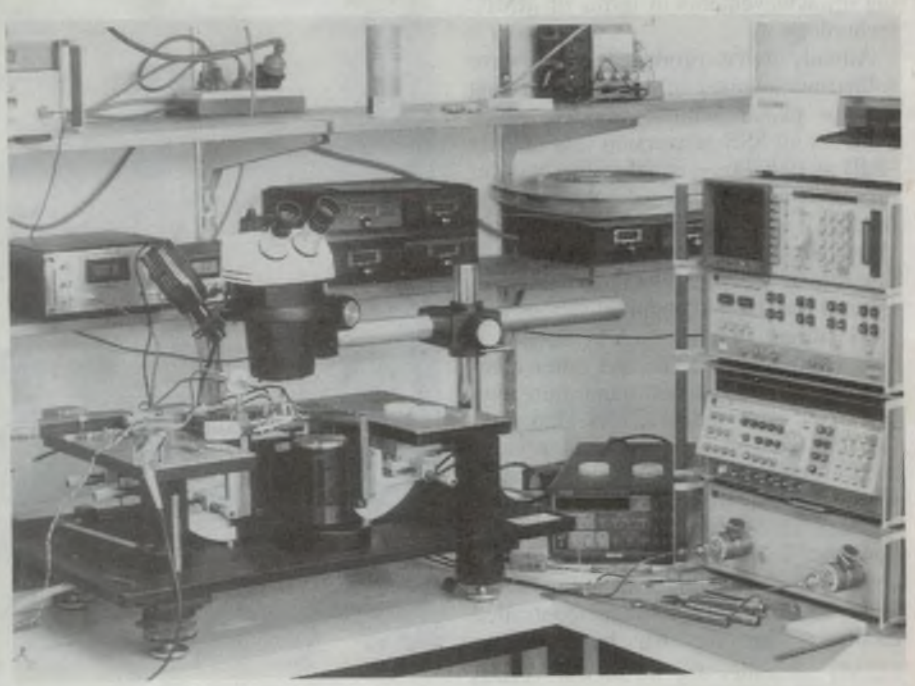
As it happens, about 5 years ago scientists in the Division of Radiophysics at Australia's CSIRO began research work into GaAs device technology, concentrating on 'linear' devices for microwave (3-30GHz) and millimetre-wave (above 30GHz) applications rather than the somewhat more popular digital applications. This has turned out to be a very wise move, because the Division's Solid State Devices Group is now well and truly at the leading edge of this 'hot' technology.

Led by Dr John Archer, the Group is now able to make state-of-the-art FET (field-effect transistor) and standard HEMT (high electron mobility transistor) devices, for example, with cutoff frequencies extending well beyond 100GHz. They can produce HEMT's with noise figures of less than 1dB at 12GHz, and with transconductance levels of no less than 240 millisiemens per millimetre of gate width. This means that for a device with a typical gate width of 1mm, the transconductance is 240mS – or for old timers, 240mA/V (milliamps per volt, or millimho).

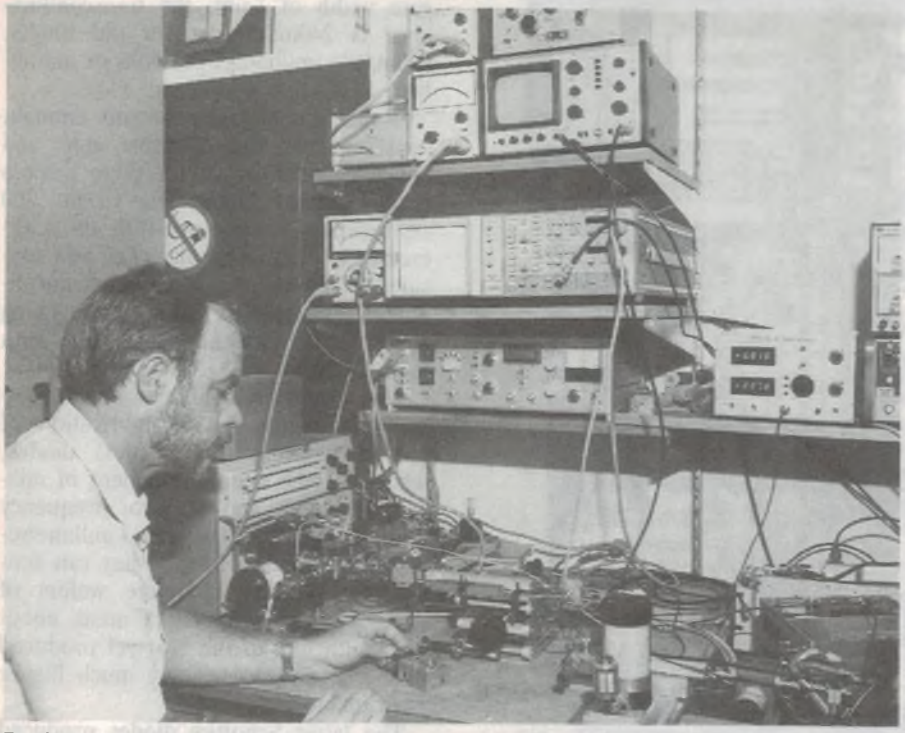
If this doesn't impress you enough, consider that the effective gate and hence channel *length* for these devices is only around 200nm. That's right, 200 *nanometres* – only one-fifth of a micrometre. Not bad at all, when you consider that most of the world's semiconductor foundries are currently struggling to master the fabrication of devices with features of around ONE micrometre!

The Group has also achieved outstanding results in the fabrication of planar Schottky (hot carrier) diodes, which are the main component of mixers, detectors and varactor frequency multipliers at microwave and millimetre-wave frequencies. In fact they can consistently produce complete wafers of these devices with active areas about one tenth that of the best yet produced overseas, and accordingly much higher performance.

The latest Schottky diodes produced at the time of writing have an active area only 2um x 2um, and a calculated cutoff frequency of no less than 10THz. That corresponds to 10,000GHz – making them pretty darn close to a perfect diode at microwave and millimetre-wave frequencies. In terms of performance they beat the pants off the best 'whisker-contact' diodes currently in use.



The Group's HP8510B network analyser and Cascade Microtech microwave wafer probe station, used to check device performance directly 'on wafer'.



Dr John Archer pictured again, this time checking out a completed device at the Group's millimetre-wave testing station.

Of course the ultimate aim is not just to make discrete devices with such blistering specs, but complete 'MMICs' or *microwave monolithic integrated circuits*. And along with the work on discrete devices – which are after all the main 'building blocks' of ICs, in any case – the Group has also been notching up achievements in terms of MMIC technology.

Already it has produced a mm-wave subharmonic mixer MMIC incorporating its new planar Schottky diodes, which achieves an SSB conversion loss of only –8dB at 100GHz – equal to the best yet produced with traditional 'whisker' type diodes. It has also produced a prototype very low noise 2-stage balanced amplifier MMIC for the 12.6GHz 'Ku-band', as used for satellite communications and DBS (direct broadcasting by satellite). This combines HEMTs and other components with compact quadrature hybrids, all on a single GaAs chip, and the final version is expected to achieve a performance target of 12-15dB gain with a noise figure of less than 1dB.

Other HEMT and MESFET (metal-semiconductor FET) based MMICs are already in the pipeline, including a varactor-tuned VCO (voltage-controlled oscillator) for the Ku band and a HEMT amplifier for 40-50GHz. Pretty impressive stuff!

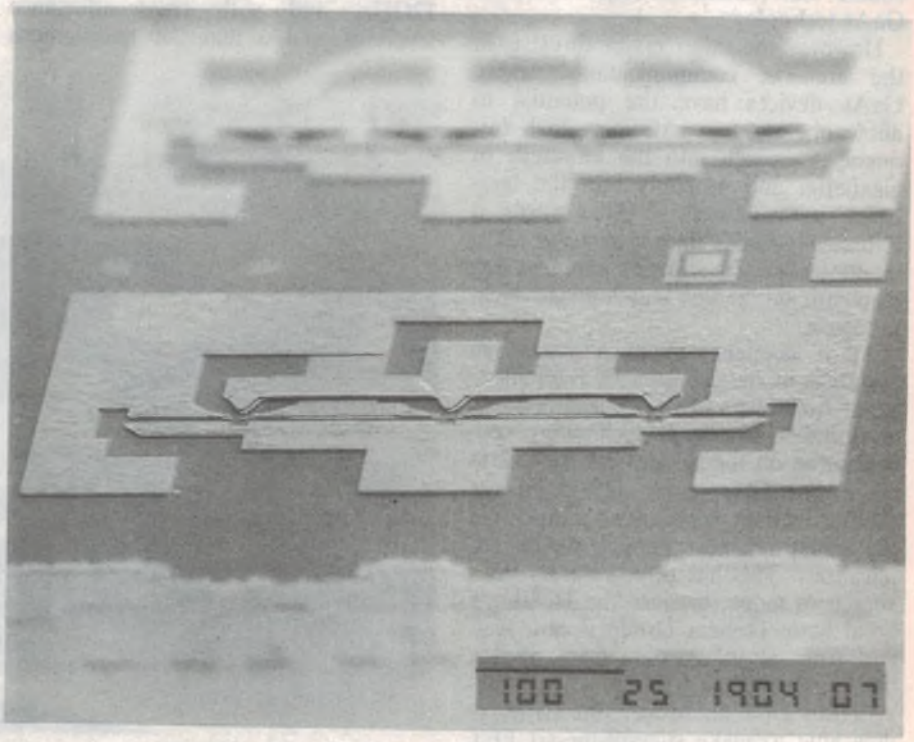
Of course these achievements have not come out of the blue. They represent the product of years of painstaking research – research into the behaviour of GaAs and its related semiconductor materials, research into the operation of and optimum structure for each different kind of device, research into the various kinds of fabrication technology, and so on.

In round figures the CSIRO has now invested around $8 million in this research, and there's still plenty of work to be done. However the results already achieved are now sufficient to support commercialisation, with a view to bringing in a return on the investment to date, and helping to finance future research.

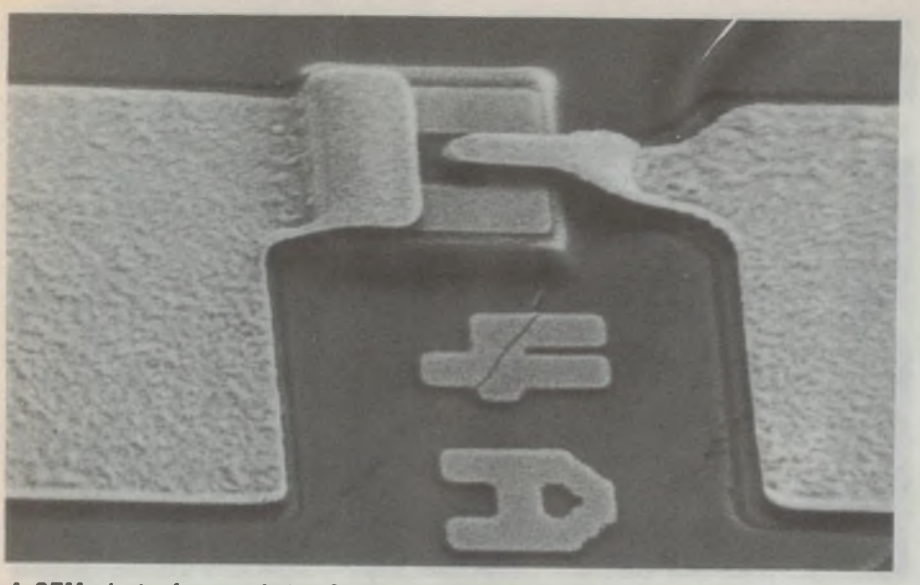
To achieve this commercialisation, CSIRO recently entered into a commercial partnership with Triune Pty Ltd., a newly incorporated Australian company formed especially to undertake production and marketing of GaAs technology. Shareholders in Triune include Muswellbrook Minerals Pty Ltd, First MIC Investments Ltd and Wandoo Pty Ltd. Shares in the company are also held by CSIRO itself, while OTC has been offered equity and is expected to accept.

Both CSIRO and Triune see excellent export opportunities for Australia in a variety of world markets, using products based on the GaAs technology already developed by the CSIRO's Solid State Devices Group.

Triune's managing director and CEO Mr Jim Bettison (co-founder of Codan, and a substantial shareholder of that company) told me that CSIRO and the company have done a careful analysis of GaAs product applications worldwide,



A scanning electron microscope shot of a mm-wave MESFET. The gate electrode is only just visible as a very thin horizontal line across the centre.



A SEM shot of one of the Group's planar Schottky diodes, showing the 'air bridge' connection to the tiny (2um square) top electrode.

and believe they have identified substantial export business opportunities.

"We believe there's a good opportunity to capture a small slice of the European DBS market, for example. But we intend focussing our activities very carefully, so that we establish a solid foundation. We don't have the luxury of throwing in large amounts of money, as you might have in the USA. Even there, some of the firms working with GaAs technology have burnt their fingers, and we believe that's because they lost focus."

Triune aims to set up a local state-of-the-art GaAs fabrication facility in the early 1990's, but in the meantime hopes to subcontract much of the early production work back to the CSIRO. The company is also in the process of setting up strategic alliances with major overseas firms, to establish both international marketing arrangements and product/technology second-sourcing.

Mr Bettison told me he expects to deliver early engineering samples of the company's first devices before the end of this year. These are likely to be discrete devices, such as HEMTs and Schottky diodes.

So the future is looking good, for the establishment of an Australian GaAs industry.

But enough of the commercial aspects, important though they may be. Let's look a little more closely at the technology, to understand how GaAs and its related materials are used to produce solid state devices capable of working at microwave and millimetre-wave frequencies.

First of all, we'll look at the devices themselves.

MESFETs and HEMTs

There have been many different kinds of transistor developed for operation at microwave and millimetre-wave frequencies, but most of the really promising ones are derivatives of the low-frequency field-effect transistor or 'FET', with which many *EA* readers will already be familiar.

In other words, they're three-terminal devices where an insulated electrode called the *gate* is used to control the conductivity of a narrow semiconductor *channel* linking the other two electrodes, the *source* and the *drain*. A control voltage applied to the gate voltage is thus able to control the source-drain current, so that the device has *transconductance* and power gain – just like an old thermionic valve or 'vacuum tube'.

Of course the FETs used at low frequencies are all based on silicon technology, and fall into one of two categories. There's the *junction FET* or 'JFET', and the *metal-oxide-semiconductor FET* or 'MOSFET'.

With the JFET, the gate is simply an adjacent semiconductor region of opposite impurity type to the channel material, and is isolated from it by applying a reverse bias. Control is achieved by varying the reverse bias, which varies the amount by which the gate junction's depletion layer extends into the channel, and hence varies the effective channel width.

The gate of a MOSFET is formed from a layer of metal, deposited on the top of an insulating layer of oxide laid effectively on the top of the source-drain channel. However the control mechanism is much the same, as varying the voltage on the gate electrode is used either to create and vary the width of a depletion layer in the channel, as before (for a *depletion-mode* device), or to induce the creation of carriers in a relatively depleted channel region (for an *enhancement-mode* device).

The equivalent basic GaAs FET device developed for use at UHF and microwave frequencies is the *metal-semiconductor FET* or MESFET, whose contruction is shown in Fig.1. As you can see it is not all that different from a MOSFET, although there are various points which may be noted as we look a little closer.

The active semiconductor region is a layer of lightly-doped N-type GaAs material, typically about 200 nanometres thick before etching. This is grown epitaxially on an undoped GaAs 'buffer layer' about 1um thick, itself previously grown on the basic semi-insulating GaAs substrate. (In case you've forgotten, *epitaxial* growth is where the added material continues and adds to the existing crystal lattice structure.)

A layer of highly doped N-type GaAs is then grown (again epitaxially) on the surface of the active layer, and this time typically only 50nm thick. This is used to ensure that when the metal 'source' and 'drain' contact pads are added at each end of the device, at the top, these form a true *ohmic* connection – i.e., with no appreciable energy band gap. These metal contacts are usually an alloy of gold, germanium, nickel and silver.

In the centre of the device, a narrow trench is etched down through the highly-doped top GaAs layer, and partly into the active layer. It is the thinned section of the active layer remaining under this etched trench which forms the controlled channel. On the top of the exposed surface of the active layer, at the bottom of the trench is deposited the metal gate electrode. This is formed typically from triple layers of titanium, platinum and gold.

Because the active layer is lightly doped N-type material, the interface between it and the metal gate electrode possesses a significant energy band gap. In other words, a non-ohmic metal-semiconductor or *Schottky* junction is formed; and with it a depletion layer is formed in the active channel region – immediately under the gate electrode. So the gate electrode itself forms the gate region of the device.

Varying the voltage on the gate varies the depth of the depletion layer under it as before, and hence the conductivity of the path between source and drain, through the channel.

Note that the highly-doped layer above the active layer effectively extends the source and drain 'contacts' right up to each side of the etched gate trench. So that the effective electrical *length* of the source-drain channel is basically only that of the thinned active layer beneath the trench. And as the gate metal covers all but the very ends of this length, it exercises a high degree of control – despite the short length involved.

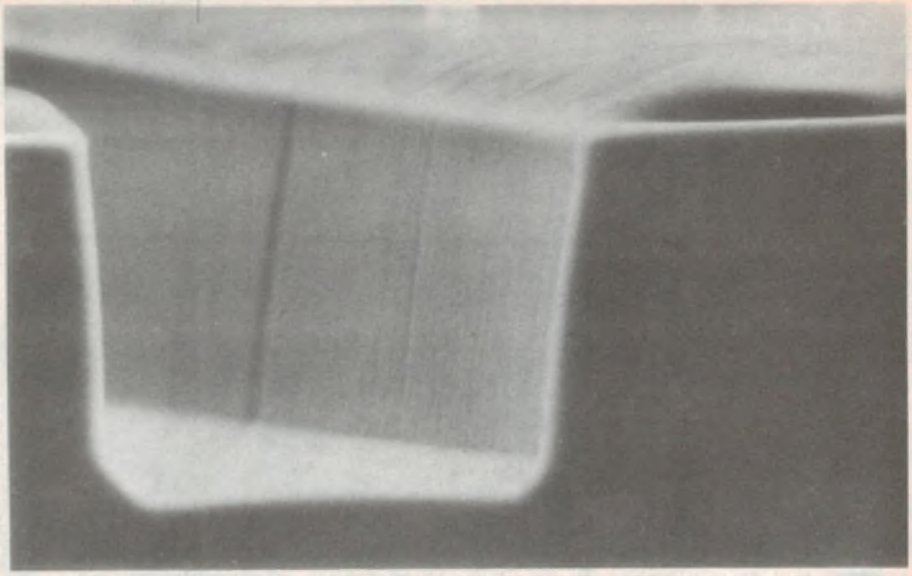
Incidentally just to clarify things (I hope), what you're looking at in Fig.1 is a cross-section of a device that is typically very short in terms of its dimensions along the source-gate-drain axis, called its *length*, but may be quite large (relatively) in terms of its *width* – the dimension along the axis going 'down into the paper' and 'coming out of the paper'.

For the best possible performance at high frequencies, the *length* of the gate and channel must be kept as short as possible – typically less than a micron (micrometre). However for the highest gain and lowest noise figure, the *width* needs to be made relatively large – perhaps as much as a millimetre (1000um). So the active part of a MESFET is very much wider than it is long, with the gate metal laid in a long, very narrow trench whose length forms the effective gate *width*, and whose width determines the gate *length*. This same basic 'extremely short/very fat' physical structure also applies for HEMTs, by the way. In fact externally the two types of device are identical.

If you find the foregoing a bit confusing, a glance at the SEM (scanning electron microscope) photograph of one of CSIRO's MESFETs may make things clearer. The very thin horizontal line in the centre is the gate; its long dimension is the *width*, while its very short dimension is its *length*.

With careful design, MESFETs can give excellent results up to at least 30GHz. They have high transconductance (considerably higher than MOSFETs) and low noise figure. But in order to make them operate much above about 30GHz, the gate length must be reduced to very low sub-micron levels.

The basic reason for this is that, as with MOSFETs and JFETs, the channel of a MESFET contains *fixed donor impurity ions* within its crystal lattice. These are, after all, the added impurity atoms which originally 'donated' conduction electrons to the lattice, to give it enhanced conductivity.



Cross-section of one of the sub-micron trenches etched into a GaAs wafer by the Group, using reactive ion etching. Note the steep sides.

So as the conduction electrons drift through the channel of the device, under the influence of the source-drain voltage and electric field, they have a significant probability of meeting with a donor ion and being scattered by electrostatic forces. The effective drift velocity for a given field intensity – in other words, the *carrier mobility* – is therefore limited, and this sets a limit to the frequency at which the transistor can operate.

Here's where the HEMT or *high electron mobility transistor* comes in. Another name that has been used for the HEMT is the MODFET, or 'modulation-doped' FET.

The basic structure of a HEMT is shown in Fig.2. As you can see it is externally very similar to the MESFET, although inside there is an important difference.

In place of the lightly doped GaAs active layer of the MESFET, there is now two rather thinner layers, both formed not from GaAs but from *aluminium gal-*

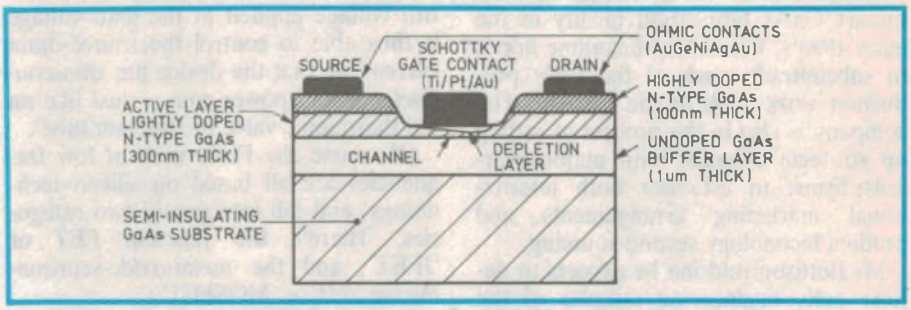


Fig.1: The basic construction of a GaAs MESFET device. Its operation is explained in the text.

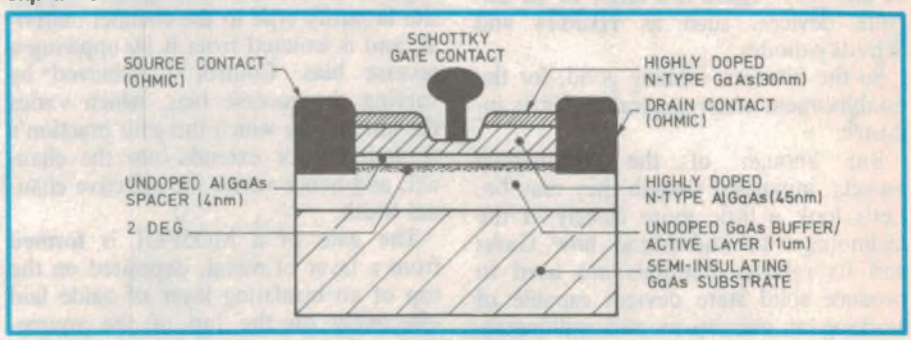


Fig.2: Construction of a standard high electron mobility transistor, or HEMT, which conducts via a two-dimensional electron gas or '2 DEG'.

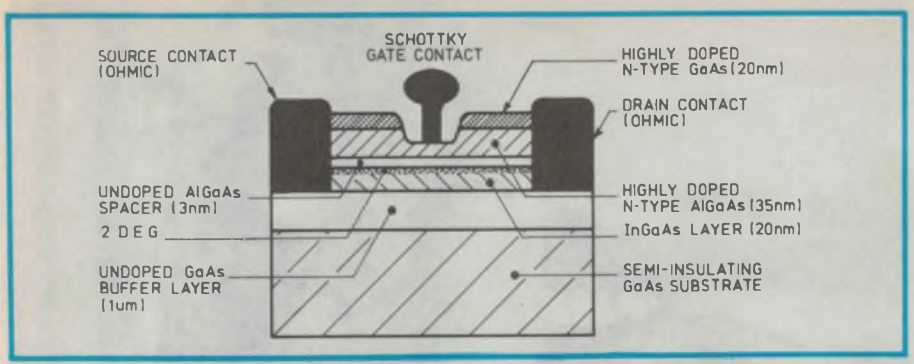


Fig.3: Construction of a 'pseudomorphic' HEMT device, which achieves operation at even higher frequencies than the standard HEMT.

lium arsenide – AlGaAs. The upper layer is of highly doped N-type material, about 45nm thick, with a very thin (typically only 4nm) 'spacer' layer of undoped AlGaAs below it and above the undoped GaAs buffer layer.

Now the effect of the highly doped AlGaAs layer is quite interesting. Because AlGaAs has a high energy-band gap compared with the undoped GaAs of the buffer layer, a conduction band 'step' or discontinuity is formed at the junction. And the effect of this step is that virtually all of the 'free' conduction electrons in the heavily doped AlGaAs layer move through the spacer layer and 'fall' into the undoped GaAs buffer layer, where they are trapped.

What happens, because of the crystal's energy band profile, is that these electrons congregate in a thin 'potential well', just inside the undoped GaAs. The well is typically less than 5nm wide, and very near the junction with the AlGaAs.

Now although these electrons become trapped in the vertical direction, it turns out that they can move exceptionally easily in the horizontal plane. This is because there are virtually no impurity ions in the undoped GaAs layer where they now find themselves, so that they e erience virtually no scattering.

ı fact the electrons have a much g ıter *horizontal mobility* than in the doped GaAs which forms the channel of a MESFET, and can mover much faster. They form what scientists call a *two-dimensional electron gas*, or '2 DEG'.

It is actually this 2 DEG which forms the conducting channel of the HEMT. As you can see from Fig.2, the metal source and drain contacts are taken right down into the undoped GaAs buffer layer, where they can directly contact the ends of the 2 DEG itself. In addition the highly N-type GaAs layer at the top forms an extension of the source and drain electrodes as before, which also allows electrons to move into and out of the 2 DEG vertically, by tunnelling through the AlGaAs layers.

Varying the voltage on the gate electrode allows control as before, in this case by varying the profile of the energy-band well which maintains the 2 DEG in the undoped GaAs buffer layer, in the region immediately below the gate. Increasing the negative voltage on the gate gradually 'lifts the bottom of the well' in the centre of the layer, allowing the electrons to diffuse away into the buffer layer and reducing the conductivity of the 2 DEG channel. Conversely reducing the gate bias deepens the well and improves the vertical confinement of the 2 DEG, increasing its conductivity.

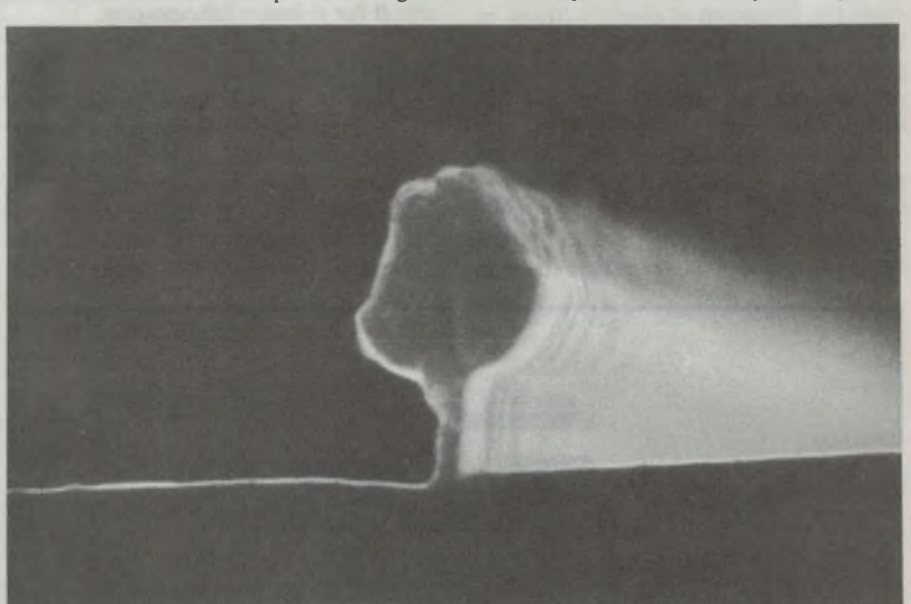
Because of the much greater mobility of the electrons in the HEMT's 2DEG, this device has significantly greater transconductance, lower noise and higher cutoff frequency than a MESFET of comparable gate length. Hence the kind of performance figures given earlier for the CSIRO devices: transconductance around 240mS per mm of gate width, noise figure of better than 1dB at 12GHz, and a cutoff frequency of well beyond 100GHz, with a gate length of around 200nm.

As you can see, the basic secret of the HEMT's superior performance is that it effectively uses an AlGaAs/GaAs *heterojunction* to separate the conduction electrons from the donor atoms (now ions) which introduced them to it. By shifting the electrons to the impurity-free undoped GaAs, and 'marshalling' them into a 2 DEG, they are able to move almost as freely as if they were in a vacuum – in the horizontal plane, at least. And that's all we need, for device operation.

Note that Fig.2 shows the gate metal formed into a 'T' or 'mushroom' cross section. This is in fact the kind of gate electrode used nowadays for both HEMTs and MESFETs, and the reasoning behind it is that the electrically effective bottom part of the gate needs to be extremely short, in the source-drain 'length' direction, for best high-frequency performance of the transistor.

However making good external contact to such a short gate can be a problem, even though it may be quite 'wide'. The resistance of a strip of metal only 200nm thick can be quite appreciable, and this tends to introduce series gate resistance – which degrades performance, especially at the higher frequencies. By fattening the gate metal at the top, this series resistance is reduced without affecting the device's internal operation.

The top dimension may be typically



Scanning electron microscope shot showing the cross-section of one of the Group's gate electrodes. The wide 'mushroom' at the top is about 0.7um wide (long), and the base only 0.1um. The latter is the effective gate length!

around 800-900nm, considerably wider (sorry – longer!) than the gate's effective length at the bottom.

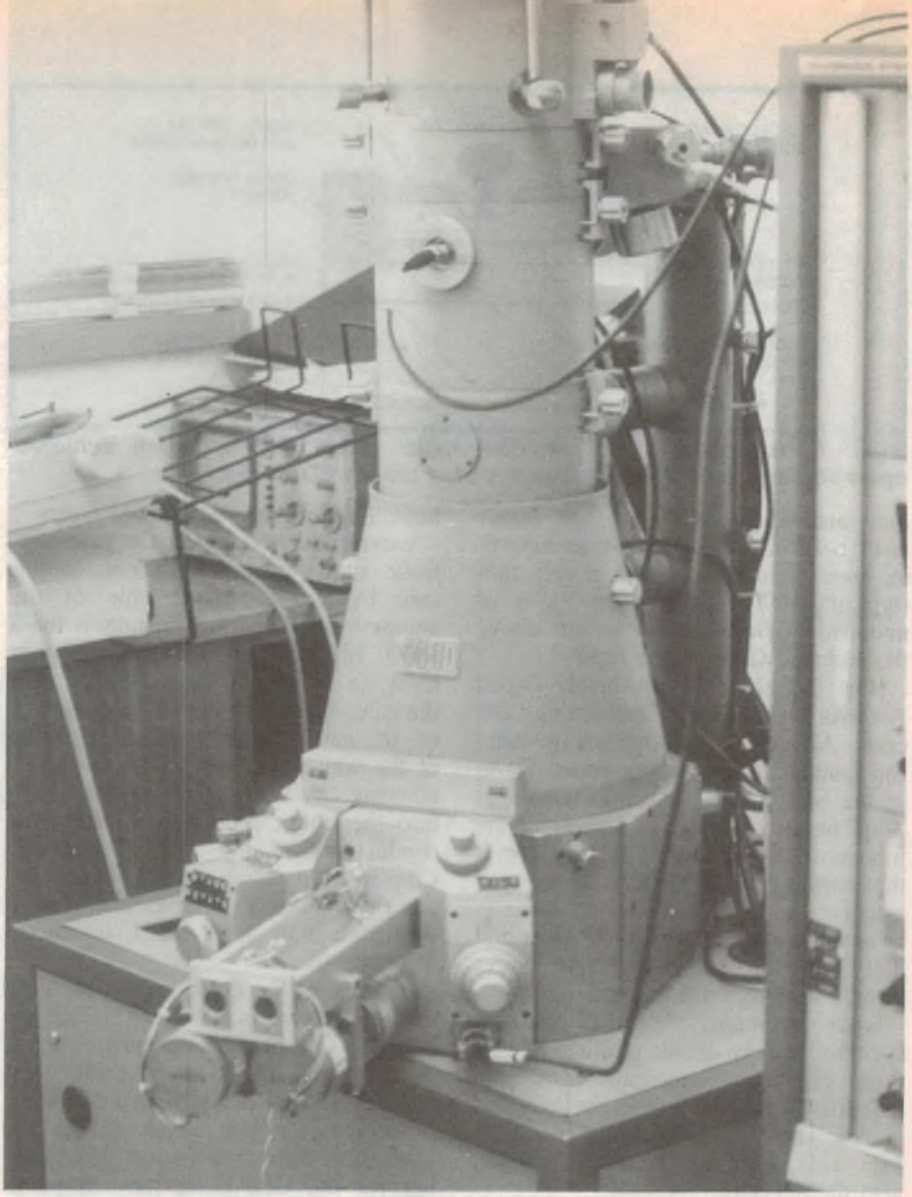
Note also that although the gate trench is shown somewhat wider (longer!) in Fig.2 than the metal gate contact, in practice the trench has quite steep sides and is only very slightly longer than the gate itself. Again this is to achieve the shortest possible channel length, and best device performance. This again also tends to apply for practical MESFETs.

Before we leave HEMTs, I should perhaps mention a rather newer and enhanced form of this device again, which is currently under development. This is the *pseudomorphic HEMT*, whose structure is shown in Fig.3.

The pseudomorphic HEMT is generally rather similar to the 'standard' HEMT, as you can see, except that it has an additional layer again. This is a layer of *indium gallium arsenide* (InGaAs), below the undoped AlGaAs spacer layer and above the undoped GaAs buffer layer. The new layer is typically only around 20nm thick – still quite thin.

The basic idea of this device is that instead of forming in the undoped GaAs buffer layer, the 2 DEG is now formed in the InGaAs layer instead. It happens that InGaAs has a lower bandgap than GaAs, allowing the use of a form of AlGaAs with a lower proportion of aluminium, in the 'carrier donor' and spacer layers. And this in turn prevents the formation of electron 'traps' in the AlGaAs, particularly at lower temperatures where theory suggests that the performance of HEMTs should be dramatically better than MESFETs.

Results so far achieved with pseudomorphic HEMTs suggest that these devices may well be able to perform considerably better again than standard HEMTs, and extend operation to even higher frequencies.



The Group has modified a standard scanning electron microscope (SEM), to use it for E-beam lithography.

Where does that name 'pseudomorphic' come from? Well, the natural crystal structure of InGaAs is rather different from that of GaAs, whereas that of AlGaAs is almost exactly the same. As a result, while layers of AlGaAs can be epitaxially grown on the GaAs lattice without any significant distortion, a layer of InGaAs grown on GaAs has its own structure unnaturally compressed, in order to match that of the GaAs.

In fact this forcing of InGaAs into the GaAs lattice structure is only possible for a thin layer of the InGaAs – if you try to make it thicker, it will start reverting to its own structure or *morphology*. That's not a problem here, because the InGaAs layer is only 20nm or so thick, and for this kind of thickness the distortion is within the InGaAs crystal's 'elastic limit'.

This kind of semiconductor layer, which has distorted its structure to 'mimic' that of another lattice – here the GaAs – is known as a *pseudomorphic* layer. Hence the name of the device.

A final comment before we leave MESFETs and HEMTs: Dr Archer and his CSIRO team have been able to mas-

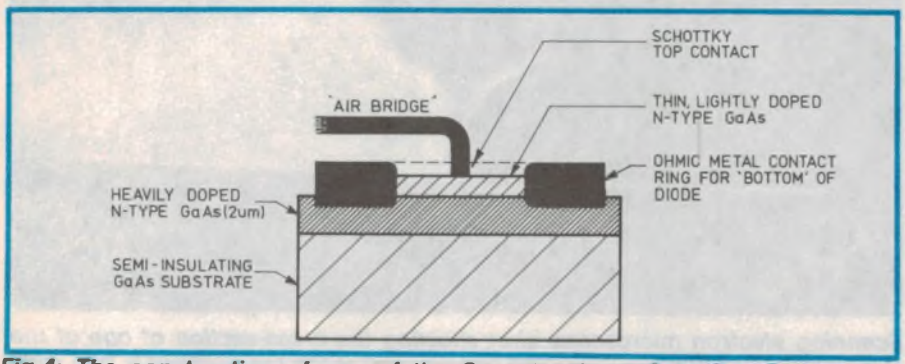


Fig.4: The construction of one of the Group's planar Schottky diodes. The 'business' end of the top contact measures only 2um square.

ter the technology of producing these state-of-the-art devices because they've spent a lot of time and effort analysing exactly how they work. In fact they've been able to clear up a number of previously-held misconceptions regarding the quite complex operation of these devices, and this is one of the Group's major achievements.

Schottky diodes

The structure being used by the Group for its millimetre wave planar Schottky diodes is shown in the second SEM photograph, and also in Fig.4.

As with the HEMTs and MESFETs, the diodes are grown on a semi-insulating GaAs substrate – in other words, one that is very lightly doped. In this case a layer of heavily-doped N-type GaAs is grown on the substrate first, about 2um thick. Then on top of this is grown a very thin and lightly doped N-type layer, which forms the active part of the device.

A rectangular 'ring' electrode is added around the active device area, extending down into the heavily-doped layer so that it makes a good ohmic connection to this layer all around the device. This is basically because the heavily-doped layer becomes the bottom internal connection for the diode.

The 'top' metal electrode is finally added, with an integral 'air bridge' connecting it to a metal bonding pad nearby (but outside the bottom contact ring, as seen in the SEM picture). The end of the top electrode is deposited directly onto the surface of the lightly-doped top GaAs layer, and as a result of the conduction band step between the metal and semiconductor, a Schottky junction is formed.

The active area of the resulting 'vertical' Schottky diode is effectively just the 2um square section immediately below the top electrode, with a very short conduction path down through the thin lightly-doped GaAs layer to the heavily-doped bottom electrode. And the air bridge in series with the top electrode is very short, so that the overall series impedance of the diode is very small.

It is this very low series impedance, coupled with the low capacitance of the 2um-square junction, which gives the Group's Schottky diodes their exceptionally high performance. And one of the secrets of this achievement is that *air bridge* connection. In fact the Group is a world leader in this technology: producing tiny metal connections which bridge air gaps to provide microscopic 'flyovers' on the surface of a chip.

Similar kinds of air bridge are used in the Group's HEMTs and MESFETs, to achieve multiple parallel connections to the gate electrode. Three such air-bridges are visible in the SEM photo of a MESFET, in fact – one right in the centre, and the other two along to the left and right towards each end.

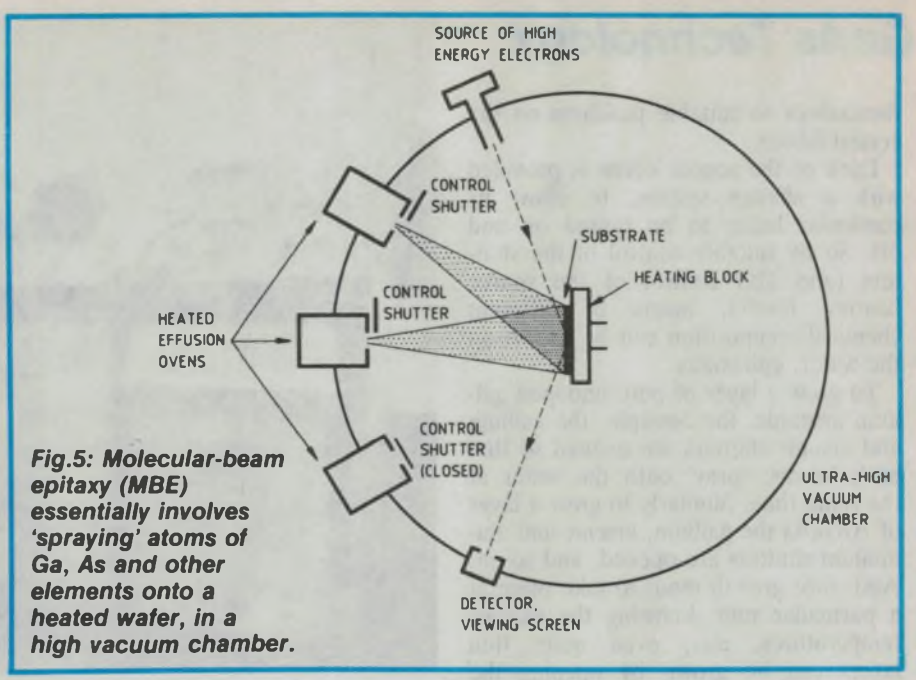


Fig.5: Molecular-beam epitaxy (MBE) essentially involves 'spraying' atoms of Ga, As and other elements onto a heated wafer, in a high vacuum chamber.

New fab gear

One of the things you've no doubt noticed, in the foregoing description of the devices themselves, is that they involve various layers of crystal – some of which are very thin indeed. Just how thin becomes apparent when you consider that a single layer of gallium and arsenic atoms is 2.82 angstroms thick. This is just under a third of a nanometre, so you can see from Figs.1-4 that some of the layers we've been talking about are not many atomic layers thick!

The other thing you may have noticed is that production of MESFETs and HEMTs involves etching of very small (sub-micron), narrow and quite steep-sided trenches, into the surface of the crystal wafers. It also involves depositing metal electrodes into those trenches, again with sub-micron dimensions and with a 'mushroom' profile.

None of these processes is really within the capability of standard semiconductor fabrication process equipment, as used for silicon devices. So in order to produce these esoteric devices it has been necessary to take advantage of new kinds of processing equipment, and master the techniques concerned.

In a tour of the Solid State Group's labs I was able to see this equipment in operation, and find out a little of how it all works. Here's what I found:

Growing the layers

First of all, the process needed to grow those special highly-controlled layers of crystal is called *molecular beam epitaxy*, or 'MBE' for short. And the impressive looking machine with which it's done is called an MBE system.

As you can see from the picture, the Group's MBE system is a pretty impressive beast. It's one of only two such machines in Australia, and together with its control equipment and support plant it fills most of a large laboratory.

Although it looks extremely complicated (and is!), this is mainly because all of the 'works' must be enclosed in an ultra-high vacuum chamber. So a lot of the machine consists of air locks, high-vacuum valves and seals, and mechanisms to manipulate the GaAs wafers and move them from one chamber to another inside the high-vacuum areas. There are also various kinds of pumping systems, to establish and maintain the ultra-high vacuum in the main growing chamber.

Deep inside the machine, though, what essentially happens is that a wafer of GaAs substrate is rotated on a heating block. Facing it are a number of *effusion ovens*, each containing a heated source of an element such as gallium, arsenic, aluminium, indium, silicon or whatever – see Fig.5.

The basic idea is that atoms are 'boiled off' the surface of the various sources, and the free molecules produced tend to travel through the vacuum as a 'beam', ultimately reaching the GaAs wafer where they attach

themselves to suitable positions on the crystal lattice.

Each of the source ovens is provided with a shutter system, to allow its particular beam to be turned on and off. So by suitable control of the shutters (and also control of the source heating levels), layers of different chemical composition can be grown on the wafer, epitaxially.

To grow a layer of pure undoped gallium arsenide, for example, the gallium and arsenic shutters are opened so that both beams 'spray' onto the wafer at the same time. Similarly to grow a layer of AlGaAs the gallium, arsenic and aluminium shutters are opened, and so on. And since growth tends to take place at a particular rate, knowing the various temperatures, etc., even quite thin layers can be grown by opening the right shutters for the appropriate length of time.

Of course it isn't quite as simple as this. The beam flux densities must be carefully adjusted to certain ratios, in order to ensure that the layer concerned has the correct chemical composition. The proportions of gallium and arsenic in the crystal can vary slightly from the optimum, and care must be taken to produce the correct balance.

Happily GaAs itself isn't all that critical, it seems. Arsenic atoms won't 'stick' to the wafer's surface unless there are free gallium atoms already there, so correct growth of new GaAs tends to occur as long as there's a surplus of arsenic. But other compounds are rather more critical.

As Dr Grant Griffiths, the Group's MBE crystal growing expert explained to me, there's also a handy technique that is used to monitor the growth of crystal layers in the MBE system. This is known as *reflection high energy electron diffraction*, or 'RHEED' for short. And as the name suggests, RHEED uses a narrow beam of high-energy electrons, which are directed at the surface of the wafer in the growth chamber – at a very low angle as shown in Fig.5. Typically the angle is only about 2° to the wafer surface.

The idea is that to the electron beam, the surface of the wafer is anything but 'hard' and 'smooth'. In fact, the electrons see the crystal as an array of atoms – a bit like rows of soldiers on a parade ground. As a result, the beam is both *reflected* and *diffracted* from the surface.

Before growing begins, the surface is relatively smooth and there is a certain ratio between the *specular* (reflected) and diffracted beam components. However during the actual MBE growth, with atoms busy sticking to the surface in random fashion, the wafer surface becomes rather 'rough' – at the microscopic level, of course. As a result, the intensity of the specular beam tends to decrease to a minimum, until each growing layer of atoms is 'half full', and then increase to a maximum again as it fills right up.

By arranging a detector system and viewing screen at the specular reflection point, as shown in Fig.5, this changing intensity of the beam can be seen and monitored.

In fact what happens is that the beam intensity rises and falls in virtually sine-wave fashion, with each 'cycle' of the RHEED beam's 'oscillations' corresponding to the growth of another crystal layer. This makes it possible to count the precise number of molecular layers that have been grown.

In basic terms at least, then, that's how all of those fancy layers of GaAs and other materials are grown. Now let's look at the way those very fine trenches are etched in the resulting crystals.

E-beam lithography

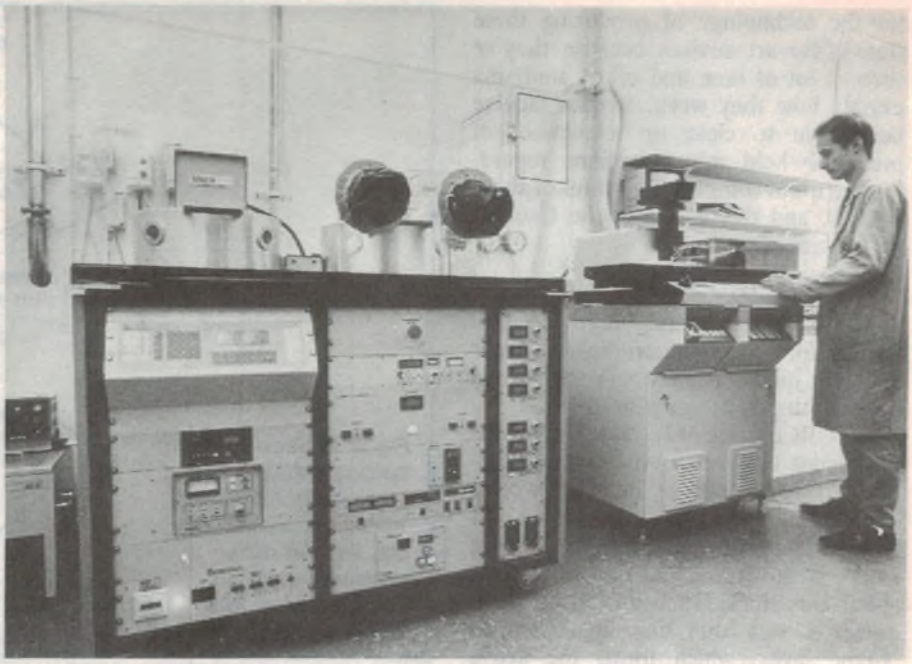
During the manufacture of transistors, ICs and other semiconductor devices, it is obviously necessary to remove unwanted material in some areas and deposit new material in others. This is done by using extremely fine templates or *masks*, to guide and control etching and depositing processes. The production of these highly accurate masks is known as *lithography*.

The traditional way of producing the masks is by optical reduction printing – rather like a photographic enlarger in reverse, although generally using a single wavelength of ultra-violet light. However as the size of devices has fallen, this technique has been pushed to its limits.

One technique has been to use double reduction: one to produce the master masks themselves, say 5 times larger than the final size, and then the second reduction to print from them onto the prepared wafers. Another approach is to prepare the masks using high-energy electron beams, and then reduction print from these down onto the wafers.

However to produce the kind of super-fine masks needed for the microwave and millimetre-wave devices that the CSIRO Group has developed, even these techniques are simply not good enough. The only real approach is create the masks directly on the surface of the wafers themselves, using an electron beam: *direct E-beam lithography*.

Specialised E-beam masking machines have in fact been available for a few years now, but at a rather daunting price – around $3 million. Because the CSIRO didn't have this kind of money, the Group had to work out another way of achieving the same result for less outlay.



The Group's RIE/PECVD plasma etching and deposition system, left and centre, with its wafer dicing saw in use at right.

With hindsight this was probably a good thing, because they came up with a way to do the job using an adapted second-hand SEM (scanning electron microscope), at a fraction of the cost. Just another of their achievements, along the way!

Plasma etching

Once the masks have been created on the surface of the wafers, frequently one of the next steps is to etch away the unwanted material exposed.

The traditional way to perform this etching is to do it chemically, using a liquid etchant. However this type of etching is *isotropic*; in other words it has no preferred direction. As a result the etching tends to 'undercut', removing material from underneath the sides of the mask. This makes it quite unsuitable for etching trenches and other details considerably smaller than a micron, as are needed for devices like MESFETs and HEMTs.

To achieve the much finer details that are needed for these devices, various kinds of *dry etching* process have been developed. Basically these work by using an excited plasma to carry atoms of the etchant or 'reactive species' (in the form of a gas) to the wafer surface, and impart energy to assist in the etching reaction. This results in very directional or *anisotropic* etching, with very little undercutting.

The kind of etcher used by the CSIRO Group places the wafer between two horizontal electrodes in a vacuum chamber, and sets up a low-voltage RF discharge between the electrodes. A separate chamber of the same machine can also be used for depositing material onto the wafer surface, again with the assistance of a plasma, so it is called a *reactive ion etch/plasma-enhanced chemical vapour deposition system* or 'RIE/PECVD' for short. The etching occurs at quite low pressures – between 2 and 10 millitorr.

In addition to this fairly esoteric fabrication equipment, the Group also has conventional mask alignment, metallisation, bonding and packaging equipment. It has also combined a Hewlett-Packard HP8510B network analyser with a Cascade Microtech microwave wafer probe station, allowing the microwave performance characteristics of both discrete and integrated devices to be measured 'on wafer' – without even having to separate and package them.

For testing devices at millimetre waves there's also a comprehensive mm-wave test station, complete with the appropriate test instruments and test jigs connected up via tiny mm-waveguide 'plumbing'.

All in all, the Group's facilities are most impressive, although it's fairly obvious that everything has been done on a tightly controlled budget, with initiative and creativity taking over where dollars were running thin. Of course this makes the Group's achievements even more impressive, knowing they've been achieved with rather fewer resources than would probably be available overseas.

It's great that their work to date looks set to make a significant impact on the world semiconductor scene, and hopefully on Australia's balance of payments as well. With a bit of luck, this will also result in additional funds to provide the resources for future phases of this important research.

I hope this article gives you an insight into the work of the CSIRO Solid State Devices Group. My grateful thanks to Dr John Archer, Mr Bob Batchelor and Dr Grant Griffiths for their time and patience in helping with its preparation. EA

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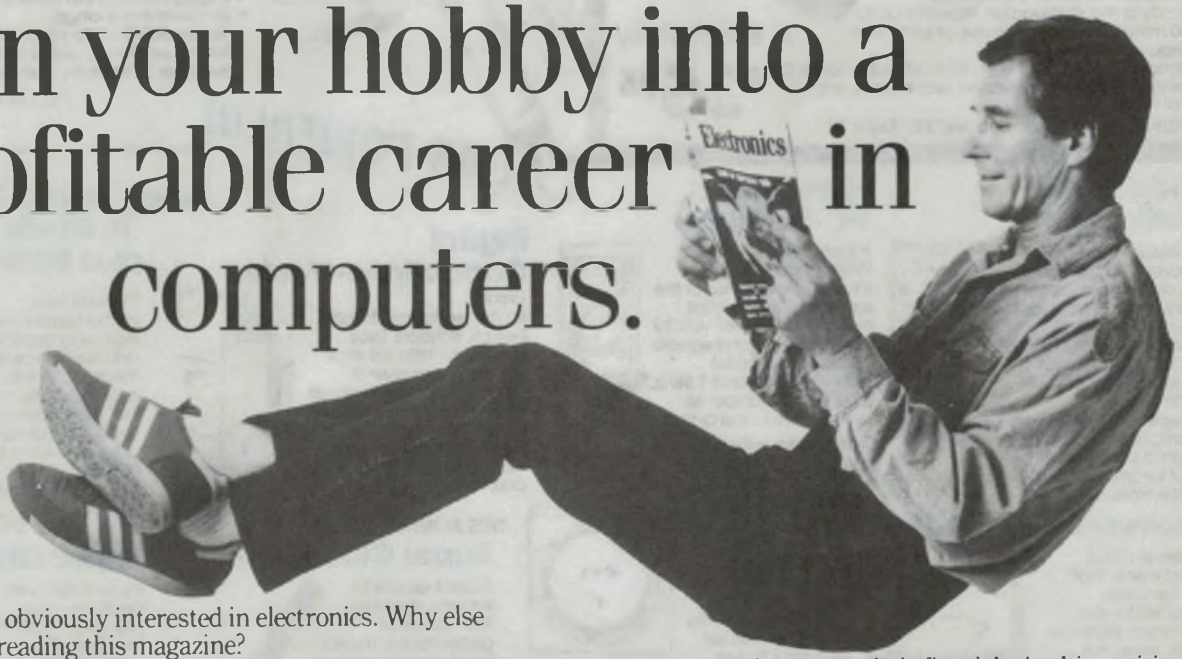

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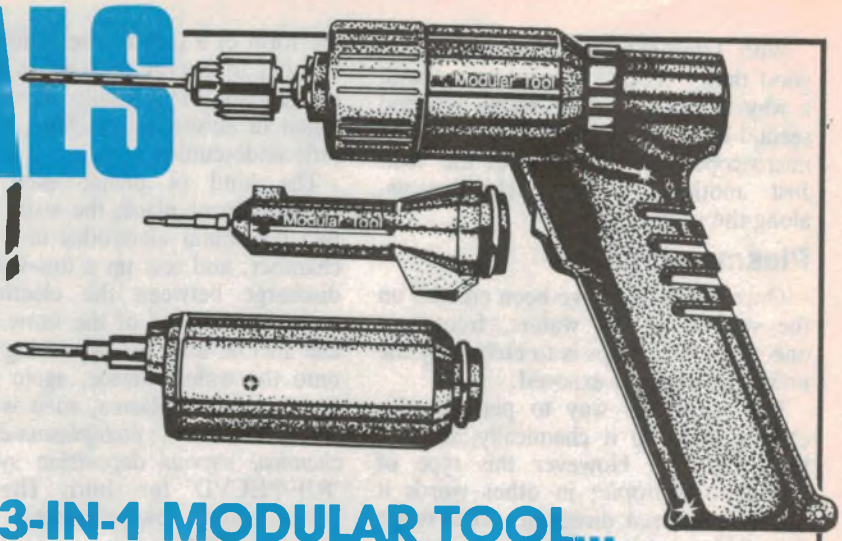

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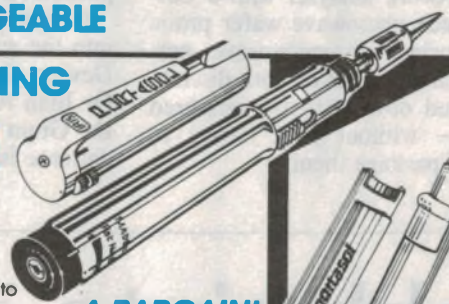

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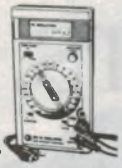

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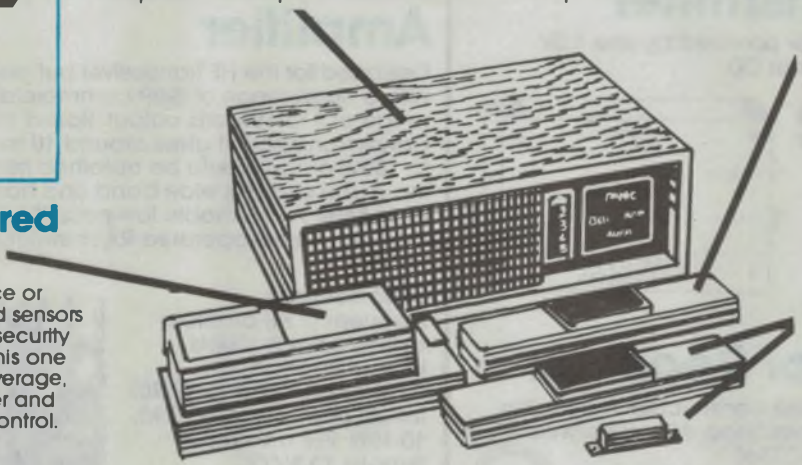

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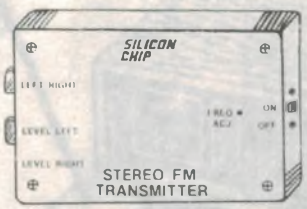

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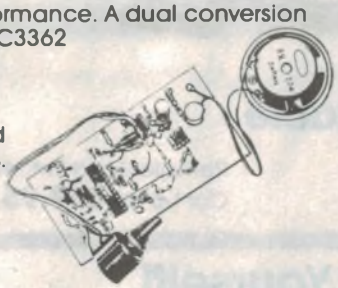

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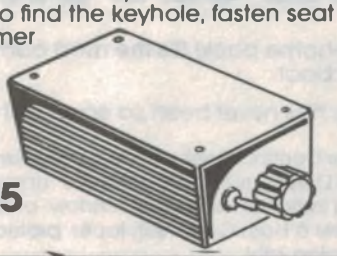

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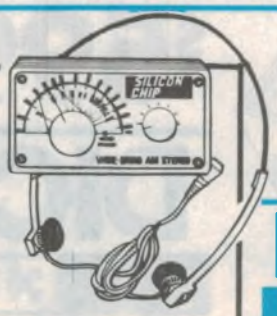

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Power Supplies & Chargers

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Just right for CB's, car radio/stereo's, small amateur transceivers (hand-helds especially), etc. 12 volts DC regulated with terminals for easy connection. Makes a great service supply, too. Cat M-9545

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The high power Panther. With a 3 amp continuous (or 4A continuous at 75% duty cycle!) and a huge 8 amp instantaneous peak rating, it's deal for those higher current and higher peak demand applications. Cat M-9547

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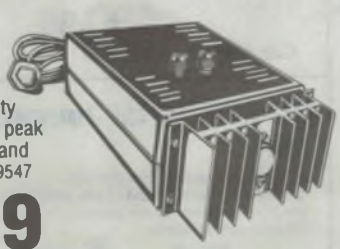

3-6-9-12V DC @ 1 Amp

Invaluable around the home or workshop. It will gives a maximum of 1 amp at 3, 6, 9 and 12 volts DC. Simply plugs into 240V AC power socket - DC connections via screw terminals on front of unit. Ideal for use with alarm systems, intercoms, etc. Cat M-9530

$29.95

Car Voltage Converter

6, 7.5 and 9 volts output at 800mA

Most battery devices include an external DC connection. Use them in the car from your car battery via this voltage converter. Suitable for high current device, simply plugs into cigar lighter. Cat M-9584

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12V AC @ 500mA

Ideal power supply for projects that require 12V AC at 500mA. Because the whole of the plug-pack is a transformer, you get a much higher current rating than other plug-packs. Cat M-9555

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NiCad Batteries

Save with these quality NiCads. There's one to suit most applications.

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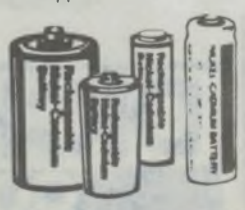
'C'	(1.2 Ah)	S-3301	$9.95
'C'	(2.0 Ah)	S-3311	$11.95
'D'	(1.2 Ah)	S-3303	$9.95
'D'	(4.0 Ah)	S-3310	$14.95
9 Volt	(Varta)	S-3308	$19.95



AC Supply 16V 900mA

The biggest problem with most projects is fitting in the transformer! This one obviates the problem - keep the supply components inside, but the plug-pack hangs on the power point! With a very healthy 16V at 900mA. It's perfect for 12 volt DC supplies. Energy authority approved. Cat M-9567

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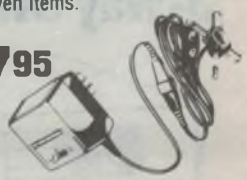
$17.95



9V DC @ 200mA

For all equipment requiring 9V DC at a 9V transistor type battery or many other static hobby models that require 9V. Eliminator modules simply plugs into a 240V AC power socket. Cat M-9514

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3-4.5-6-7.5-9-12V @ 300mA

An extremely versatile supply ready for just about any application. Switchable output gives 6 different voltages ranging from 3V to 12V, at up to 300mA. Cat M-9526

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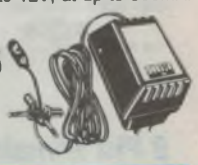

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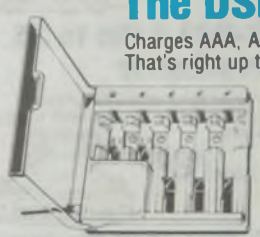
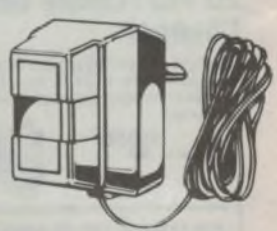
For high capacity NiCads Cat M-9506



NiCad Charger

Most devices these days allow for an external charger to be plugged in to charge NiCads (usually a 2.5mm socket). This charger is ideal for all NiCad packs from 6 to 10 cells (ie 7.2 to 12 volts). Fully approved by Electricity Authority. Cat M-9517

$17.95



DICK SMITH ELECTRONICS

YOU'LL NEED OUR INPUT

RS-232 Serial Breakout Box

A complete in-line tester/adaptor which makes complex and time consuming Serial connections a breeze. Comes with 25 pin male connector at one end and 25 pin female connector at the other. With jumper pads and wires, as well as 24 in-line swtches, for quick selection for any RS-232 configuration. The tester itself has 8 bi-colour LED's which monitor the lines and tell you at a glance when you've got it right.

Cat X-2654 **$49.95**

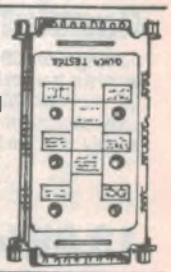
RS-232 Serial 9 Line Tester

An easy to use line tester with 25 male and 25 pin female connectors. 18 bright LED's monitor the lines so you'll know immediately where the problem lies. A great time and headache saver!

Cat X-2650 **$19.95**

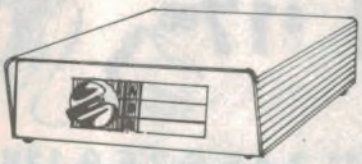
RS-232 Quick Tester

An in-line tester which has both 25 male and 25 pin female connectors. Three switches and 6 LED's allow quick selection for the most popular RS-232 configurations. You simply set the switch to select the connection you need.



Cat X-2652 **$39.95**

3-Way Switch Boxes



A great idea! The switch box allows the switching of a common input or output to any one of three other devices. All lines are switched. Ideal for sharing a printer or modem with more than one computer or connecting several printers to one Centronics port.
25 Pin With DB25 Connectors. Cat X-3575
36 Pin With Centronics Connectors. Cat X-3576

$49.95

9 Pin Male Gender Changer

An in-line gender changer which has DE9 male connectors at each end. Changes the gender of a plug or connector from female to male.

Cat X-2657 **$9.95**

9 Pin Female Gender Changer

Just like the male gender changer above, except this one has DE9 female connectors on each end.

Cat X-2656 **$9.95**

25 Pin Male Gender Changer

Changes the gender on any 25 pin plug from female to male. DB25 male connectors at each end. Wired pin for pin.

Cat X-3565 **$9.95**

25 Pin Female Gender Changer

Changes the configuration of any 25 pin male connector to 25 female. DB25 female connectors at each end. Wired pin for pin.

Cat X-3566 **$9.95**

RS-232 25 Pin to 9 Pin Adaptor

A line adaptor with DB25 pin female connector one end and DE9 male at the other.

Cat X-2661 **$9.95**

RS-232 9 Pin to 25 Pin Adaptor

In line adaptor with DE9 female connector one end and DB25 male at the other.

Cat X-2660 **$9.95**

RS-232 Null Modem Adaptor

With DB25 connectors at each end. Wired for full handshaking. Allows the connection of two computers 'back to back'.

Cat X-2664 **$9.95**

RS-232 Serial Jumper Box

25 pin male and 25 pin female connectors. With jumper pads and wires which allow permanent soldering for RS-232 connections.

Cat X-3569 **$9.95**

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A 2 metre extension cable with 9 pin 'D' connectors that allows you to distance monitor and CPU.

Cat X-2602 **$12.95**

Centronics Printer Cable

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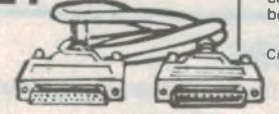
Cat X-8614 **$24.95**

25 Pin M/M Serial Cable

For serial port connection, fitted with 25 PIN male 'D' connectors. All lines connected straight through.

Cat X-3574 **$24.95**



25 Pin M/F Serial Cable

Cable fitted with 25 female and 25 pin Male 'D' connectors on either end. All lines connected straight through.

Cat X-3564 **$24.95**

9 Pin(F) - 25 Pin(M) Serial Cable

Ideal for modem connection to 9 Pin Serial port. Fitted with DE9 female connector one end and DB25 male connector at the other.

Cat X-8007 **$24.95**

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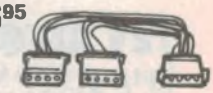
A great idea! This "Y" adaptor allows you to connect two disk drives to one power connector. Splits a 4-line Molex male into two females.

Cat X-2604 **$6.95**



Floppy IDC Universal Data Cable

A floppy drive data cable which is fitted with both Edge and DIL socket connectors. Facilitates the easy fitting of both 5.25" and 3.5" floppy disk drives.

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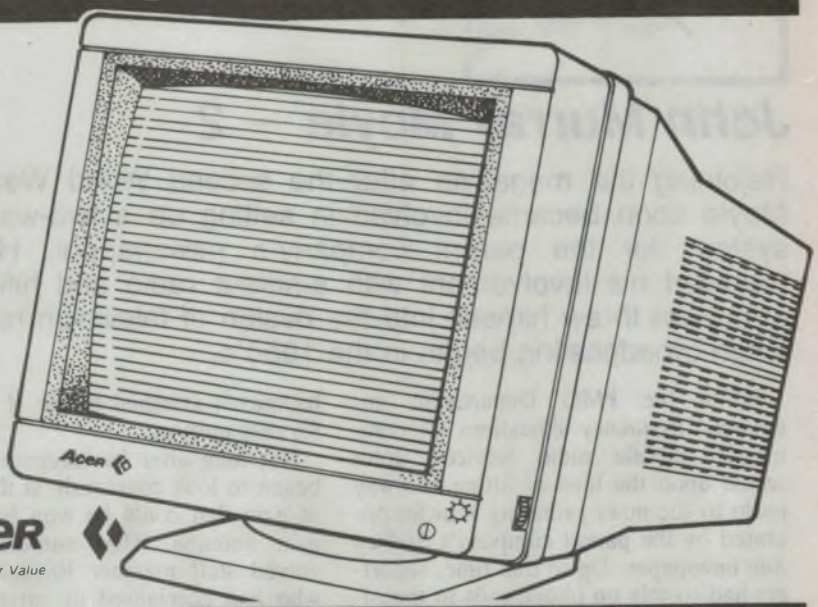

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DICK SMITH COMPUTERS

When I Think Back...

by Neville Williams

John Murray Moyle – 2

Rejoining the magazine after the second World War, John Moyle soon became involved in setting up a two-way radio system for the parent company's newspapers. He also renewed his involvement with amateur radio and hifi audio, and even threw himself into the design of television receivers when broadcasting began in the 1950's.

When the PMG Department announced frequency allocations for commercial mobile radio services, John seized upon the idea of fitting two-way radio to the news gathering vehicles operated by the parent company's *Sydney Sun* newspaper. Up to that time, reporters had to rely on phone calls to the office for instructions, and to get stories back to the sub-editors. Two-way radio would provide virtually instant access.

To John, it was simply an elaboration of what he had been doing, as an amateur on the 6-metre band, around 1936. The frequency was higher – 70MHz instead of 50MHz – and the gear would ultimately need to be suitable for use by non-technical personnel. Neither requirement should present any great problem.

The *Sun* executives were interested, if not fully convinced, and John set about adapting and/or rebuilding bits of what were essentially amateur gear. One was a base station, which was ultimately set up in a disused 2UE studio in the Associated Newpapers building in Elizabeth St, Sydney. The other, a vibrator powered transportable transceiver to be lashed to the rear seat of a news car.

Radio newsgathering

Within a matter of weeks, after a series of night-time and weekend tests using *R & H* 'volunteers', the gear made its official debut in July 1948, when the first Australian news story was despatched by radio direct from a reporter's car to the news editor. (See *Radio & Hobbies* for August 1948). It came just one month after Kemsley Newspapers in Britain has boasted of a similar 'scoop'.

The two-way radio system remained John's personal 'baby' as it developed into a full-scale system, maintained by a technician attached to the *R & H* staff for that purpose.

Not long after its inauguration, John began to look covetously at the decibels of gain that could be won from a high gain antenna. That automatically involved staff member Raymond Howe, who had specialised in antenna design in the RAAF. Many and long were the discussions (arguments?) between the two, but the consensus design was a large vertical phased array which was assembled on the roof of the *Sun* building, using knot-free timber, carefully primed and painted.

It was erected one weekend by contract riggers, who managed the job without damaging the elements and without dropping the whole lot into the street at the rear of the building. Whether John drew breath during the operation remained a matter of speculation.

But even that episode paled before what happened when the equipment had to be moved to a new building in Wattle St, Ultimo, following a takeover by John Fairfax & Sons in the late

July 2, 1948: John Moyle transmits to a news car the first instruction that has just been received by reporter Kath O'Neill from 'Sun' news editor Jack Toohey. The typically amateur station set-up was subsequently replaced by a remotely controlled system.

1950s. The haste with which the building was conceived, constructed and occupied is apocryphal – but somewhere in the process, the question arose as to where the antennas might be mounted, for two-way radio systems now serving both the *Sun* and *Sydney Morning Herald*, plus possible radio and television links.

Almost hesitantly, John suggested a scaled-down AWA-style tower – and to his amazement, the idea was seized upon by both management and architects as a much needed centrepiece for what was essentially a utilitarian building. And there it still stands, like a mini Eiffel Tower, referred to by the then-generation of company luminaries as 'Moyle's Monument'.

Amateur station VK2JU

Immediately after the war, John had set up his own amateur gear in the only place available to him at the time – in an unoccupied 'cosmetic' tower room on the roof of the original 14-storey Associated Newspapers building. It was a promising site for VHF experiments but cold, damp and abysmally isolated on dark winter nights. Even so, it was from there that he generated the enthusiasm and the technology that ultimately gave birth to the *Sun* 2-way system.

Perhaps I shouldn't talk. My own 'shack' at the time was indeed a shack, stuck out in the backyard and likewise damp, cold and isolated. But according to my old log book, it was from there that I first talked to John in his lonely tower room on 51.15MHz, at 9.25pm on April 2, 1947.

When he later set up the family home at Ryde, on the north-western fringe of Sydney, he took over a 'spare' bedroom as a 'shack'. This subsequently became the birthplace of any number of amateur and other projects subsequently described in *Radio (TV) and Hobbies*.

Most of his amateur gear, by the way, tended to be of relatively straightforward design, intended to do one job well. He was not a lover of complex switched-band equipment, especially for home construction.

His next most urgent need was for reasonably efficient antennas to cover both HF and VHF bands. For VHF he set up a modest beam but, for HF coverage, he settled for conventional resonant wire antennas of one kind and another. To support them, he needed two, preferably three, tall masts in the side lawn.

Not one to accept compromise without an argument, John chose the largest pieces of sawn timber that he felt it would be possible to erect without a crane. They were duly bolted together on the ground, painted, pivotted to a base and fitted with guys and pulleys.

A little further down the track, John tests a portable transceiver, one of several which he designed and produced in collaboration with the R & H staff. They could be used by reporters on foot, or in collaboration with news cars in remote areas. (Courtesy Dr Alice Moyle)

On the appointed (fine, non-windy) day, with (as I recall) staff member Maurice Findlay standing by, the masts were duly 'walked up' by the most physical friend John could locate: fellow amateur and Qantas pilot Alan Furze.

How Alan managed it, I shall never know. Nor can I imagine how the masts remained there, without apparently attracting the ire of neighbours, the attention of the local council or the destructive wrath of the westerly winds. Here, perhaps, I can quote directly from personal notes which his wife Alice Moyle sent me for reference when preparing this biography:

"The enormous aerials, which dwarfed the surrounding neighbourhood at Ryde, were put there primarily for his contacts with experimental stations overseas."

"John won awards for his outstanding performance in Remembrance Day and in National Field Day contests. In 1961, the year after his death, the National Field Day was renamed the John Moyle National Field Day contest."

Hifi amplifiers

But I must get back to audio and hifi. Following the war, the urgent need for hifi buffs was to win better sound from existing 78rpm discs or, better still, gain access to a superior medium.

Like his counterparts in the UK and USA, John spent a great deal of time and effort sorting out the frequency compensation curves for 78rpm discs, as used by the various manufacturers. This done, he devised preamplifiers with switchable compensation to suit them.

John Moyle

He also spent a lot of time plotting the response of various pickups – an exercise that tended to condemn crystal pickups to a utility role, despite valiant efforts by Acos/Cosmocord to attract hifi buffs with exotic designs.

But John (as I) was forced to the conclusion that, in terms of quality, traditional 78rpm discs were a lost cause. We applauded the efforts of Decca, AWA and others to launch up-graded pressings but it was John who, from his position as editor and record reviewer, championed the new 33rpm long playing microgroove format that appeared circa 1950. This, against the dogged opposition of EMI headed up, at the time, by Sir Ernest Fisk.

It is now a matter of history that, once on the market, microgroove discs swept the old 78s aside, with their outdated technology and standards and the masses of ancient equipment that had hitherto clogged progress. With LPs, 'hifi' took on a whole new meaning.

Flowing from his earlier preference for magnetic pickups, John became a firm supporter of Ortofon moving coil cartridges and, while he admitted to the existence of other makes, Ortofon remained his first choice.

In 1956, John went on a fact-finding tour of the UK, Europe and the USA, meeting many people who shared his interests in sound recording and reproduction. A man who particularly impressed him was the Swiss orchestra conductor Hermann Scherchen, who invited him to Gravesano, Switzerland, to look over his own experimental studio.

In the UK, he met Gilbert Briggs of Wharfedale loudspeakers, as well as other identities in the British hifi scene who were at their often eccentric best in the mid 1950s. He was also able to spend time at the then-new Royal Festival Hall, where experiments were in progress to test out its acoustical design.

With Gilbert Briggs, by the way, he found a great deal in common. G.B. was a pianist of some ability, a music lover and a manufacturer of quality loudspeakers who thought a lot and wrote a lot but listened even more. Ten years later, I met G.B. myself and found a similar affinity.

Hifi-stereo from disc

John arrived back from overseas convinced that stereo LPs were well and truly on the way. He was able to publish facts and figures which, at the time, were news to the very leaders of the local audio/radio industry. Some, in fact, seemed to be living in hope that the new development would go away.

1956: Photographed outside what then passed for Sydney Airport's overseas terminal, John is farewelled by his wife Alice and daughter Carolyn, on his round-the-world fact finding tour. (Courtesy W.N. Williams)

Boarding arangements in 1956 were nothing if not basic, even for overseas departures. John Moyle climbs the steps into a Qantas Super Constellation. (Courtesy W.N. Williams)

The arrival of stereo in Australia was announced in John's 'Off the Record' column in the January 1959 issue, in the tangible form of a lone commercial stereo radiogram and a half-dozen records, including Decca's outstanding 'A Journey into Stereo Sound'. That disc, by the way, is still an attention-grabbing recording, even by present-day standards.

In that very same column, he could not resist a lusty swipeat his industry critics. I quote:

'One or two companies haven't been all that happy about information published on stereo, even in our own magazine.'

'They consider much of it has been ill-informed, premature and 'little more than gossip', to quote one unofficial spokesman.'

'Here is a development likely to become one of the most important in the history of sound reproduction. It has been approaching us with agonising slowness for about 18 months. It is of the greatest importance to all audio enthusiasts.'

'Could anyone imagine that a magazine would fail to gather as much information and report as it could, and from as many sources as possible?'

'I can't regret a single word of what I've written or reported, or anything I have done with stereo in the last twelve months. For most of our readers, it was

the only information about stereo they were able to gather in.'

In this same period, John presented two public lecture/demonstrations to eager audiences at Sydney's Conservatorium of Music and Anzac House.

As I recall, they involved two large Wharfedale-style 3-way systems, brought in from his own home and driven by a pair of 20-30W mono Playmasters using EL34 valves in ultralinear mode. On standby, however, was a twin 10-watt stereo Playmaster using EL84s in a similar configuration.

While the demonstrations were highly successful, any number of hifi fans remained to be convinced that stereo was even a legitimate form of hifi. How right he was is evidenced by the fact that, in today's hifi world, stereo is routine; mono is virtually the exception.

Perhaps I should mention, here, that John enjoyed a brief dalliance with home recording, both on acetate discs and open-reel tape. He sampled the potentially excellent quality of tape, but did not see the technological explosion around the cassette format.

To him, tape was useful, interesting, even promising but 'messy' in open-reel form. Who can forget his impatient outbursts of "falls off the reel!" At heart, he was a disc man.

Oh yes – television

If stereo arrived in the late 1950s, so also did television, as far as Australia was concerned. Taken up by hifi-stereo, amateur radio and the affairs of the WIA (Wireless Institute of Australia) it was a wonder that John could find any time at all for television. But he did – somehow!

It was not at all clear at the time whether the home construction of TV sets would ever be a viable proposition, because of the lack of key major components in the shops: tuners, IF strips, picture tubes and the wherewithal to cope with deflection circuitry and EHT.

What hobbyists did have access to were stacks of oddment cathode-ray tubes, 6AC7s and other high frequency valves, 6H6s, and boxes-full of small bits.

I don't know who started it, but both John and I decided we *had* to build a poor man's TV set from disposals oddments – green pictures notwithstanding.

We contrived tuners and IF strips that shouldn't have worked, but did. We built EHT supplies using 6H6 diode detectors and paper capacitors operating way outside their ratings. We picked over 5BP1 and VCR97 cathode-ray tubes, to find ones with good emission that were reasonably free of gas and screen surface charge effects.

It was a fun challenge, and the satisfaction of receiving 'little green pictures that moved and talked' was reminiscent of that first crystal set thirty-plus years before. The sets were described in the magazine, of course, and quite a few readers apparently shared our experience.

After that, TV set building became technically respectable, with an orderly supply of parts and kits and, at that point, John opted out. In fact, after developing and publishing about four full-scale B&W TV receiver projects, we all opted out. Built-up receiver prices had become so competitive that kit suppliers simply could not compete.

John Moyle in a characteristic pose, pipe in mouth and concentrating on the job in hand – here the winding of an inductor for a loudspeaker crossover network.

John Moyle – the man

What sort of a man was John Murray Moyle?

As I have indicated, he was very capable – able to do well most things that he turned his mind to.

No less to the point, he was a thinker – tireless, free-ranging, logical, honest, but not without an emotional side.

As such, it is no wonder that he won a debating prize at Scotch. And, equally, it is little wonder that he could never resist an argument, sometimes serious, at others by way of diversion.

In my own case, John and I had countless discussions about technical topics – but also not a few on philosophical matters. From (I gather) a traditional methodist background, John adopted a viewpoint somewhere be-

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John Moyle

John Moyle could be whimsical, too. Here's an 'ode' to his typewriter.

MY TYPEWRITER

You ugly eternal monstrosity.
You deadly clarifier of thoughts.
Killer of romance – no sense of humour.
You indispensible, mute mirror of ideas.
Three months before I could speak your language
And I hope you don't mean all you say.
(Remember that letter addressed 'Dead Sir'?
You couldn't even laugh.)
Or when I wept over a sonnet – yes you remember,
There's still a stain on the letter F.
I'd like to smash your grinning teeth –
Just like that –
If I could afford to replace you.
So JJ*&%!! to you.

tween an agnostic and a rationalist.

In a reflective moment after one such discussion, he confided that our different stances concerned him. "I worry", he said, "that you set so much store by what I so positively reject". On another occasion, when his daughters had linked up with St Stephen's church in Macquarie St, City, he bought them each a Bible to acknowledge their right to their own opinion.

But not everyone saw that warmer side of his nature, with differences of opinion tending rather to turn into confrontation.

Perhaps that's the way it often is with people of strong convictions and the capacity to express them.

His ability as a writer was never in doubt, but again there was that combination of strictly practical prose with touches of whimsy. In her notes, Alice Moyle draws my attention to a snippet about stereo on page 105 of the September 1959 issue – one which I either never saw or have long since forgotten:

"Until a better suggestion comes up, that's the way I feel like viewing the subject, except when I feel like having a gentle argument over a cup of tea with Neville Williams."

"And he is an expert at arguments."

But if you want to sample the whimsical side of the man who wrote such practical prose or advanced such provocative arguments, read his observations on his typewriter in the accompanying panel.

One other thing I should add: in 20 years of close association, I found him totally honest – a man of his word.

A sad finale

John had a long-standing interest in WIA affairs, serving with the NSW Division as councillor and president. He subsequently held federal office and played a major role in drafting a uniform constitution for all states. In 1959, he attended the ITU (International Telecommunications Union) conference in Geneva, representing Australian radio amateurs.

John proved an effective advocate at Geneva, reporting back to the WIA and through the pages of *Radio, TV & Hobbies*. From Geneva, he planned to re-visit the UK and USA as a follow-up to his earlier tour.

What few knew, however, was that John was a sick man before he left and, on a number of occasions expressed to me the hope that his physical discomfort was not a symptom of a serious problem. But it was and, when John visited a doctor before leaving Geneva, he was advised to fly home immediately for urgent treatment.

On the way across to England, he had a chance meeting with A.C. Haddy, the well known British recording engineer and designer of the then popular Decca pickup. The meeting was reported in the February 1960 issue, in what proved to be his last contribution to 'Off the Record'. It is recounted with all the enthusiasm and flair of other days, with never a hint of his then desperate illness.

John died on March 10, 1960, survived by his two daughters and his wife, now Dr. Alice Moyle, attached to the Dept. of Aboriginal Affairs in Canberra and an authority on aboriginal music.

It is fitting that the final tribute should come from his peers and many friends at the Institution of Radio Engineers (Aust), of which John was a senior member. In their *Proceedings* for April 1960 the valediction reads:

He was one of the best technical journalists this country has known; his lucid thinking and enquiring mind led him along paths which few of us have travelled. His journalistic talents are forever engraved upon the technical pedestal of Australian literature.

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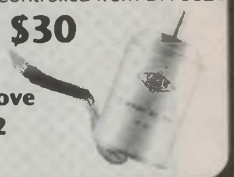

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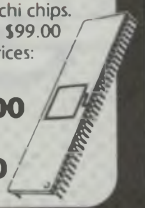

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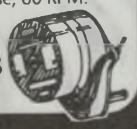

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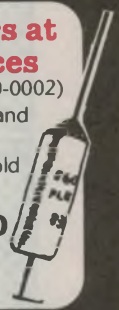

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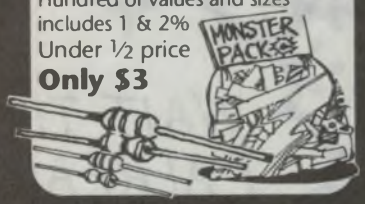

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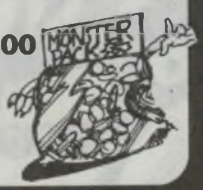

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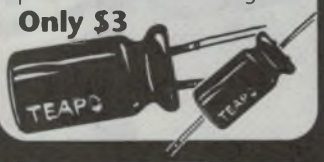

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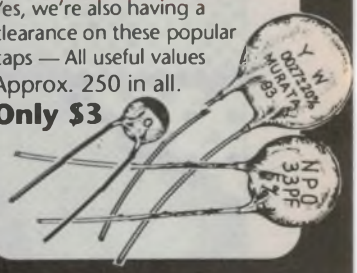

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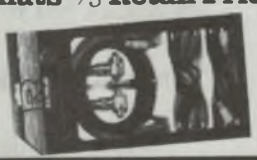

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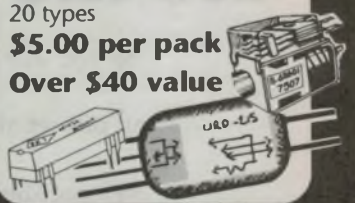

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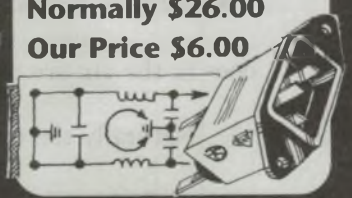

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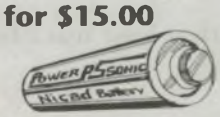

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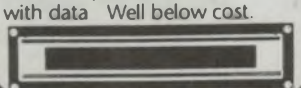

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FORUM

Conducted by Jim Rowe

The 'DI' boomerang pays us another of its regular visits

Oh no – not again, surely? Yes, that's right, it's apparently time for our regular dose of medicine on that thorny topic of double insulation. When I raised the subject months and months ago, in connection with hifi gear in particular, I had no idea that it would grow into such a long-running and controversial business.

As I said in the June issue (the last time the topic 'took over' this column), it presumably keeps on coming back because we never seem to find a solution which makes everyone happy. So every few months the pile of letters builds up again, forcing me to give it another airing – even though I sense that many readers are probably starting to find it pretty tedious.

Frankly I suspect that most of the points for and against double insulation, 'safety' and 'functional' earths have now been made, and that from now on we're all at risk of becoming repetitive. But in fairness to the latest batch of readers who have taken the trouble to write in with their comments, I've decided to give the subject one last airing.

Please note, though, that this NOT meant to stir it all up once again, and encourage yet another round of letters. After this let's turn our attention to other things, folks – what do you say? There are lots of other interesting electronics-related topics for us to argue about, after all.

That said, let's bite the boomerang and begin. The first letter on the pile comes from a reader who has commented in the past on various other topics: Bill Jolly, of Nambucca Heads in NSW. And I suspect Mr Jolly mainly wrote to correct me on the analogy I used in the lead-in of the June column, likening the topic of double insulation to that fictional ship that had to keep on sailing endlessly, because it wasn't allowed to put into port. Apparently I didn't even get that right:

I am probably the 10,000th one to suggest that in the June 'Forum', for Marie Celeste read Flying Dutchman. Wagner wrote an opera about him.

But more relevantly, I believe the confusion about double insulation really relates to classification. Few have disagreed that double insulation used with mains powered PORTABLE tools has increased operational safety. But all other fixed and mobile apparatus is still required to be earthed, including washing machines, stoves, light fittings, ceiling fans, radiators and mobile workshop equipment such as air compressors and bench saws.

How audio equipment and TV's ever got to be classified with portable tools remains a mystery. I suppose someone thought double insulation for electronic equipment was a good idea; the road to Hell is paved with them.

TV and FM tuners are frequently connected to earthed aerials via co-ax. Is that illegal, for I presume the effect is to earth the equipment? It would seem from all the correspondence that double insulation when applied to electronics is a total lemon – but what are we to do about it now?

Thanks for your comments, Bill. I still reckon I read a book once, or saw a movie, where there was a ship called the *Marie Celeste* – and it had much the same problem, if I remember rightly. But it doesn't matter.

I fully agree that there isn't much argument about the value of double insulation when used for portable power tools. In fact if you recall how this all started, I wasn't really challenging that at all. Only the use of double insulation for audio and other electronic gear, where it *does* cause complications and can degrade performance. And I don't really think anyone has disputed that claim, either.

Surely we *have* now pretty well clarified the question of how double insulation seems to have crept into audio and video equipment, though. Even if this has been by a process of elimination, in which the other possibilities have been one by one ruled out.

My understanding is that it has really occurred by default, and largely because this equipment is now made almost exclusively in Japan, Taiwan, Korea, Hong Kong or Singapore. The manufacturers are producing for a world market, and understandably wish to make as few different models as they can, to cater for that market. Probably the best way to avoid complications with the earthing requirements of the various countries has been to make the gear 'double insulated' – i.e., forget the earth altogether.

Of course while this has made things easier for the manufacturers, it seems to have caused quite a few complications for the poor old users. And that's why I brought up the subject in the first place!

Moving right along, another letter came from John Presland of Darlington in Western Australia. Mr Presland feels we have all somehow missed the main safety aspect of double insulation – now why does that sound a bit familiar? Anyway, here's what he has to say:

I have followed with much interest the seemingly never-ending discussion on the merits or otherwise of double insulated appliances. Whilst most of the contributors have brought up many valid points, I feel everyone has missed the main safety feature of double insulated appliances.

The main cause of electrical accidents in Australia is the use of incorrectly wired or faulty extension leads and plugs. If, for example, an extension lead had the earth and active wires transposed, then any conventional earthed appliance connected to this extension lead would become live, and anyone holding

or touching the appliance would receive a shock. If a double insulated appliance was plugged into the same faulty lead, all that would happen is that the appliance would not work.

Double insulated appliances also prevent the possibility of the user receiving a shock due to frayed wires in the plug touching and/or becoming disconnected, or from flexible leads becoming cut or squashed – especially in industrial environments. In addition, the safety of the appliance is not dependent upon the quality of someone else's earthing system.

If a double insulated appliance was fitted with an 'optional' earth lead, then all of the safety features would be negated because someone, somewhere, would find a way to connect this to the active conductor.

On another subject, I support your stand on circuit symbols, and I feel you are doing a good job with the magazine.

Thanks for the kind words, John, and you certainly give a good summary of the basic arguments in favour of double insulation for tools and similar appliances. What you don't seem to tackle, though, is the reasoning behind using double insulation for hifi audio and video equipment – where the lack of an earth can frequently result in degraded performance.

Assuming you'd still prefer not to have even this equipment earthed, how would you propose that we get around the resulting hum and noise problems? These seem to be admitted by even the most fervent supporters of double insulation, yet no one seems to have come up with a satisfactory answer – except to suggest connecting them to a 'functional' earth.

Another letter in roughly similar vein came from John Mackenzie, an electrical contractor in Katoomba, back in NSW. Mr Mackenzie's letter is fairly long, and goes over a fair bit of the same ground, looking at the risk of shock with 'earthed' equipment due to faulty wiring of plugs and extension cords. However after that section, which I'll skip for brevity, he makes the following points:

Today with so many plugs 'moulded on', the above problems are reduced, but a wire 'earth' firmly fixed to exposed metalwork and enclosed in a three-core flex is still very dangerous. Much better to see no such connections – but then people making any electronics equipment are not compelled to make it double insulated. Yet I shudder when I think about all of that hifi gear in loungerooms, with all that exposed metalwork, and perhaps hooked up via an extension cord wired up by 'Uncle Fred'!

I am not happy about people connecting a wire to the 'earth' screw on the back of hifi gear, because what are they going to connect it to?

In the average house the only earth connection available is in the GPO (power point). I would not like to see a person try to connect to a fixed earth wire in a building, or poke a wire in the front of a GPO – let alone in behind a GPO!

I know this does not solve any problems of hum and noise, but as a reader since 1964 (every month – and I still don't get a discount!), I felt it was about time to write.

Watch out for those boomerangs, and keep up the good work.

Thanks for your kind words also,

Forum

John, and I'm sorry we can't give special discounts to long-time readers. Your warning about boomerangs is also a bit late, I'm afraid – they're a bit hard to duck, even when you see them coming!

I take your point about exposed metalwork, and the danger if this is connected to an 'earth' which for one reason or another turns out to become connected to the mains active. Yet you and Mr Presland both seem to assume that while there's every chance that an 'earth' connection may become 'alive', on the other hand there's no way that the exposed metalwork on a double-insulated appliance could ever become 'alive'.

This seems to be a common assumption, among protagonists of double-insulation. Somehow it seems to be regarded as inherently foolproof and perfectly safe in principle – even though cases of faulty 'double insulated' appliances are by no means unknown.

"Aha!", says the true believer, "But they wouldn't be able to develop a fault and become dangerous, if they were REALLY double insulated. If they became dangerous, that simply shows that they weren't TRUE double insulated appliances in the first place." In other words, evidence from the real world is no longer relevant – the principle has assumed the status of an idealogy. True-blue double insulated appliances can *never* become dangerous, by definition.

Of course, I'm not suggesting that Messrs Presland or Mackenzie were taking things to this extreme. Nor am I decrying their concern for user safety, which is entirely laudable. But I can certainly detect a tendency towards 'dogmatic double insulationism' in some of the letters that have come in over the last few months.

That said, let's pass on to the final letter I'm proposing to publish on the topic at present (at least!). This comes from Daniel Ford of Beecroft, also in NSW. I suspect that Daniel hadn't read the June column before he wrote, because he refers to my reaction to reader Jeff Richards' first letter in February, and not to his second letter as published:

I'm afraid I can remain silent no longer, having followed your ramblings on double insulated audio equipment for several months, thinking each month that someone would finally present the finishing argument.

I found Jeff Richards' letter in the February issue quite clear, and was puzzled that you didn't get the point.

The point seems to be that a double insulated appliance, if correctly manufactured and used according to the rules (i.e., with any exposed metal NOT connected to mains earth) should be quite safe under all circumstances, despite the presence of 'tingles'. The anecdotes quoted, where badly manufactured products were capable of giving lethal shocks, do not negate the principle of double insulation – clearly these products (as manufactured) were not 'double insulated' according to the standard.

I am not, and have never been, involved in any standards-setting groups, but I seem to recall (and I probably read it in an old copy of 'Radio, TV and Hobbies'!) that the whole argument supporting the introduction of the 'double insulation' standard was based on the unsatisfactory safety record of power tools, particularly when used with extension cords (as they often are).

It is not unheard of (in fact it's more common than you or I would like to think) for extension cords to be wired by 'amateurs' and to have the 'earth' connector of the final receptacle connected to mains 'active'. The use of a 'standard' power tool, with earthed metal body is surely lethal in this situation, particularly on a damp building site. Hence the standard, and especially the proviso that any external metal parts must not be earthed. It's not that the tool wouldn't be safer if the metal WAS earthed – it would – it's just that you cannot rely on the mains 'earth' pin always being connected to earth!

In this light, Jeff's comments make complete sense. If the manufacturer provides an 'earth' connection, he cannot connect it to the mains without violating the double insulation standard, and at the same time making the equipment unsafe if connected to an incorrectly-wired (or faulty) mains outlet. By the same token, as Jeff states, he should not refer to this as a 'safety' or 'mains' earth, for the same reason. If a user connects such an 'earth' terminal to mains 'earth', he does so entirely at his own risk.

Given that audio equipment is generally used in different circumstances to power tools, it seems inappropriate to manufacture them double insulated, especially in view of the hum/noise problems which prompted this argument in the first place. THIS should have been the thrust of your argument, NOT whether the 'standard' itself is questionable.

But I wasn't! I didn't! It was Dolly – and all of those readers, who kept on changing the subject back to tools and wet building sites... Naughty readers!

My apologies to Maryanne Fahey of TV's *Comedy Company*, but I couldn't help feeling a bit like her 'little girl' character, while reading Daniel's letter. (I hesitate to think what Bee Jay is likely to do to me this month in his cartoon, when he reads that bit. Ah well – doesn't matter. I no complain...)

Seriously, though, I wasn't ever questioning double insulation as such, and as applied to things like power tools. All I *was* doing was question its applicability to hifi and video gear, and trying to fathom out why the makers of this gear were able to make out that they weren't *allowed* to earth it, by the safety authorities. It was this latter aspect that led us into looking at the actual standard for double insulation, and trying to decide (a) if it really did mean that one mustn't earth a double-insulated hifi amplifier, and (b) if so, why.

The only other aspect that concerned me was the fact that one can quite often get 'tingles' from double-insulated appliances. Daniel Ford may not find this worrying, but a lot of people do – because although the appliances MAY be quite safe, there's always the possibility that they may have become faulty. In other words, when does a tingle mean trouble, and when can it be ignored?

Somehow this started the double-insulated ball running all over the place, and we then found ourselves discussing all manner of side issues.

Actually I suppose I shouldn't be too worried about Mr Ford's letter, because when it's all boiled down he seems to agree with me. It *does* seem inappropriate to double insulate audio equipment, he notes – and even recalls that this was the reason for my raising the issue in the first place.

He even seems to be hoping that the whole discussion can be brought to a conclusion. So it looks as if we might be on the same side after all!

Ham letters

Changing the subject, there have been considerably fewer letters this month on the subject of amateur radio. Perhaps things are settling back into the usual torpor, after my April stir. I hope not, but I suppose it's inevitable.

Actually although only a few more letters have arrived, a couple of them either make interesting points, or raise matters that seem to call for a comment from me. So I thought we'd look at these, with the idea that it just *might*

keep the subject alive.

One interesting letter came from Darren Oster, of Vista in South Australia. Darren makes these comments:

It seems that in a highly affluent society, anyone who makes his or her own radio equipment has one or two screws loose.

The are two main problems I see in amateur radio. The first is space. Space is a considerable problem today, when housing blocks are getting more compact, and also more expensive.

Reading a 1987 copy of 'AEM' brought me a constructional article on an 80m 'Space-Miser' antenna. Space miser indeed – it measured 2m high by 8m long, and the article states that the length is only 1/5 as long as an equivalent dipole antenna. Who would want a 40m long dipole in their backyard?

Granted, smaller wavelengths use shorter antennas, but transceivers get more expensive.

The second problem I see is motivation. Who honestly wants to make their own equipment? People these days will not take the risk of finding out that their own creation doesn't work, and that they have wasted time and money.

If I may quote part of the 'Amateur's Code' from the 1976 ARRL Handbook:

'The Amateur is Progressive... He keeps his station abreast of science. It is well built and efficient.'

What better way to fill these idealisms than to buy hi-tech, pre-built equipment?

Amateur radio is not dead, but it is only just surviving according to what I have read. I myself am not an amateur, but am eagerly awaiting the series mentioned in the July issue.

Keep it up, and maybe we can restock ham into 'Jim's Kitchen' again.

Thanks for those thoughts, Darren – even though on the whole I didn't find them all that encouraging.

I agree that space does impose fairly serious restrictions on many people, but full-scale dipoles aren't mandatory. In fact part of the fun to be obtained from amateur radio is to see what you can achieve using an approach that IS different from the one shown in the textbooks. Often that's been how the frontiers of the science *have* been pushed forward, by imaginative and persistent people trying to do things another way.

Don't forget there's still a lot of work being done in the area of antennas and propagation, and plenty of opportunity to show how to achieve more with less.

I think I see what you're driving at with your other point, about people being unwilling to risk failure these days. There does seem to be a kind of 'couch potato' mentality growing in our midst, I agree. It's sad, because the old saying is quite true: 'The person who has never experienced failure has never done anything.' We learn by our mistakes and failures, after all – in fact I sometimes think that they're the only things we do learn from.

As for using commercial pre-built gear being the only way for an amateur to keep abreast of the science, I guess you *can* look at it that way. And judging by the number of hams that have swung over to appliance operation, apparently a lot of them would agree with you (secretly at least).

All I can say in reply is that twiddling the knobs on a glorified CB transceiver doesn't strike me as being terribly scientific. I suspect the proverbial trained monkey could do it, in fact.

I'll go further. If using appliances has become the only way for hams to keep abreast of their 'science', then I predict that the hobby will continue its decline, and expire altogether – sooner rather than later. I just don't think there's enough left to survive, after you extract the experimental side of the hobby.

On a more cheerful note, another letter came from Leon Williams VK2DOB, of Bungendore in NSW. Leon's letter is fairly long, and includes a number of suggestions regarding possible future projects. However he also makes the following comments:

As an amateur radio operator who enjoys building as much station equipment as possible, I was very excited to see your comments in Forum. I have felt for some time that the constructional side of the hobby was diminishing. This is due to many reasons, which have been covered in EA.

I do feel, however, that there are many amateurs left, who like me enjoy building radios and the like. I also feel that many more would take up their soldering irons if relevant articles appeared in magazines such as EA.

I feel that interest in construction will in the future mainly be in the area of simple, less costly projects. The price of technology has decreased to a point where the average amateur would not consider building a complex transceiver. However projects of a simple nature will still encourage amateurs to warm up the soldering iron.

Once again, I am very pleased that you are trying to encourage construction in amateur radio, and I hope this letter has helped your task.

Thanks for those comments, Leon, and thanks also for your project suggestions. We'll see what can be done.

Although it may sound like a backdown after what I wrote above, I suspect you're quite right about the construction of complex equipment like transceivers now being a thing of the past, and the future lying with simple gear. That's certainly the way we've been thinking, anyway.

That doesn't mean a steady diet of tiny antennas and SWR meters to the exclusion of all else, though. In fact we're working on a series of simple transmitter and receiver modules, to show that you *don't* necessarily need a lot of fancy gear to achieve results. Anyway, we'll see what happens, and I hope you're right.

Another cheering letter came from a young ham who has just obtained his licence: James Webb, VK3THC, of Maryborough in Victoria. I found his letter very encouraging, in fact, not just because of what he wrote, but because he represents the kind of young people that are surely needed, in order to inject new life and enthusiasm into the hobby. Here's what he wrote:

I must disgree with your opinions that the experimental side of amateur radio has died, at least in respect to myself.

I have just obtained my licence, and I am 14 years of age. Although no champ home-brewer, in fact a mere hobbyist and enthusiast, I still enjoy the feeling of a home-brew piece of equipment working – or at least showing healthy signs.

In the process of designing and constructing, I know that I am slowly learning more and more about radio and electronics, gaining useful (sometimes) equipment and feeling satisfied with the results. This is what originally lured me towards the hobby of amateur radio.

Despite the new and fancy radios involving microprocessors, etc., nearly all of my apparatus is constructed from the many valves obtainable from second-hand dealers and similar outlets. Whilst having many disadvantages, quite simple and cheap equipment may be constructed from them – a prime consideration as I am a student, and my income is weekly pocket money.

My latest valve transmitter idea was inspired by the 'Mate' design in May 1989's 'Vintage Radio' column. My transmitter simply involved a 12AX7 oscillator driving a 12BY7A pentode as a class-C amplifier, with the cathode of the pentode modulated by the triode section of a 6GV8. The second section of the 12AX7 was used as a voltage amp. The transmitter took just over a month's

work and experimentation, and when completed and connected to a random length of antenna, a friend of mine readily received it at his QTH, some five kilometres away. The power was calculated at three watts.

Much of my gear is kits, the most notable being an 80-metre QRP transceiver. Other home-brew equipment includes a five-watt power meter, a restored valve LF/MF/VHF receiver and a low power video modulated oscillator.

On the drawing board at the moment is a hybrid 500kHz – 32MHz transceiver, which may eventually be constructed depending on available time, money and several components.

Please keep pressuring the topic – I hate to think that amateur radio is suspected of being 'dead'.

Well, what can I say after that, except 'Bravo, James!' It sounds like you're well and truly keeping the hobby alive at your place, at least. What a pity that some of the old-timers couldn't get stuck back into things again, and rediscover for themselves what you've been discovering for yourself.

Keep on with that enthusiasm, and keep using that initiative – it doesn't matter whether you're using valves, transistors or ICs. You're experimenting and learning, that's the main thing for all of us. And isn't it FUN!

A final request, though, James: how about spreading the good news to some of your mates – we need all the young people we can get involved, if amateur radio is to pull through.

Finally, there was a letter from an amateur who signs himself simply as 'Phil, VK3AAM', hailing from Rye in Victoria. His letter is a little worrying, I think, because he seems to think there's some sort of conspiracy to 'attack' amateur radio:

Over recent times there appears to have been an orchestration of criticism of amateur radio, and one cannot but question the motives of the critics.

However I believe that both you and your magazine have a genuine desire to become supporters of the hobby again, and for that reason I make the following observations.

Critics do not seem to appreciate that amateur radio is a hobby, just like fishing, boating, bowling etc., and that it needs no more justification for its existence than do other hobbies. It uses relatively little of earth's resources or the radio spectrum, in comparison to the amount of both that are wasted from time to time by other users. What amateur radio uses of the spectrum is in the main carefully and economically used.

Amateur radio is a different hobby to each individual, dependent upon his/her background, training, skills and inclinations, and no particular facet should be considered superior to another.

To criticise the owners of black boxes would probably be to criticise most hams, but the use of black boxes is a consequence of economics, and the fact that it would be impossible in this country to buy the components for a comparable piece of equipment. It would also be unrealistic to expect a hobbyist to out-design and out-build the very clever young people who are fulltime trained and employed in the electronics industry and have designed and built the marvellous equipment of the space age, with the spin-offs that result in the modern commercial transceiver.

That does not mean that the hobby should be curtailed or cease to exist. The fact that NASA are prepared to put up satellites for hams shows that they at least recognise the usefulness of feedback from the hobby.

Other spin-offs from the hobby such as WICEN need not be gone into, but if the critics cared to visit the small Southern Peninsula Amateur Radio Club (30 members, of whom 28 are retired), they would find that the spirit of amateur radio is still alive. There is much old junk still being converted into operative equipment, classes run, and most importantly a group of retired people are keeping themselves active and interested in a healthy hobby.

I look forward to some practical demonstration of your renewed interest in the hobby.

Thanks for your comments too, Phil, and it's good to hear that you and the other members of your club are also keeping the ham radio fires burning.

I really don't know what you mean about some sort of 'orchestration of criticism' regarding amateur radio, however, or what ulterior motives you hint at. I simply can't imagine who would have a vested interest in conspiring to 'pull down' amateur radio, unless perhaps it would be some of the commercial users of the spectrum looking enviously from their crowded bands into the sometimes very quiet VHF ham bands. And surely the best way of tackling this – if it is happening – is to encourage amateurs to get off their tails and become active, so that the ham bands will once again be full of hams busy experimenting, trying out new gear and antennas, and so on.

That's exactly what *I'm* trying to do, anyway.

One of your other comments suggests that you have somehow taken some of my criticisms as suggesting that amateur radio should somehow be 'curtailed' or 'closed down'. I wasn't suggesting anything of the kind. All I was driving at was that the experimental side of ham radio *has* declined, and that unless this side can be rejuvenated, I think the hobby may well fade quietly into oblivion of its own accord. It won't NEED anyone to curtail it or close it down.

Actually I wasn't even criticising the hams who do own and use 'appliance' rigs, either. I was mainly pointing out that from an outsider's point of view, there's isn't all that much difference between one bunch of people sitting around chatting over the air using CB rigs, and another bunch sitting around chatting over the air via fancier ham radio rigs.

In other words, that the trend away from home-brewing and experimental ham radio is tending to reduce the uniqueness of ham radio, and make hams closer to being the same as a lot of other spectrum users. And I was suggesting that for the longevity of the hobby, this was not a good thing.

I still believe that's the case, too, although I'm not criticising individual hams for buying and using commercial gear.

Finally, I have to comment that I hope not all hams will take the same attitude as VK3AAM seems to be expressing, with regard to the difficulty in and/or advisability of making their own gear. It does sound a bit defeatist, surely: "You can't compete with the commercial designers, so why try?".

Surely there are lots of areas where hobbyists *can* still compete. For example, building gear for applications which are too specialised for the commercial designers, or where the likely sales volume would be too small for them to be interested.

I guess what I've been trying to do, over the last few months, is encourage hams to *think positively* again, and to jump in and have a crack at doing the kind of experimenting that built up amateur radio in the first place. It's amazing what you can achieve with positive thinking – like the reverse, it tends to be self-fulfilling.

But that's enough pontificating for one month. Next month I'll try to get you all going on another subject altogether. We need a change, don't we?

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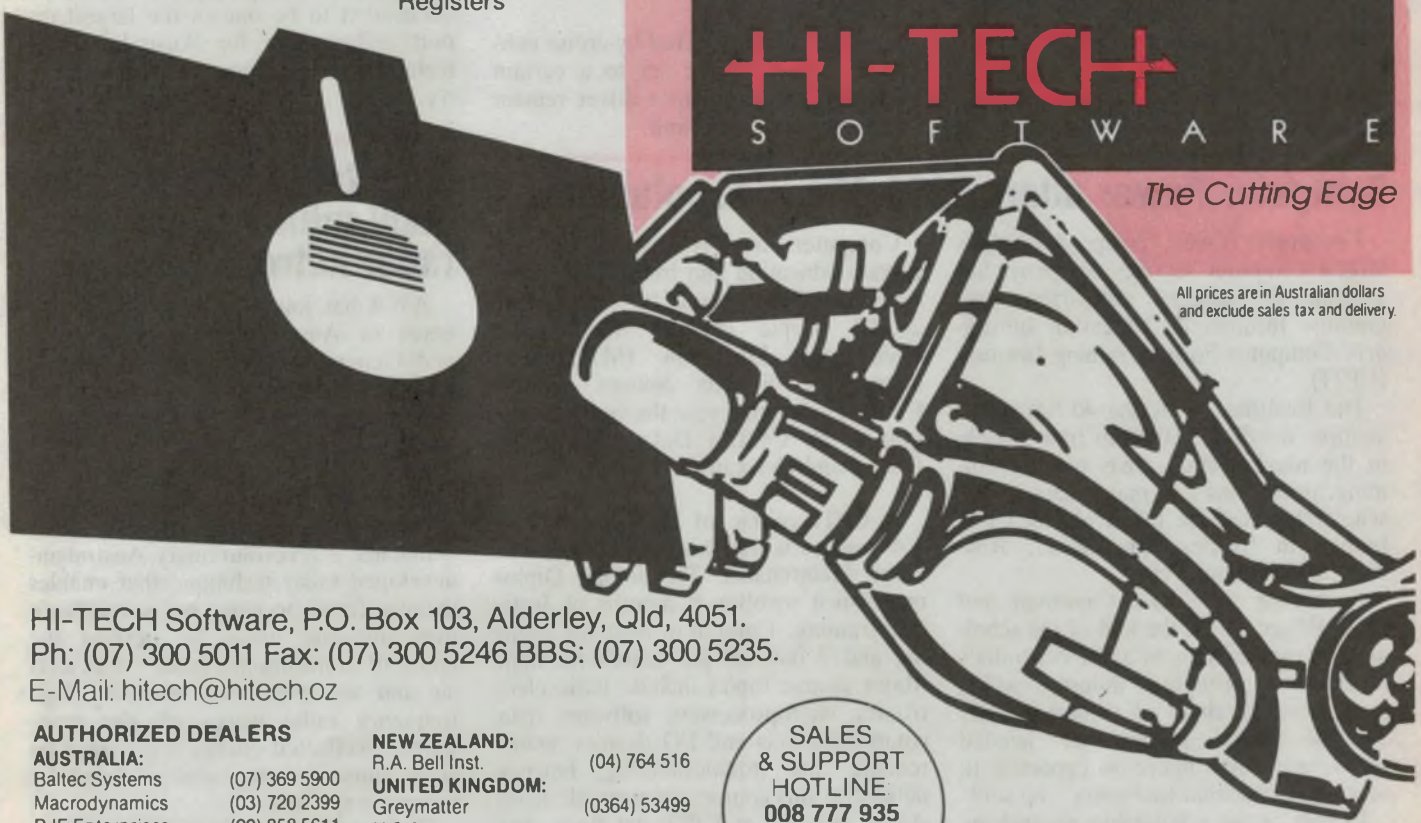

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News Highlights

VDO cruise control for Brock Falcons

An after-market cruise control unit manufactured by instrument specialist VDO has been chosen as optional equipment for the latest range of customised Peter Brock vehicles.

Brock's Austech Automotive Developments has been upgrading the current model Ford Falcon with an enhanced body styling kit, interior upgrade, improved engine, exhaust and suspension components and custom designed alloy wheels.

The incorporation of the VDO cruise control unit has raised the level of sophistication of the cars and has the advantage of reducing fuel consumption.

An automobile with electronic cruise control such as the VDO unit can achieve fuel savings of up to 15%, said VDO's automotive manager, Mr Mel McNiece.

"A cruise control is an important after market accessory that should be given more priority," he said.

"Apart from the fuel savings potential it can help reduce driver fatigue on long trips."

Another benefit offered by cruise control is that it can be set to a certain speed and thereby help a driver remain within an area speed limit.

Computer Power offers $250,000 in scholarships

Computer Power Group, Australia's largest computer services company, has announced a special scholarship programme through its education subsidiary, Computer Power Training Institute (CPTI).

The Institute is offering 40 full scholarships, worth $250,000, to train people in the much-needed areas of programming, operations and maintenance. The scholarships can be taken at any CPTI branch in Sydney, Melbourne, Brisbane, Adelaide or Perth.

According to CPG's Chairman and CEO Roger Allen, the aim of the scholarship programme is to assist Australia's information technology industry, which is desperately short of skilled people. "47,000 skilled people are needed today, and that figure is expected to reach 82,000 within two years", he said.

Details of the scholarship programme are available from CPTI branches in each state.

Computer Power is Australia's largest private education and training organisation, running courses for more than 20,000 people through Management Technology Education (MTE) and about 800 diploma courses through CPTI. Earlier this year the company acquired the Control Data Institutes in France and Germany.

A CPTI course of likely interest to *EA* readers is that leading to the Computer Maintenance Technology Diploma, which involves 8 months of Institute training, 1 month of field site training and 2 days of job search training. Major course topics include basic electronics, microprocessors, software, data communications and I/O devices, maintenance and troubleshooting. Further details on this course are available from Annie Johnson at CPTI, 1st floor, 493 St. Kilda Road, Melbourne 3004 or phone (03) 820 2211.

Telecom & Olex win $30 million Pakistan contract

An Australian high technology joint venture between Telecom Australia (International) Ltd and Pacific Dunlop Limited's Olex division has won a $30m contract for a major telecommunications project in Pakistan.

The contract involves the supply, installation and commissioning of some 2,000km of Australian manufactured optical fibre cable along the country's main communications route between Karachi and Islamabad.

Olex will supply the optical fibre cable and Telecom Australia (International) will be responsible for project management, including route survey and specification work as well as oversighting the installation of the cable and associated transmission equipment.

Announcing the contract, Minister for Telecommunications and Aviation Support Mrs Ros Kelly noted: "It's excellent to see that Telecom Australia (International) has been awarded this contract with Pacific Dunlop (Olex) to supply the optical fibre network to Pakistan", Mrs Kelly said.

The Managing Director of Pacific Dunlop Mr. Philip Brass said that he believed it to be one of the largest export orders ever for Australia's high technology telecommunications industry.

AWA team bids for $500 million Jindalee radar network

AWA has joined with Computer Sciences of Australia (CSA), Transfield and General Electric (GE) in bidding for the Commonwealth Government's $500 million Jindalee Operational Radar Network (JORN) contract.

AWA will be the prime contractor, with the other three companies operating as dedicated subcontractors.

Jindalee is a revolutionary Australian-developed radar technique that enables defence forces to carry out surveillance over immense areas far beyond the limits of conventional radar. It detects air and sea targets by bounding high frequency radio waves off the ionosphere. Reflected energy is gathered by large antenna arrays and analysed by computer systems.

The operational system will include a transmitting site, a receiving site and a

Airvision unveils in-flight TV monitors

A new range of in-flight monitors and related hardware was unveiled by Airvision, the Warner Bros/Philips joint venture, at the Paris Air Show.

Airvision's new Model 30 monitors, which give vivid, full-colour images and on-screen displays, are now available for every class of airline service. These feature distinctive styling and increased flexibility of movement.

Six channels of video entertainment are available on the enhanced LCD (Liquid Crystal Display) screens, which give crisp pictures in the cabin, regardless of light levels. New push-button controls on each set allow passengers to adjust brightness or volume easily.

The new units have optional audio and video jacks, which allow input from other portable video playback units, such as cassette players and camcorders.

Airvision's entertainment system has been extensively tested by major airlines including Qantas and British Airways. Results from passenger surveys have been very positive, with 69% of users saying they would be more likely to choose a carrier with Airvision than one without it.

This has been reinforced by the presentation to Airvision at a ceremony in Atlanta, Georgia, of Airline Executive magazine's 1989 Industry Award for 'contributions to passenger comfort'.

radar operations cell in Queensland with a similar configuration in Western Australia.

Mr. Sam Makeham, AWA'S General Manager, Major Projects, said: "AWA, CSA, Transfield and General Electric are all experienced defence contractors with international reputations. They bring a wealth of complimentary skills and expertise to the project."

"The team will design and build a system that precisely meets the needs of the Australian Defence Force. It will be an Australian solution designed in Australia for Australian conditions."

"The AWA team recognises the critical importance of the JORN project to Australia's defence and self-reliance. All four members are fully committed to providing a system that ranks among the most advanced in the world," said Mr. Makeham.

For more information please contact Roger Searle on (02) 887 7111 or Brian O'Shea on (02) 489 6496.

Festival Records doubles tape duplication capacity

Festival Records has added a new Lyrec P-4400 'master loop bin' to its tape duplicating facility, a move which is capable of increasing production capacity by as much as twofold, according to Festival's Barry Nagel.

The master loop bin represents a new approach to tape transport design, enabling improved quality and accelerated high speed duplication of audio cassettes in a cost-efficient way.

Festival's dual master Lyrec P-4400 with eight P-2500 slaves is a two-speed system, able to duplicate cassette tapes at a speed of 32 times normal or 80 times normal.

Says Barry Nagel: "At 32 times normal speed, the Lyrec increases our production capacity by about 40%; at 80 times, it doubles our capacity."

The increased capability is in response to the continuing strong market demand for audio cassettes. "Compact disc has experienced a surge in demand, but while this has affected sales of 'analog' records (12" long-play albums and 7" singles), which have come to a plateau as far as demand is concerned, the market for cassettes is still very much alive, and on the rise."

News Highlights

Winner of our satellite TV system

The winner of the *Electronics Australia* subscription promotion lottery, conducted in our April – June 1989 issues, was subscriber Mr R.M. Backhouse of Mollymook, NSW. Mr Backhouse wins the complete satellite TV receiving system from Space Communications International (SCI) and Grundig, valued at over $11,500.

Components of the system are a top-quality 3.7m SCI gelcoated FRP dish antenna system fitted with LNA and block down-converter, a Grundig STR 201-plus satellite receiving unit and a Grundig M70-390/9 28" multi-standard colour TV receiver/monitor, together with all cabling and free installation.

First Australian microelectronics degree

Australia's first School of Microelectronic Engineering will begin classes at Brisbane's Griffith University in 1990.

Up to 60 students will be accepted into the inaugural class of the four-year Bachelor of Microelectronic Engineering.

Queensland industry and technology Minister Roy Borbidge officially launched the university's new microelectronic facilities, valued at about $5 million.

Leaders in the field from throughout the world attended the launch, including Professor Stan Hurst, dean of microelectronic engineering at the Open University in England, Dr. Wolfgang Wach from the German division of the American giant AT&T, expatriate Dr Neil Weste who now has his own microchip company in the United States, and Dr. Tony Walton from the University of Edinburgh.

Griffith University's Vice-chancellor Professor Roy Webb welcomed the support of the State Government which has already provided a $100,000 grant to create "clean rooms" in Queensland's first microelectronics integrated circuit fabrication facility.

News Briefs

- Melbourne-based semiconductor distributor ***NSD Australia*** has added Rockwell Semiconductor Products, a division of Rockwell International, to its current product line. The company has also appointed Howard Hathaway to the position of Product Manager, National Semiconductor and Rockwell products.
- Following its acquisition last year of a 26% interest in Perth-based Computer Protocol, data comms specialist ***Datacraft*** has changed the name of its local operating subsidiary to ***Datacraft Computer Protocol***.
- After assessing and negotiating with a number of local instrumentation firms, well known maker of digital storage oscilloscopes and fast pulse instrumentation Le Croy has appointed Melbourne firm ***Scientific Devices Australia*** as its exclusive Australian representative.
- Mr R.E. (Dick) Brett, Executive Director of the Australian Electrical and Electronic Manufacturers' Association, has been elected for a 3-year term as President of the ***International Electrotechnical Commission (IEC)***, at the Commission's annual meeting in Brighton, UK. The Geneva-based IEC has 43 member countries, Australia being represented by Standards Australia.
- ***Promark Electronics***, part of the Electron House Group, has been appointed Australian distributor for Harris Semiconductors. As Harris acquired the GE Solid State Division last December, this adds to the Promark semiconductor range not only Harris devices, but those of GE, RCA and Intersil as well.
- Melbourne power semiconductor maker ***Fastron*** has been acquired by a local investor, and has become ***Fastron Australia***. Major agencies have been retained and all staff transferred to the new company. The company makes diodes and thyristors under licence from AEG of West Germany, and also distributes other AEG power semiconductors.
- Antenna and RF combiner manufacturer ***Radio Frequency Systems*** (RFS), of Kilsyth in Melbourne has appointed the Communications Division of ***Hills Industries***as its agent for Queensland. Hills will handle the full range of RFS products made in Kilsyth, as well and the Celwave product range.
- US laser stabiliser and control system maker Cambridge Research and Instrumentation Inc has appointed ***Warsash*** of Sydney as its exclusive distributor for Australia and New Zealand.
- What is mooted as the first seminar for technical writers in the Southern Hemisphere is to be held on October 21 and 22 at Kuring-gai College of Advanced Education in Sydney, and is expected to be attended by experienced writers from all over the region. The seminar will be opened by Assoc. Professor Robert Eagleson of Sydney University's English Department. Further information is available from Phil Cohen on (02) 27 3437, or by contacting the NSW Society for Technical Communication, PO Box R812, Royal Exchange NSW 2000.

Binary Engineering wins ATE export order

In a breakthrough for the Australian electronics industry, Binary Engineering of Brookvale in Sydney has supplied the first of two of their wholly Australian designed and manufactured CTS Series ATE systems to a Hong Kong based fax and telecommunications manufacturer, in an initial order totalling A$100,000.

The Hong Kong based manufacturer, who declined naming due to competitive reasons, has reported a 300%–400% leap in productivity following the installation of the first system, allowing in excess of 7000 fax PCBs to be tested per month.

"We were up against PC based ATE systems from the UK and US, but won the order because of the CTS Series' complete digital/analog functional and in-circuit test ability, which is unusual in PC based ATEs. Our customer was also impressed by Binary's local origin," said Tony Richardson, Technical Director and founder of Binary.

Richardson also commented that he and the Binary team were pleased to be not only stemming Australia damaging dependence on imported ATE, but were especially pleased to be reversing the flow and demonstrating this country's technical ability abroad.

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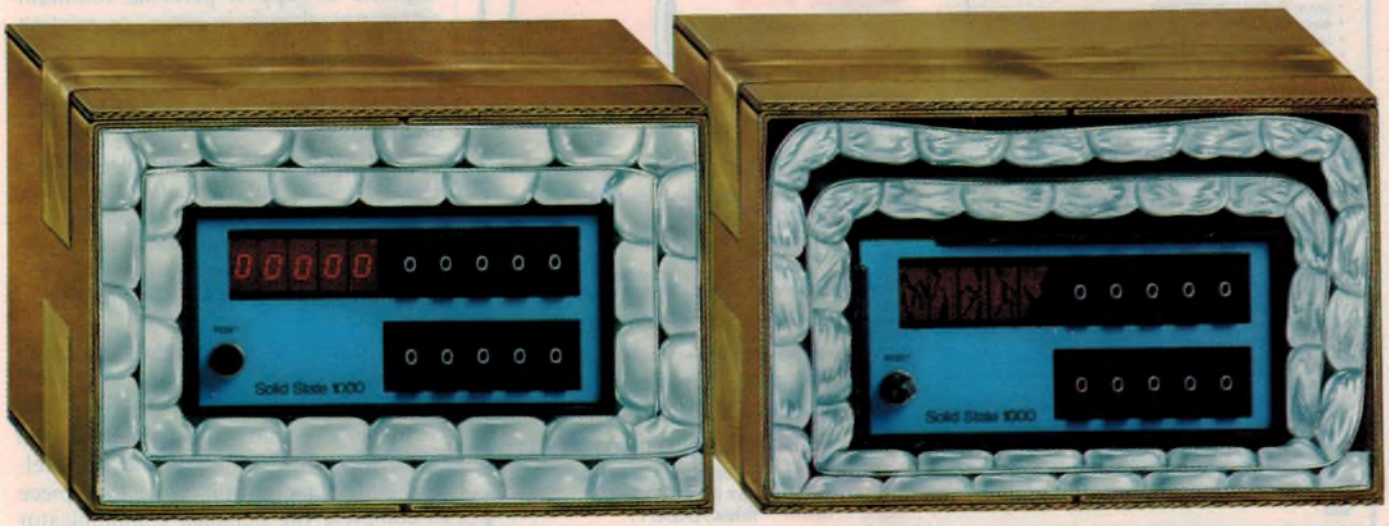

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Aust. telescope detects Soviet spy satellites

Scientists from the University of California at Riverside, carrying out gamma ray astronomy experiments in Alice Springs, have detected radiation from Soviet nuclear-powered spy satellites – believed to be orbiting 800km above the earth, and monitoring nuclear weapons on the West's naval ships and submarines.

The scientists were using a balloon-borne gamma ray telescope, and detected interference which was 50 times stronger than that from the celestial sources being studied. Suspecting Soviet nuclear-powered satellites, the scientists enquired but were first told that the information was classified. However shortly afterwards NASA made public information about the existence of the satellites, and this has since been admitted by the Soviets.

The USA itself currently has no nuclear-powered satellites in orbit, but these are apparently included in plans for the Strategic Defense Initiative.

Global pocketphones for all

Global personal communicators-pocketphones that will work anywhere in the world - will soon be as common as pens and wallets in shirt pockets and purses. That's the prediction of Olof Lundberg, Director General of the world mobile satellite organisation, Inmarsat.

The prediction was one of many contained in Lundberg's closing address, 'Futures Possible' at the Inmarsat 10th Anniversary Conference on Mobile Satellite Communications at the Queen Elizabeth Conference.

Much of the technology and systems required to support personal communicators was already in place, or existing, Lundberg said.

"By the mid-1990's we can expect to buy cellular handsets weighing less than eight ounces."

"The integration of cellular, cordless and telepoint will bring together three of the four major pieces necessary to usher in true global personal communications. It will do nicely for the chap who is always in range of these networks."

The fourth piece is satellite communications.

"It is the integration of the terrestrial cellular, telepoint and mobile radio technologies with those of mobile satellites that snaps into place the final piece to complete the personal communicator jigsaw puzzle," he said.

GSA Technology to scramble crime fighters

Australian firm GSA Technology has won two major contracts to supply secure voice devices for radios to the Royal Hong Kong Police Force. The Melbourne-based company will supply the devices as part of contracts worth more than A$2 million.

GSA Technology defeated several international companies to win the contract, with a system said to be one of the most flexible of its kind available anywhere in the world.

Designed by GSA Technology in Australia for two way radio systems, the product can be supplied in three secure levels, offering up to 10^{35} permutations. Effectively this means that the system offers a variety of several hundred billions of scramble codes.

The overall contracts for the supply and installation of new radio systems has been won by Philips Telecommunications and Data Systems Division.

The Managing Director of GSA Technology, Mr Geoff Ross said that his company's equipment would be resident within Philips mobile and portable radios.

Universal skyphones closer

The London-based International Maritime Satellite Organisation (INMARSAT) has joined forces with the International Civil Aviation Organisation (ICAO), to plan and provide airborne satellite communications for both airliner crews and their passengers.

Under a co-operation agreement signed at ICAO'S headquarters in Montreal, the two organisations will meet regularly and set up co-operative working arrangements for the new aeronautical satcoms.

Mr. Peter Wood, manager of INMARSAT aeronautical services, commented: "This Agreement marks an important stage in the evolution of a satellite network to meet ICAO's requirements for future global air navigation services."

INMARSAT, a global satellite operator with investors from 56 countries, provides mobile communications worldwide. Almost 9,000 ships and land transportable units currently use the INMARSAT Standard-A satellite communications system for direct-dial telephone, telex, facsimile and data communications.

Successful launch of Olympus 1

The highly advanced Olympus 1 communications satellite, built by a consortium of aerospace companies led by British Aerospace (Space Systems) Limited, has been successfully launched by Ariane rocket from the Guiana Space Centre, Kourou, French Guiana.

Olympus 1, built under contract to the European Space Agency, is the world's largest and most powerful civil three-axis stabilised communications satellite. Designed as a technology demonstrator, Olympus 1 employs a range of innovative satellite and payload technologies. Weighing 2612kg (5,758lb) at launch, it uses a bi-propellant fuel system to power the satellite's on-board liquid apogee engine (LAE) and 16 reaction control thrusters.

Olympus 1's flexible solar array provide the spacecraft with up to 3.6kW of electric power. The Olympus power subsystems and design can accommodate larger arrays measuring up to 56m (184ft) provide up to 7.7kW to meet predicted trends for increased power which will be necessary for future high powered services such as high definition direct broadcast television.

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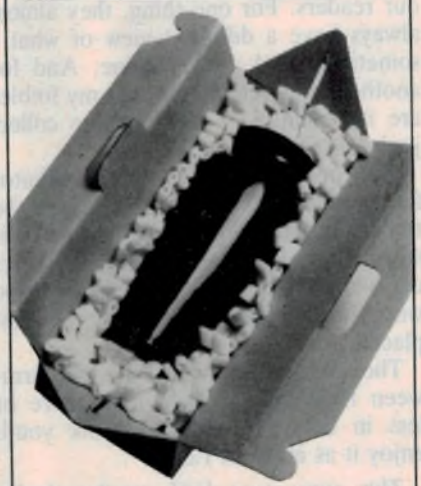

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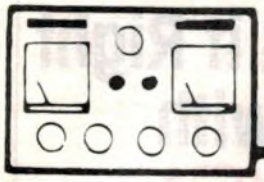


The Serviceman

The snow that wouldn't go — and other frustrating cases

This month we have a couple of stories from readers, and one from my own workshop. One of the readers had a very frustrating TV set with 'snow' that took ages to track down, while I almost tied myself in knots trying to re-string a dial cord...

It's always interesting to hear from our readers. For one thing, they almost always have a different view of what I sometimes find mere routine. And for another, they remind me that my foibles are not unique – other people collect junk just like me!

For instance, our first contributor feels just the way I do when we see the things people throw on the tip. His story concerns a junked TV and finishes up with a delightful suggestion as to why the set was dumped in the first place.

The story comes from F.K., of Girraween NSW, and is told here more or less in his own words. I think you'll enjoy it as much as I did:

This story goes back to the closing days of the B&W television era in Australia. Colour TV had just been introduced, but most service technicians still had very little contact with these receivers.

During this time I was still committed to servicing B&W receivers. The company I worked for had a huge number of these still under maintenance contracts, although this situtation was changing rapidly.

During my daily rounds I collected a number of older B&W sets that customers wanted to get rid of. After cannibalising these for useful parts, the junk was taken to the local tip. These trips became quite routine for a while.

(During these visits I couldn't help but notice the number of sets which had been dumped by owners themselves. Sometimes it was hard to accept such a fate for complex electronic equipment.)

I developed a certain amount of curiosity while making these trips. So it was that one day I stumbled across a 17" fully transistorised National B&W portable, a model TR171 if I remember rightly.

The rear cover of this set was still in place, the cabinet was like new, but the picture tube had been totally blown out. The only glass left was at the CRT mounting points.

At first glance the chassis seemed to be intact and there were no visible breaks on the PC board. I thought this was a real find, as at the time this set in working condition was worth quite a bit, being fully transistorised.

I thought I'd take the set home and do it up for my own use, but I couldn't help wondering why such a relatively new set had been dumped in the first place. I obtained a regunned tube and while removing the remaining glass of the old tube I noticed heavy chunks of green glass lying in various corners of the set. I wondered how this had got inside the set, but couldn't explain it because the TV had not been lying near other likely debris when I found it.

I thought no more about it, as I fitted the regunned tube and examined the chassis for possible physical damage. Everything seemed intact, which surprised me because I would have expected there to have been at least one fault with it. Why else would it have been junked?

I switched on and to my amazement the set worked! Raster size was correct and after the hold controls were adjusted everything was stable with good video and sound. Needless to say I was very surprised, but after my excitement subsided I noticed the snow on the picture.

This was probably due to the telescopic aerial, I thought. It was either not connected or not extended. I corrected this but the snow persisted. Adjusting the AGC controls made no difference either, so I put the back on and left the set as it was. After all, I had a picture and that was a big improvement.

After a week or so I got tired of the snowy picture and thought it was time to investigate. All connections between aerial and tuner seemed in order, so I proceeded to the tuner itself.

I measured the RF AGC voltage, the level of which indicated the RF amp was working at maximum gain. But this shouldn't be, as I get a strong signal in my location.

Just to make sure there were no AGC problems, I connected an external 9V source to the AGC line. I varied the applied voltage and at no setting did the snow disappear. So the problem had to be in the tuner.

I put the set aside and some time later began the task of disassembling the tuner to get at the RF transistor. It seemed to be in order, but I had a good substitute on hand and thought replacement was the best way to go.

With some confidence I reassembled the tuner and switched on – but there was no change! My frustration was intense and it was some weeks before I returned to the job.

This time I checked the mixer transistor, as these can sometimes produce a snowy picture. It was OK, but I replaced it with a good substitute. I checked the surrounding circuitry for any visible faults, but could find nothing.

After this thorough going over I was confident I had the problem licked. But at switch on, the picture was still snowy. I was fed up and just put the set back together again.

It was several months before I made another attempt to solve this riddle. This time I almost rebuilt the tuner, but the picture was still as before. I resigned myself to the fact that this set was always going to be snowy. It was a second set and the picture was watchable, so it didn't matter all that much.

About a year later I was moving the set around when I happened to glance at the aerial terminals. In usual fashion the telescopic aerial was connected to the antenna terminals on the cabinet back, via a short length of 300 ohm feeder. This feeder terminated in two spade terminals, crimped onto the feeder wire.

The cable ends were crimped alright, but not onto the copper of the feeder. They were crimped onto the black insulation! (The terminals were not of the type which are designed to penetrate insulation).

An ohmmeter confirmed my suspicion

that there was an open circuit – but everything was original! The set must have left the factory that way. After soldering the feeder to the terminal ends the set worked perfectly and I began using it more frequently, with considerable satisfaction after solving such a long standing problem.

Then one evening I noticed a glass ashtray on the table near the set. It struck me that this was of the same type and colour as the chunks of stained glass which were inside the cabinet when I found the set. Furthermore the shape of some of the chunks was also similar to the shape of the ashtray.

So I suspect that the glass fragments found inside this TV set had come from an ashtray. Had the original owner in a final bout of frustration with his snowy picture thrown his heavy ashtray at the set? I wonder!

Thanks, F.K. – and I agree with your theory about the set's demise. I can just imagine the original owner, after a Sat'dy arvo at the footie, settling down to watch the replays of his team being beaten, while trying to make sense of the umpire's decisions through the snowy image on his telly.

A particularly bad call by the ump was the last straw and the owner threw his ashtray, the first thing that came to hand. I've felt that way myself at times!

The only question I would ask about this whole exercise is why did nobody think to connect an external antenna. This adventure could not happen at my place, because I can't get any reasonable reception on rabbit ears or an indoor spiral inside my (foil insulated) workshop. I *have* to use an external antenna and this would, of course, bypass the problem area in F.K's story.

But don't think that because his story is fourteen years old it couldn't happen now. There are still plenty of those antenna connections on new B&W portables and on not-so-new colour TV's, as well as on the common 75/300 coax baluns. So watch out for it!

Dead amplifier

My second contributor this month is L.K., of Daintree via Cairns, in Queensland. His story is much more straightforward and concerns a stereo amplifier and the difficulties that simple faults can introduce. Again, I'll let L.K. tell the story in his own words:

This story concerns an Hitachi amplifier model HA330 that came into the shop recently.

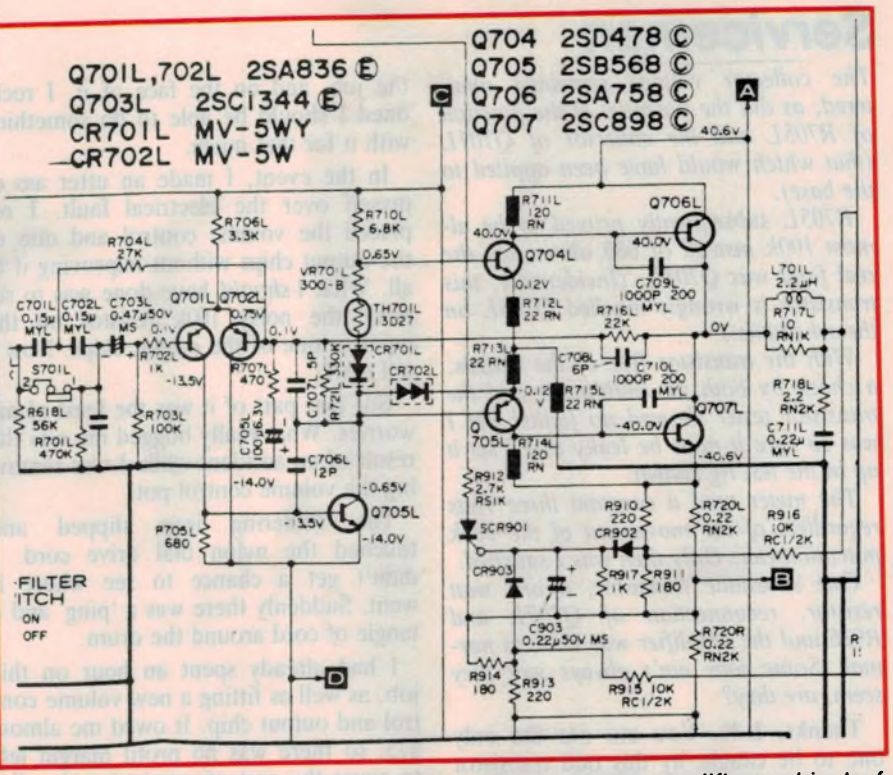
The customer said the unit was dead and asked if I have a look at it 'fairly soon' as it was wanted for a forthcoming birthday party.

I guessed it would be a straightforward fault, so I suggested he come back the following afternoon. What a surprise was in store for me!

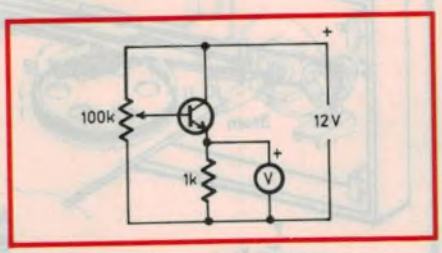
I set it up on the bench and connected a dummy load. At first glance it seemed to be working normally. A closer look, however, established that although the right channel was nicely balanced about the two voltage rails, as measured on the output transistors, the other channel had an output voltage of about –30 volts.

A little baffled by the customer's assertion that the amplifier was 'dead', I fished out the circuit and then, as the old saying goes, the penny dropped.

The design included a relay to disconnect the speakers in the event of a malfunction, and the minus thirty volts from the left channel was sufficient to activate this protection – hence the observed symptoms.



The output stage for one channel of the Hitachi HA330 amplifier, subject of this month's second story.



Here's the little test circuit used by L.K. to check the driver transistor.

I suspected a faulty transistor somewhere in the chain, so I open-circuited the base of Q707L (to effectively break the feedback loop), intending then to take some voltage readings, and thereby deduce the defective component.

I was surprised to find the minus thirty volts still present. "Ah ha!" I thought, "Cracked it in one", as I reached for a pair of replacement output transistors.

When I switched on again it was surprise! surprise! – the negative voltage remained as dogged as ever.

By this time I was sipping a rather tepid cup of coffee and wondering where to go from here. After several minutes of searching the circuit, R916 took my fancy.

I didn't bother to determine its precise function, but it provided a path to the negative rail. Lifting one end made no difference to the outlaw voltage, but again open-circuiting the base of Q707L produced the desired effect – zero volts on the output line – and the relay clicked over in response to the correct conditions.

With the loop now open, a few minutes with the multimeter should have the problem laid low. Two suspicious readings were noted. The base voltage of Q703L seemed a shade high, while the collector voltage was way too low. I wondered if I had two faults here or only one!

I opened the base and checked again.

The collector voltage remained unaltered, as did the potential at the junction of R705L and the collector of Q701L (that which would have been applied to the base).

R705L subsequently proved to be almost 100k instead of 680 ohms, but the real fault was Q703L. (Incidentally, this transistor is wrongly labelled Q705L on the schematic.)

With the transistor free of the chassis, a check by both the multimeter and the transistor tester showed no faults! Yet I was so sure it must be leaky that I set it up in the test rig shown.

The meter read a constant three volts regardless of the movement of the 100k potentiometer. Only then was I satisfied.

One substitute transistor, a one watt resistor, reconnection of Q707L and R916 and the amplifier was back to normal. Some jobs ain't always wot they seem, are they?

Thanks, L.K. You are not the only one to be caught by this odd transistor behaviour. Many times I have been puzzled by an apparently shorted transistor that isn't shorted when the power is removed.

My theory is that that the transistor turns itself into an SCR and goes short when any voltage is applied to the base. Removing the base drive restores the open circuit that should exist between a normal collector and its emitter.

The trouble is, of course, that similar symptoms can occur from an external fault in practical circuits. So L.K.'s test rig is really the only way to prove that the transistor is a dud. Thanks again, L.K.

All strung up

Now, for my own short exercise – although I only wish it had been. Have you ever had one of those dreams where you are trying to catch a train, but no matter how fast you run, the station is always too far away?

I had something like that recently, and although I kept hoping I'd wake up to find it was only a bad dream, it just kept on and on for most of two days and had me tearing my hair out (well, what's left of it!) with frustration.

I had been asked to fix a Sanyo 3-in-1 stereo that was exhibiting a scratchy volume control and distortion in one channel. It was a GXT4503K, a mid-range model capable of reasonable performance, but not one that warranted any extended repair work.

The owner said she didn't want to spend more than about $60 – $70 on the job, and on the face of it, I reckoned I should be able to do something with it for that much.

In the event, I made an utter ass of myself over the electrical fault. I replaced the volume control and one of the output chips without improving it at all. What I *should* have done was to replace the noisy 100k resistor on the input to one of the output chips. Now I tell me!!

But that part of it was the least of my worries. What really bugged me was the result of an accident while I was removing the volume control pot.

The soldering iron slipped and touched the nylon dial drive cord. I didn't get a chance to see where it went. Suddenly there was a 'ping' and a tangle of cord around the drum.

I had already spent an hour on this job, as well as fitting a new volume control and output chip. It owed me almost $75, so there was no profit margin left to cover the cost of restringing the dial – even if it was an easy job, which it wasn't!

The problem was, of course, that without the dial the radio wouldn't work and without the radio the whole thing was useless (as far as the customer was concerned). I had no option but to restring the dial, no matter how long it took.

Dial cord stringing is one of those occupations considered to be undesirable by 100% of the workforce – or at least by 100% of the service technicians I've ever met. I'm happy to say that I finally got the job done, but you'd never believe the aggravation it gave me before it was finished.

It's very rare to be able to restring a dial drive without reference to the service manual. On this occasion I considered myself to be lucky, because I had a copy of the manual for this model and it included what appeared to be a clear diagram of the dial stringing layout. The drawing agreed closely with the actual arrangement in the set, and it looked as though the job would be straightforward, even if a bit more complicated than most similar jobs. Little did I know what fate had in store for me!

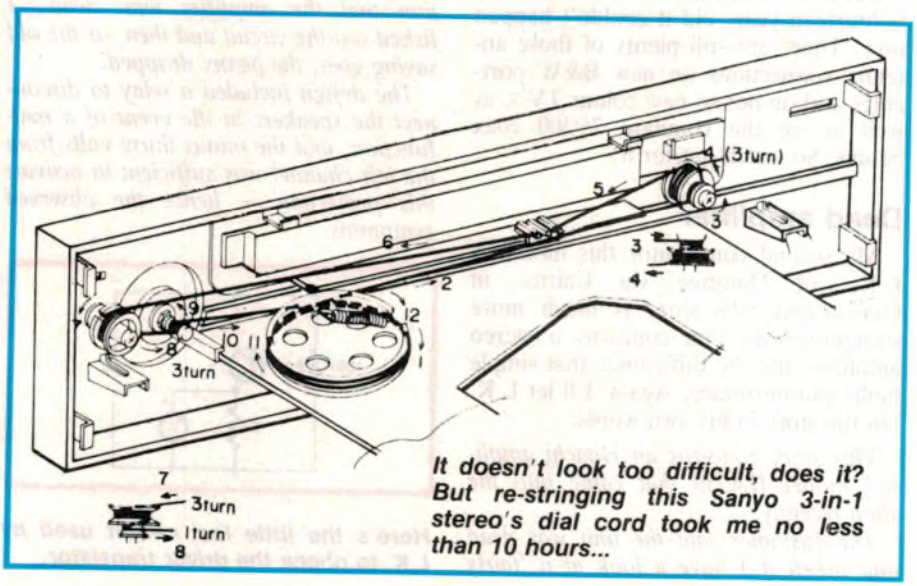
I began by attaching the new cord to the tension spring and lacing the first loop around the drum, as shown by (1) in the diagram. The lead (2) across and around the first pulley (3) was easy enough. But when it came to getting the three turns around the larger pulley at (4) I began to wonder if the designer of this system had his head on the top or the bottom.

There was no way that I could wind the three turns easily around the pulley. Each turn had to be laced in behind the cord (2) and taken around the pulley one turn at a time.

This in itself was quite difficult, but it was made much more so because the cord kept slipping off the drum and the first (smaller) pulley.

I tried time and time again to get the cord past the first pulley, before I decided that this couldn't possibly be the right way to go. I had spent nearly four hours trying to lace the cord as shown in the diagram and it simply would not stay in place.

If this had been the designer's intention, the production manager would have killed the model before it ever got started.



It doesn't look too difficult, does it? But re-stringing this Sanyo 3-in-1 stereo's dial cord took me no less than 10 hours...

So it seemed that if 1, 2, 3 and so on was not the right way, then 12, 11, 10 etc. would be the only other way to go. And so it appeared to be.

There were few problems in getting the cord into position this time, and a few minutes later I was able to try the tuning knob. It was funny, though! The pointer insisted in staying in the centre of the dial. If I tuned towards either end of the dial, I had the odd experience of seeing the pointer slowly winding itself back to the centre.

Quite obviously there was something wrong, but for some time I couldn't see what it was. Then it struck me. I had omitted the full turn around the drum at (11). This called for an extra 20cm of cord, so I cut a new length and started again – for the 210th time!

After this things were a little better. Now the pointer would stay put over the centre half of the dial – but I had to work out why it wouldn't go the full distance. Several times I tried to force the pointer to the end of the dial, only to have the cord snap on one or the other end pulleys.

In the end, it was careful observation of these pulleys that provided the answer to the problem.

The pulleys are stepped, with one turn of cord around the small diameter and three turns around the larger diameter. So arranged, one of the small pulleys loses its turn soon after the pointer is moved from the centre of the dial. By a similar process, the larger pulley gains a turn. Of course, the opposite occurs on the pulley at the other end of the dial.

In fact, the small pulleys require two turns of cord to accommodate the range of movement needed. It may be that the larger diameters need only two turns for the same range of movement, but certainly the small pulleys are the key to the system and are wrongly illustrated in the manual.

In all, I spent no less than **ten hours** trying to get this dial cord properly strung. What looked like a clear and easy-to-follow illustration turned out to be a most unhelpful and confusing drawing.

And the pity of it all is that if I had been a little more careful early on I would not have had all of this trouble. As I said at the beginning, I kept hoping that I would wake as from a bad dream, but no such luck. To recover any income from the job I had to press on, no matter how long it took.

Just make sure you don't get caught like I did.

'Bye for now. I'll be back again next month.

Fault of the month

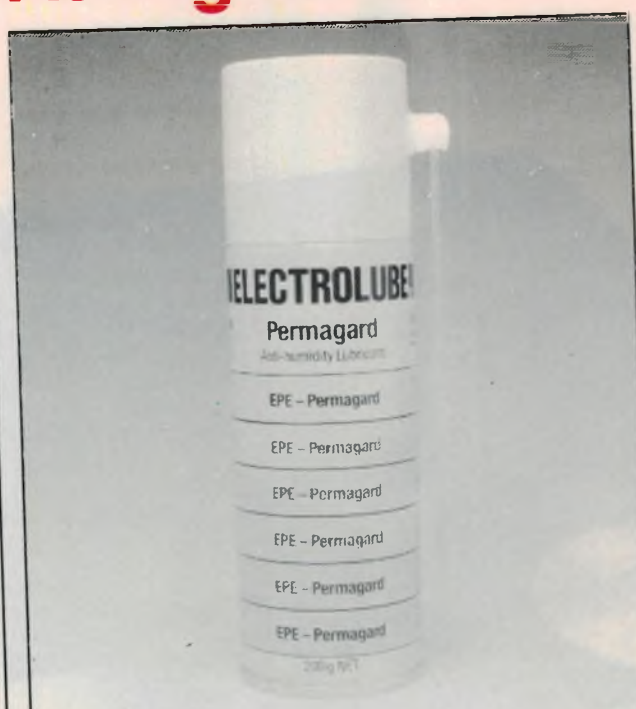
Philips K11

SYMPTOM: Weak or no horizontal sync. Picture pulls to the left at top of screen. Set sometimes goes into hiccupping mode when channels are changed.

CURE: D608 (BAW62) short circuited. This diode is part of the beam current limiter circuit. When it goes s/c it ties the 30V rail to pin 9 on U330, the line control module, thus giving the wrong beam current information to the module. This fault occurred when the earth return from the picture tube aquadag became detached from the line output board.

This information is supplied by courtesy of the Tasmanian Branch of The Electronic Technicians' Institute of Australia (TETIA). Contributions should be sent to J.Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

Acting In Defence Of The Ozone Layer



From Australia-Wide Dealer Network

Electrolube is set to be the largest manufacturer of electronics grade aerosols based on ozone-friendly propellant, having converted its extensive range of aerosol products to non-flammable Propellant 22 (FC22). The development comes at a time when industry as a whole is making stringent efforts to reduce the use of ozone depleting substances as set out in the Montreal Protocol.

Switching from fully halogenated (cfc) propellants has entailed investment in a new aerosol production line and bulk storage facilities for Propellant 22. The aerosols cover the full Electrolube range of cleaners, coatings, lubricants and service aids.

Non-toxic and non-flammable, Propellant 22's propelling qualities are equally as good as the cfcs used previously. However, this alternative has the environmental advantage of a hydrogen atom in its chemical formula which ensures the breakdown of the molecule within the atmosphere rather than in the ozone layer.

Electrolube chose Propellant 22 as the best alternative after holding extensive trials with a number of other possible propellant methods. Hydrocarbons such as butane were considered unsuitable because of their flammability, especially for electrical and electronic applicfations where arcing might occur. As for the other options, air pumps were discounted because they give an uneven spray and require pump action at each application.

Carbon dioxide propellants, as well as being unsuitable for use with water-based products, were found to give variable pressure — with the spray area and the level of penetration reducing in proportion to the contents.

Electrolube products are also available in non-aerosol packaging including bulk packaging, squeeze bottles, syringes, pens and tube dispensers.

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Hifi Equipment Review:

Pioneer PD-Z72T twin-tray CD player

Seemingly not content with its existing standard single-disc CD players and innovative multi-disc players, Pioneer has now come out with a further variation: the two-tray player, which allows loading of one disc while another is being played. This allows things like continuous playback and mixed programming of music from two different discs.

At first sight, the idea of having a CD player with two trays may seem an unnecessary luxury, or perhaps just a marketing gimmick. Why would you want a second tray?

In fact, though, it turns out to be surprisingly handy to have a second tray. For one thing, it lets you load in the next disc while one is already playing, for virtually continuous playback. When one disc ends, the player can automatically shuffle the two internally, and begin playing the second with a break only a few seconds longer than between normal tracks. No more long pauses, until you've found that other disc...

You can even make it automatically eject the disc just played, so that you can replace it with another, and have this automatically played after the second – and so on, *ad infinitum* or at least until you get sick of it. Great for keeping the music going at parties (or when you're entertaining), without having to hover around whenever you sense that a disc is nearing its end!

The other worthwhile advantage is that you can program a combination of tracks from two different discs, in any desired order. First say track 3 from disc I, then track 2 from disc II, then track 7 from disc I, and so on. Not that you'd want to do this all the time, perhaps, but it would come in very handy for producing special music sequences to accompany slides or to assemble the sound track for a home movie or video program.

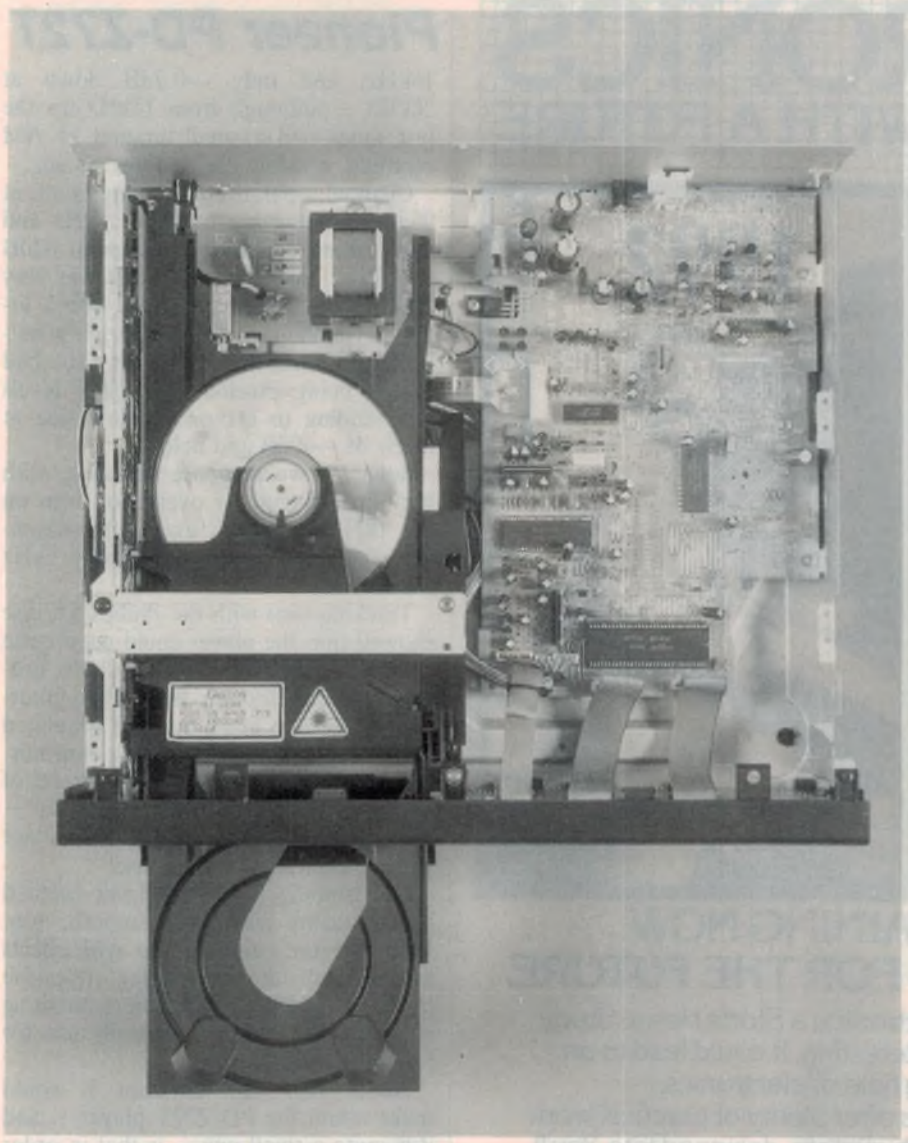
How it's done

Given that it's a good idea having two trays, Pioneer has achieved this enhancement very elegantly and with surprisingly little additional hardware. The complete player fits in a compact case, virtually identical in size to most single-tray players.

The basic player mechanism is quite standard for a current-generation model, with a single direct drive spindle motor and laser pickup sled assembly – consisting mainly of precision moulded plastic parts, with steel items where necessary. But in front of this mechanism, instead of the usual single loading tray assembly there are now two, spaced one above the other and about 20mm apart.

Both tray assemblies are driven by a single micromotor, with an ingenious twin clutch system to engage its drive mechanism with each of the two tray rack-and-cam systems as this is required. Basically each tray can occupy one of three positions: extended out of the front panel for loading or unloading, withdrawn just behind the panel into its 'standby' position, or taken fully back and lowered to mate with the player mechanism for playing.

Normally one or the other of the trays is always in the playing position, and while it is the other can be in either of the two other positions (or being moved between them). Obviously only one tray can be in the playing position at any instant, but providing the other is loaded



A shot inside the PD-Z72T, which is surprisingly compact.

and in its 'standby' position, the two can be swapped within a couple of seconds. In fact with one disc playing, the total time to swap and reach playing speed with the other disc is about 4 seconds – very nifty!

The top stabilising boss of the player mechanism is positioned by a rather longer actuator than usual, so that it can be lifted clear while the trays and discs are shuffled. However apart from this, it appears to be fairly standard. The effective diameter of the boss at the disc surface is about 40mm, and it uses magnetic clamping.

Most of the circuitry of the player is mounted on a reasonably large PCB alongside the mechanism, with a smaller vertical board immediately behind the front panel to support the control switches and fluorescent display. A third and smaller PCB again mounts behind the mechanism, and supports the power transformer, power switch and mains cable terminations.

Electrically the player is quite respectable and up to date, with twin 16-bit linear DACs and digital filtering – although Pioneer doesn't specify the actual oversampling ratio. Specified frequency response is from 4Hz to 20kHz within +0.5dB/—1dB, with a signal to noise ratio of 100dB, dynamic range of 92dB and channel separation of 93dB.

Control functions

From a functional point of view the player is fairly standard, with the usual play, pause, stop, intra-track and inter-track stepping buttons along with those for repeating, programming and random play. However instead of the usual tray open/close button there are now two, one for each tray and marked 'I' and 'II'.

Similarly there are two further 'Disc Select' buttons, used for manual selection of the disc to be played. There's also a button labelled 'Auto eject', used to enable or disable the player's ability to automatically swap discs and eject the first disc when it has been played.

There are actually two ways to achieve continuous playing. One is to press the Repeat key twice during playing; this gets the player to begin playing the 'other tray' disc automatically, when the current disc ends. All you need to continue playing is to keep opening the non-playing tray each time and replacing the discs.

The other approach is even simpler. You simply press the Auto Eject key, which achieves the same thing as before except that the player now automatically ejects the 'played' disc each time it swings over to the next one – prompting you to replace discs again.

Programming the player for sequences involving tracks from discs in both trays is also quite simple. In fact it's much the same as programming a normal one-tray player, except that you can specify one tray or the other by an additional keystroke, using the 'Disc I' or 'Disc II' select buttons.

Incidentally as far as I can see you could have it play quite an involved sequence of tracks from a variety of discs, providing you were present during the program's operation to swap the discs in the trays as they were used.

The program memory will store up to 24 steps, each of which can be the playing of a selected track or a pause. The player will also indicate total program time and track count, providing these don't exceed the display limit of 99:59 and 18 respectively.

Another little feature which could be quite handy is a 'Timer' function. As soon as the player is turned on, it checks whether there is a disc in one of the trays. And if it finds one, it begins playing it from track 1. If it finds discs in both trays, that in tray I takes priority and is played.

So if the player is left with a disc in either tray, and turned on via a timer, it will start playing the disc as soon as it comes on – like your own fully programmable hi-tech and hifi alarm clock, with any wake-up music you fancy (*Wachet Auf!*, perhaps?).

How it went

Checked out in our lab with both the Denon 38C39-7147 and Philips 410 055-2 (Test 3)/814 126-2 (Test 5A) test discs, the PD-Z72T gave quite a good account of itself. Frequency response over 3kHz, still only 0.1dB down at

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ALA/ST6820/EA589

Pioneer PD-Z72T

16kHz, and only —0.7dB down at 20kHz – although from 15kHz up the test tones had a small amount of AM on them, possibly due to filter ringing.

Channel separation was quite good, at 95dB or better up to about 5kHz and then falling off slowly to around 82dB at 20kHz. Signal to noise ratio was very close to the 100dB specified, with a little RFI making is difficult to get a better figure. DAC linearity wasn't too bad either, being excellent at higher levels and tending to err on the low side at levels of —40dB and below.

Square wave response was fine, with very little ringing or overshoot even on the 1kHz waveform, and quite reasonable rendition of the 'impossible' 5kHz waveform.

Tracking tests with the Philips 5A disc showed that the player could cope quite easily with the worst of that disc's 'horrors', sailing through the 900um interruption, 800um black dot and simulated fingerprint tracks with nary a murmur. Mind you, most of the latest breed of players seem to be able to do this – perhaps Philips will have to come out with an even tougher test disc!

On listening tests the player seemed commendably clean and smooth, too. Whatever the cause of the AM effects evident on the frequency response tracks, I couldn't really detect anything amiss on the tracks I normally use for listening comparisons.

About the only criticism I would make about the PD-Z72T player – and it is quite a small one – is that in order to fit two trays into the space normally taken by one, Pioneer has made them rather small and shallow. This makes it a little trickier to lift discs out, with large adult male fingers. You have to slip your little finger into the central hole, and use your thumb to grip the disc edge at one of the two small recesses provided.

On the whole, though, the Pioneer PD-Z72T twin-tray player seems a nice performer, and at the quoted price of only $399 recommended retail it seems excellent value for money – especially considering its extra feature of being able to shuffle discs for continuous and multi-disc playing.

The review sample came from Pioneer Electronics Australia, of 178-184 Boundary Road, Braeside 3195. You should be able to find the PD-Z72T at most Pioneer stockists, but if there are any problems you can ring Pioneer on (03) 580 9911 to find out where it's available near you. (J.R.)

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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.

Remotely adjustable aerial attenuator

This aerial attenuator is useful in controlling receiver cross-modulation problems with strong signals. It gives 2dB minimum to 48dB maximum attenuation over the medium and short-wave bands.

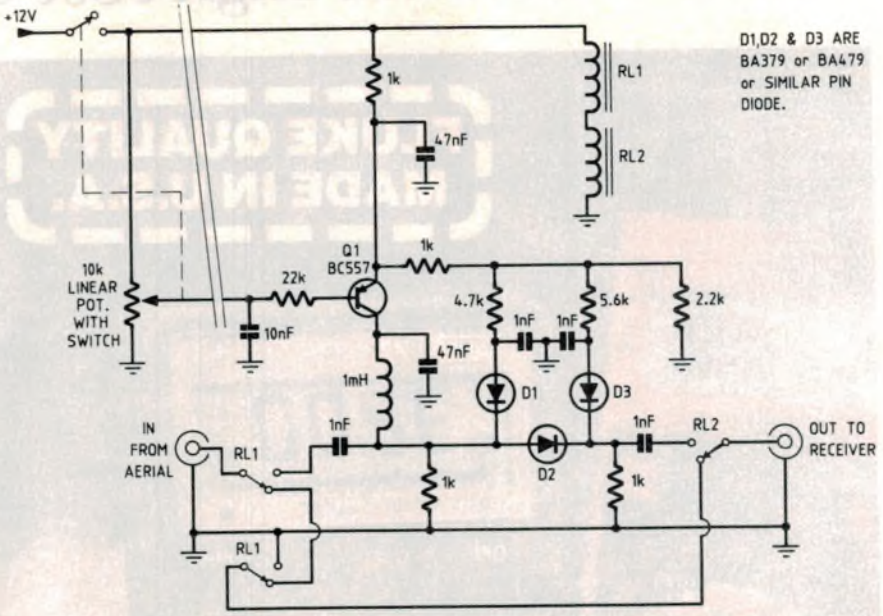
The relays are used to bypass the attenuator when no attenuation is required. They could be omitted if the circuit's minimum attenuation of 2dB is regarded as acceptable. Similarly a single relay with triple changeover contact set could be used, if available.

The 10k pot controls the DC bias on the BC557, which in turn controls the three PIN diodes (BA379, BA479 or similar) to achieve the adjustable attenuation.

I built the unit into a small metal box, with co-axial connectors for aerial input and output to the receiver.

S. Farrand,
Edgewater, WA

$40

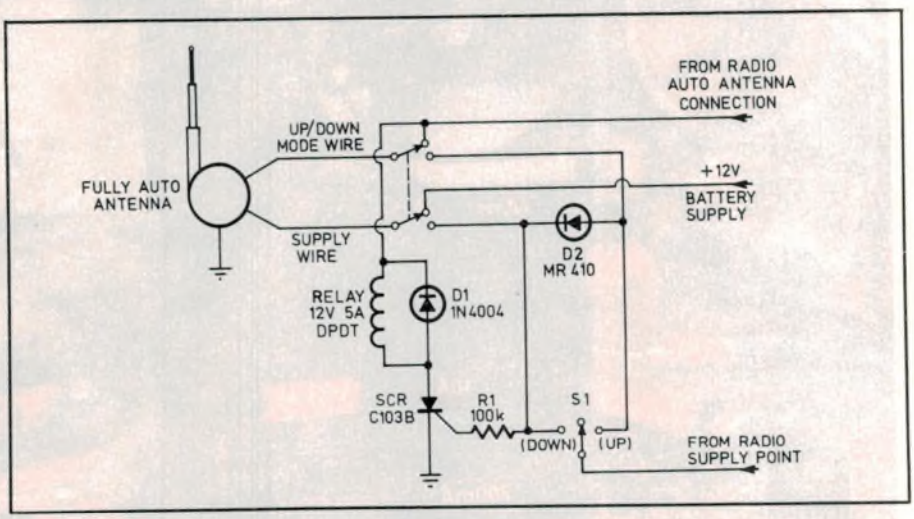


Manual control for automatic car antenna

This circuit allows a fully automatic car antenna to be operated manually when required, allowing any intermediate mast height to be selected. It works as follows.

Normally the DPDT relay is unenergised, which connects the two antenna lines to the car radio for fully automatic operation. However if the manual switch S1 is activated into either 'up' or 'down' mode, while the radio is turned on, the SCR is latched on via R1 (and D2 in the 'up' position). This causes the relay to energise and swing over to the NO contacts.

If S1 has been moved to the 'down' position, +12V will be fed to the supply wire of the antenna only, causing it to retract. However if the 'up' position has been selected, power is also fed to the up/down mode wire, causing the antenna to extend. In this case it is diode D2 which feeds +12V to the supply wire and the SCR via R1.



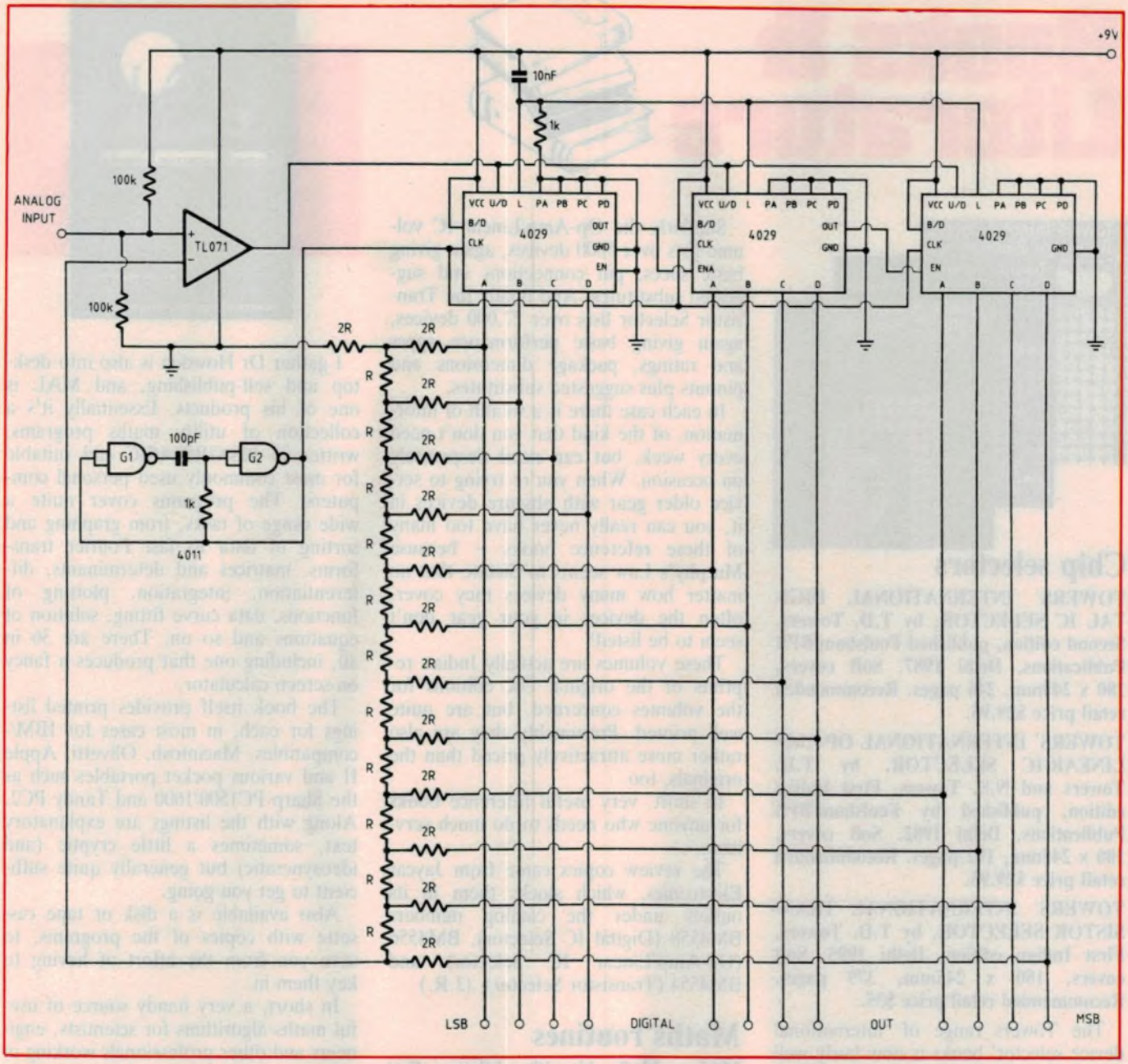
When the radio is turned off, the supply is cut off to the relay and SCR. The relay then drops out, switching back to full auto mode and causing the antenna to retract normally.

R.G. Love,
Highbury, SA

$40

Dreamed up a great idea or circuit?

If YOU have developed an interesting circuit or design idea like those we publish in this column, why not send us in the details? As you can see, we pay for those we publish – not a fortune, perhaps, but surely enough to pay for the effort of drawing out your circuit, jotting down some brief notes and popping the lot in the post (together with your name and address). Send them to Jim Rowe, Electronics Australia, PO Box 227, Waterloo 2017.



12-bit A to D converter

This simple design is based around a bi-directional ramp counter and is useful for designs where cost is more important than stunning results or ready-made packages.

Starting from the front end, the analog signal comes into the non-inverting input of the op-amp. Let us assume that it is a DC voltage of one volt. Upon turning the converter on, the 10nF capacitor allows a pulse through to the LOAD point on each of the three counters, loading a '0000' into each. This is then transferred to the outputs of the counters. This again is then passed through a resistor network acting as a D-A converter, converting the counter value back to a voltage.

Initially, with the counter as '0000' this voltage is zero, which is fed into the inverting input of the op-amp. Thus the op-amp output is high, which tells the counters to count up.

The three counters are connected so that they count synchronously in either direction, so as to reduce any large errors while counting.

Hence, the counters count up (at the rate of about 4MHz) until such a point arises that the voltage from the resistor network is slightly above the input voltage. This causes the op-amp output to go low, and start the counter counting down again, until it goes below the input voltage and the counter counts up again, and so on. In other words, the counters 'hunt' around a final value.

This small ripple is an error of one in 4096, which is quite small and will not be too critical. Only half of the 4011 is used in the square wave clock. You might like to use the other half as an added buffer on the clock output, or as a Schmitt trigger on the output of the op-amp.

The most critical part of the design is the resistor network. I suggest you use 1% tolerance resistors or small mini pots, and measure accurately their values, which must be in the R-2R ratio for it to work correctly.

Layout is critical only in the clock circuit because of the low value capacitor, so keep those leads as short as possible.

Darren Yates,
Frenchs Forest, NSW **$40**

Books & Literature

Chip selectors

TOWERS' INTERNATIONAL DIGITAL IC SELECTOR, by T.D. Towers. Second edition, published Foulsham/BPB Publications, Delhi 1987. Soft covers, 180 x 245mm, 246 pages. Recommended retail price $29.95.

TOWERS' INTERNATIONAL OP-AMP LINEAR-IC SELECTOR, by T.D. Towers and N.S. Towers. First Indian edition, published by Foulsham/BPB Publications, Delhi 1982. Soft covers, 180 x 245mm, 192 pages. Recommended retail price $29.95.

TOWERS' INTERNATIONAL TRANSISTOR SELECTOR, by T.D. Towers. First Indian edition, Delhi 1985. Soft covers, 180 x 245mm, 379 pages. Recommended retail price $35.

The Towers range of 'international device selector' books is now fairly well known, having first been published back in the 1970s, I think, by English engineer and writer T.D. Towers. The idea is that they provide basic technical performance parameters and connection data for a huge number of different devices produced by manufacturers around the world, to assist users with both identification and selection of replacements if the original is unobtainable. This makes them particularly valuable for anyone attempting to service equipment which is now getting a little elderly.

The digital IC volume lists over 13,000 different American, European, British and Japanese devices, giving function, basic input and output capabilities, pinouts and other mechanical data.

Similarly the Op-Amp/Linear IC volume lists over 5000 devices, again giving basic specs, pin connections and suggested substitutes. And finally the Transistor Selector lists over 27,000 devices, again giving basic performance specs and ratings, package dimensions and pinouts plus suggested substitutes.

In each case there is a wealth of information, of the kind that you don't need every week, but can need desperately on occasion. When you're trying to service older gear with obscure devices in it, you can really never have too many of these reference books – because Murphy's Law seems to dictate that no matter how many devices they cover, often the devices in your gear don't seem to be listed!

These volumes are actually Indian reprints of the original UK editions for the volumes concerned, but are quite well printed. Presumably they are also rather more attractively priced than the originals, too.

In short, very useful reference books for anyone who needs to do much servicing.

The review copies came from Jaycar Electronics, which stocks them in its outlets under the catalog numbers BM4558 (Digital IC Selector), BM4556 (Op-Amp/Linear IC Selector) and BM4554 (Transistor Selector). (J.R.)

Maths routines

MAL – Maths Algorithm Library, first edition by Dr Patrick f. Howden. Published by Oneness-Life Press, 1988. Soft covers, 278 x 210mm, 12mm thick. Comes with floppy disk with program files.

Not quite a book, and more than just a collection of useful programs – this one's in a category all of its own.

Sydney-born Dr Howden (middle name 'ffyske') spent two years at CSIRO after graduating at Sydney Uni, then did high-level research in the USA, working in various areas including aerospace and robotics. He has also travelled the world by schooner, tramp steamer, campervan and bicycle, and currently resides in solar-powered self reliance on Macleay Island, near Brisbane.

I gather Dr Howden is also into desktop and self-publishing, and MAL is one of his products. Essentially it's a collection of utility maths programs, written in MS/GWBASIC and suitable for most commonly used personal computers. The programs cover quite a wide range of tasks, from graphing and sorting of data to fast Fourier transforms, matrices and determinants, differentiation, integration, plotting of functions, data curve fitting, solution of equations and so on. There are 36 in all, including one that produces a fancy on-screen calculator.

The book itself provides printed listings for each, in most cases for IBM/-compatibles, Macintosh, Olivetti, Apple II and various pocket portables such as the Sharp PC1500/1600 and Tandy PC2. Along with the listings are explanatory text, sometimes a little cryptic (and ideosyncratic) but generally quite sufficient to get you going.

Also available is a disk or tape cassette with copies of the programs, to save you from the effort of having to key them in.

In short, a very handy source of useful maths algorithms for scientists, engineers and other professionals working in scientific areas. It would also be of value to secondary and tertiary students – to help alleviate tedious number crunching.

By the way, you don't need to be a programming boffin to use these programs. In fact they're intended to be used simply and uncomprehendingly as tools to achieve the desired purpose, as Emeritus Professor Harry Messel notes in his foreword. But you do need to know what you're trying to achieve, maths-wise.

The review copy came from UniQuest Ltd, an arm of the University of Queensland, which is apparently marketing the book/programs. Enquiries to UniQuest, University of Queensland, St Lucia 4067 or phone (07) 377 2899. (J.R.)

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Fig.1

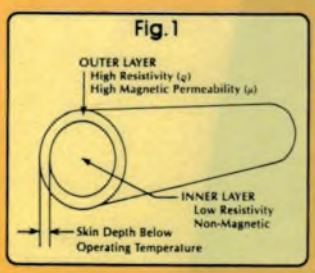


Fig.2

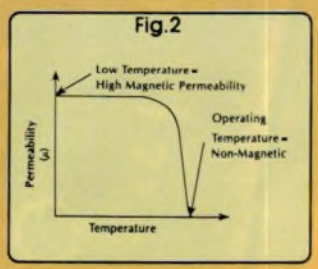


Fig.3

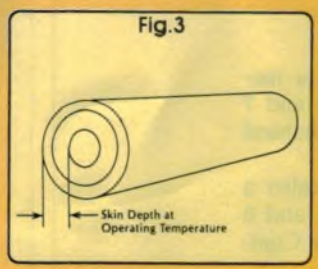
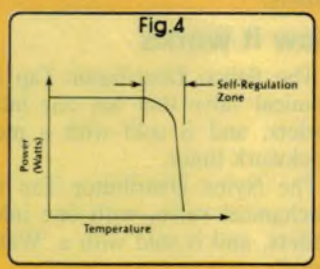


Fig.4



HOW DOES IT WORK?

The "heater" is a laminate of two metallic layers. The outer is a magnetically permeable material with relatively high electrical resistance, the inner a non-magnetic material with low thermal and electrical resistance. The power source supplies a high frequency alternating current which flows near the surface of the laminate due to the "skin effect" phenomenom. When the heater temperature is below its operating temperature, this skin effect causes most of the current to flow in the outer, high permeably layer. **(fig.1)**. Since this layer also has a relatively high resistance, considerable heat is generated by the current. As the temperature increases **(fig.2)**, the magnetic permeability decreases (due to the Curie phenomenom) allowing most of the current to flow through the low resistance inner layer, thus dramatically reducing resistance and heat generation **(fig.3)**. At the design temperature, heat generated and heat used by the tip are in balance and the temperature is maintained at ±2°F. When the temperature of the self-heating tip assembly is reduced by a thermal load, heat generation instantly increases to maintain temperature **(fig.4)**. This process is inherently reversible and provides the industry's first high power, precision, self regulating temperature source.

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Construction project:

Timer/Controller for garden sprinklers

Here's the design for a timer-cum-controller unit for garden watering sprinklers, which can be built for a fraction of the cost of commercial units. It won the author a runner-up prize in our recent Dick Smith Electronics – EA 'Grand Aussie Hobby Electronics Contest'.

by TONY AGIUS

Have you thought about buying an automatic water sprinkler system for the lawns or garden? Perhaps you have, but then perhaps changed your mind when you priced a commercial controller together with the necessary solenoid valves...

A commercial six-sector controller plus six solenoids will cost you around $250. That's OK for the front garden, but what about the back yard? That will cost you another $250. I think you'll agree that's pretty steep for most budgets – well it was for mine anyway, which is why I looked for an alternative.

The Sprinkler Timer design described here will control seven sectors using only *one* solenoid, or 14 sectors using only *two* solenoids.

The use of one solenoid to control seven sectors is achieved by using a device called a distributor tap. The one I use is made by Sabco, and will provide seven selectable outlets from one inlet. Nylex also makes one, which has six outlets.

How it works

The Sabco Distributor Tap is a mechanical valve that has one inlet and 7 outlets, and is sold with a mechanical clockwork timer.

The Nylex Distributor Tap is also a mechanical valve, with one inlet and 6 outlets, and is sold with a 'Water Computer'.

Both the mechanical timer and 'Water Computer' perform the function of turning the water supply to the inlet of the distributor tap on and off. This on/off sequence is important in the operation of the unit, as turning the water on to the distributor tap selects a sector by internally directing the water to the next sequential outlet.

Turning the water off for a couple of minutes causes the distributor tap to select the next sector. Turning the water back on causes the tap to internally direct the water to the new outlet. Turning the water off again selects the next outlet and so on, until all sectors have been watered.

The clockwork timer is a purely mechanical device and once the timed sequence has been completed the unit remains in the off position until you manually rewind the timer.

This is fine, until you decide to go away for a period of time or just simply want an automatic system.

The 'Water Computer' is a sophisticated timer which automates your system, but it costs around $175 (you will need two of these to control more than six sectors).

This is where I decided to design my own timer/controller, to operate the

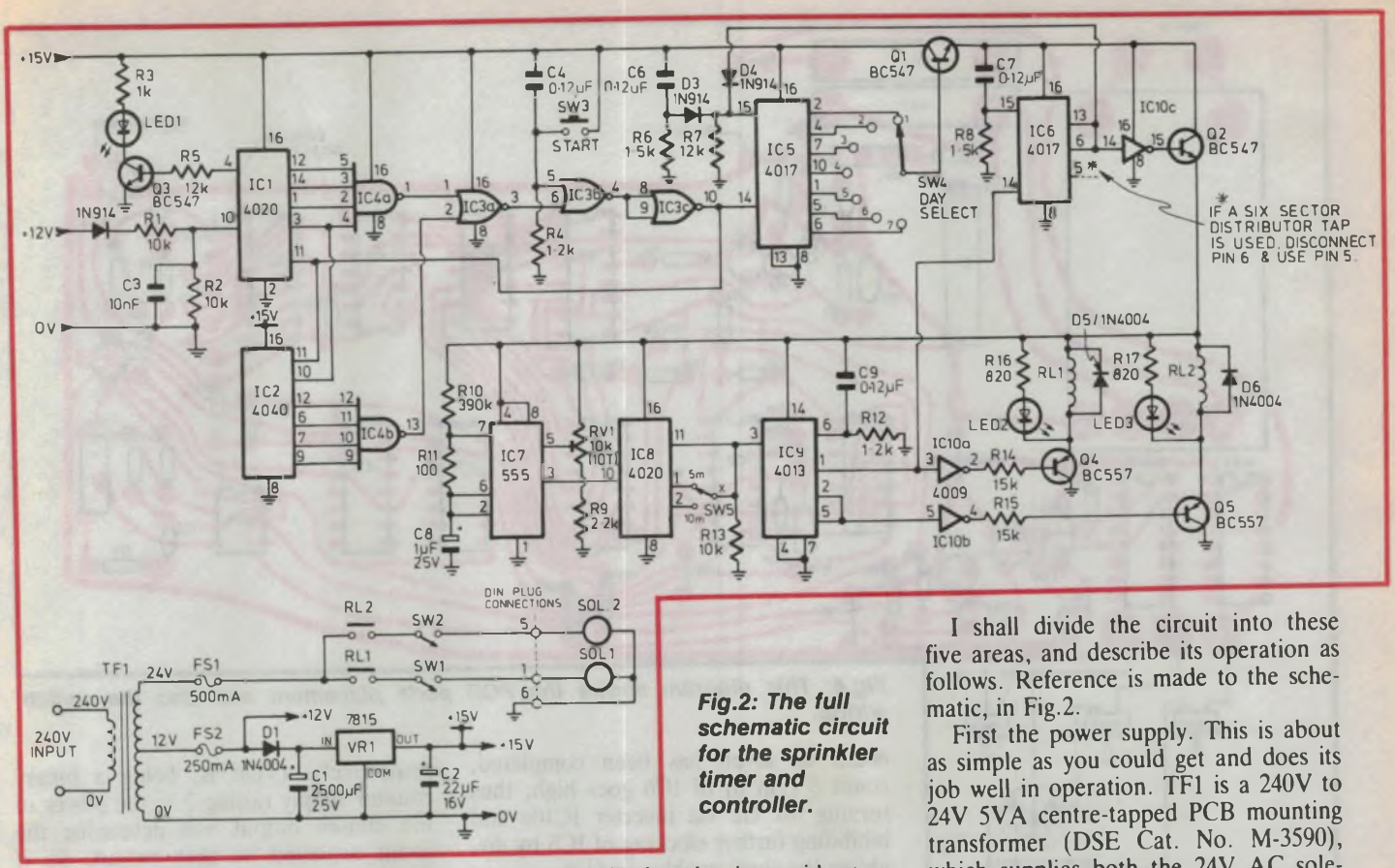


Fig.2: The full schematic circuit for the sprinkler timer and controller.

economical distributor taps. The system I evolved is shown in the block diagram of Fig.1, and works very well.

You see, to set myself up with a commercially available system, using the cheapest solenoid valves on the market (about $18), twelve sectors would cost over $200 in solenoid valves alone. Then I would need a couple of controllers (about $120 each), which brings the total cost to about $500.

The distributor taps cost about $65 each, while my controller can be built for about $80, plus either one or two solenoid valves at around $18 each. This brings the grand total to about $250, or only half the price of a commercial system despite the fact that it provides two more sectors.

Circuit description

What I needed was a controller that would be able to provide the following:

1. Power both the solenoid valve(s) and the controller circuit itself.
2. Allow programming of a 24-hour period.
3. Discriminate between one to seven days.
4. Count up to seven/14 sectors.
5. Time both on and off periods during these seven counts, as well as drive the solenoids.

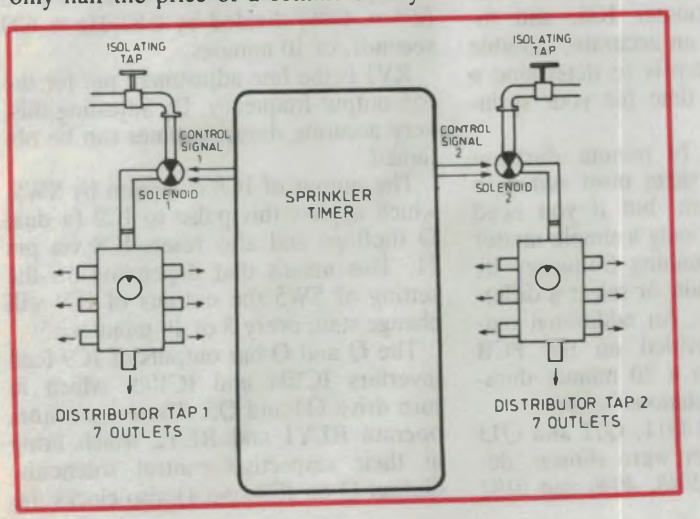


Fig.1: Block diagram of the sprinkler control system based around the author's control unit, together with one or two distributor taps.

I shall divide the circuit into these five areas, and describe its operation as follows. Reference is made to the schematic, in Fig.2.

First the power supply. This is about as simple as you could get and does its job well in operation. TF1 is a 240V to 24V 5VA centre-tapped PCB mounting transformer (DSE Cat. No. M-3590), which supplies both the 24V AC solenoid supply and 12V AC to D1, providing half wave rectification to the filtering capacitor C1. VR-1 regulates the DC output to 12V, which supplies the controller circuit.

D2 provides a half wave signal to the R1/R2 voltage divider, providing a 50Hz timing signal to the Schmidt trigger input (pin 10) of IC1.

IC1, IC2, IC3 and IC4 form a counter, dividing by 4,320,000. This figure is the number of pulses obtained from a 50Hz timing signal in 24 hours).

This is accomplished by using a 4020 14-stage binary counter (IC1) cascaded with a 4040 12-stage binary counter (IC2). The binary output representing 4,320,000 decimal is used to provide a reset pulse via the NAND/NOR gate system using IC3 and IC4, as shown.

Pushbutton SW3 is used as a 'Start' switch, which both resets the timer and provides a clock pulse to IC5, by providing a high logic level to the input of the OR gate formed by IC3b & IC3c.

With SW3 in the normally open position, the timer formed by IC's 1, 2, 3 and 4 provides a clock pulse every 24 hours at the pin 14 input of IC5. This pulse both resets the timer itself and advances the day select counter IC5 (described below), eliminating the expense of having to build a clock/display circuit.

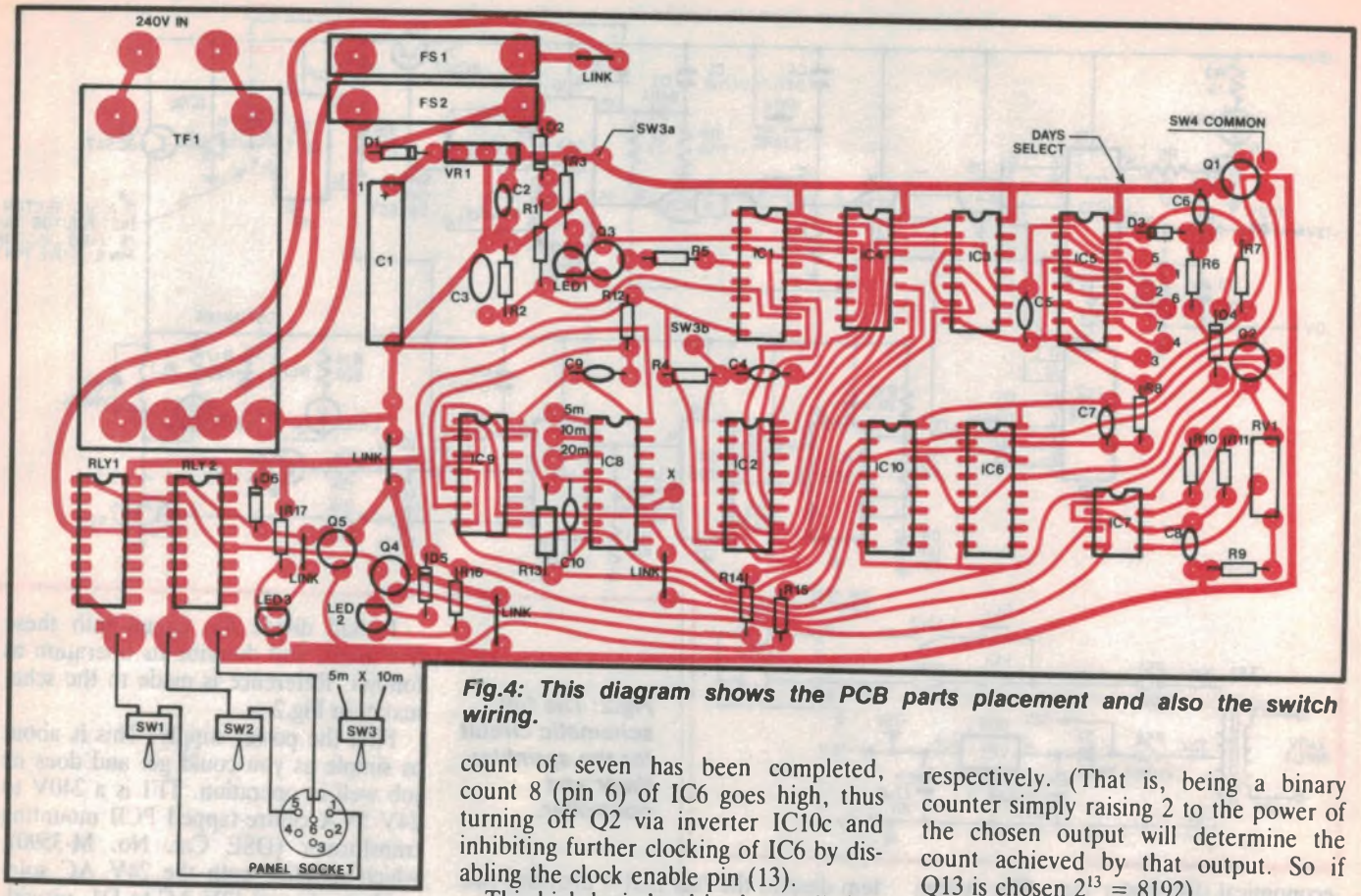


Fig.4: This diagram shows the PCB parts placement and also the switch wiring.

The 24 hour reset pulse from IC3c is also used to clock the 'day counter' IC5. This is a 4017 decade counter, wired to advance on a positive going pulse. Seven outputs, representing the seven days of the week, are selected by SW4.

One pulse every 24 hours from the previously described circuit advances this counter by one 'day'. The desired 'day' signal then turns on Q1, forming a simple series voltage regulator, thus providing power to the rest of the circuit. It can be seen that until the selected 'day' output from IC5 is high, the remainder of the circuit is de-activated since Q1 is off, so the solenoid valves remain off.

The RC network R6/C6 provides power 'on' reset to the day counter IC5 via D3. D4 provides a reset pulse at the end of the sector count from IC4 (see below). R7 maintains a low logic level on pin 15 of IC5 (the reset pin), which is active high.

Sector counting is performed by IC6, which is also a 4017 decade counter. One output is used in this case, to detect the end of the sector count by detecting the eighth count. It can be seen that while this count is low the inverter IC10c turns on Q2, thus providing supply to the remaining duration and interval timer section of the circuit. Once a count of seven has been completed, count 8 (pin 6) of IC6 goes high, thus turning off Q2 via inverter IC10c and inhibiting further clocking of IC6 by disabling the clock enable pin (13).

This high logic level is also applied to the reset pin (15) of IC5 via D4, which resets the day select counter until the next 24 hour pulse comes along to recommence the cycle.

Duration and interval timing of the actual watering is achieved by IC's 7, 8, 9, 10a and 10b.

IC7 is a 555 timer wired in an astable multivibrator configuration, the output frequency being determined by the RC network of R10, R11 and C8. Fine tuning of the output frequency is achieved by RV1, which is used to set the sector duration time (see below).

The output of the 555 feeds the 4020 14-stage binary counter IC8, and together these form an accurate, variable timer. The next step is to determine a required duration time for your sprinklers to be run.

I chose 5 and 10 minute duration times, as I found them most suited to my sprinkler system, but if you need different times it is only a simple matter to alter the 555 running frequency by changing R10, to suit, or select a different counter output. An additional output has been provided on the PCB which will result in a 20 minute duration, using the calculations below.

On the PC board Q11, Q12 and Q13 on the 4020 counter were chosen, detecting a count of 2048, 4096 and 8192 respectively. (That is, being a binary counter simply raising 2 to the power of the chosen output will determine the count achieved by that output. So if Q13 is chosen $2^{13} = 8192$).

This meant that to detect a count of 5 minutes at Q11 (pin 1) for a desired frequency, the count at Q12 (pin 2) will be 10 minutes and the count at Q13 (pin 3) will be 20 minutes.

The next step is to choose the desired running frequency of the 555 timer, so as to determine the values of R10, R11 and C8.

The count at Q11 is 2048. This means that for that count to be achieved in 5 minutes the required frequency is 2048 divided by 300 seconds = 6.827Hz. This then is our 555 frequency.

As a check of the 10-minute duration time provided by Q12, a count of 4096 ($2^{12} = 4096$) divided by 6.827Hz = 600 seconds, or 10 minutes.

RV1 is the fine adjustment pot for the 555 output frequency. By adjusting this, very accurate duration times can be obtained.

The output of IC8 is chosen by SW5, which applies this pulse to IC9 (a dual D flipflop) and also resets IC8 via pin 11. This means that depending on the setting of SW5 the outputs of IC9 will change state every 5 or 10 minutes.

The Q and Q-bar outputs of IC9 feed inverters IC10a and IC10b, which in turn drive Q4 and Q5. These transistors operate RLY1 and RLY2 which bring in their respective control solenoids. Output Q on IC9 (pin 1) also clocks the

sector counter IC6, until this reaches a count of eight – which then resets the system as described above.

Incidentally if a six-sector distributor tap is used, a count of seven is required from IC6 rather than eight. In this case use pin 5 as the count detection output, rather than pin 6.

The timer outputs from RLY1 and RLY2 alternate between channel 1 and channel 2, providing the requirement of having an 'off' time for advancing the distributor tap(s) to the next sector. Note also that this means only one channel is on at any given time.

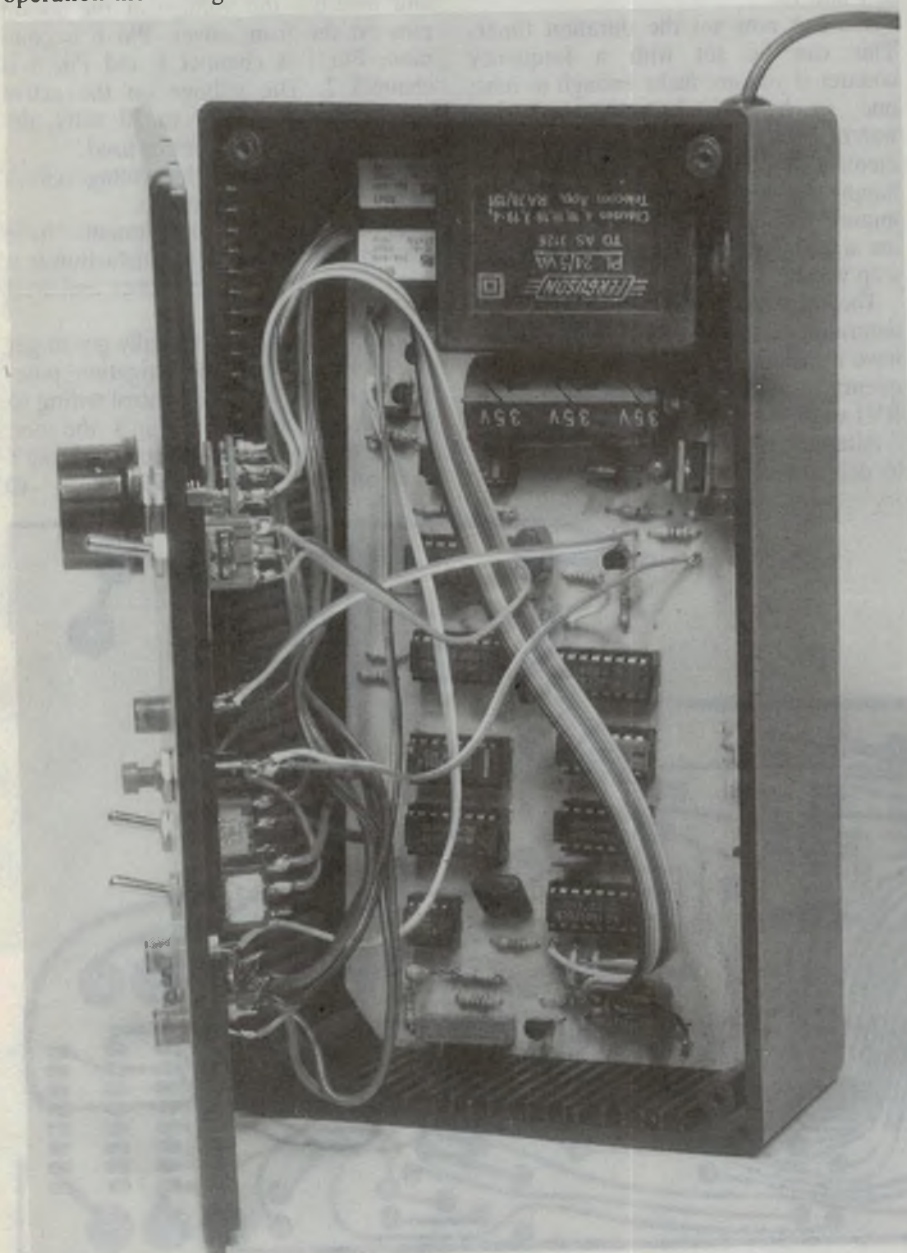
In my case I use channel 1 as the front garden control and channel 2 as the back garden control. This means that while the front garden system is in operation the back garden control is off, for the time duration chosen. When the output changes to channel 2, channel 1 is then off for the same time duration, allowing the front garden distributor tap to advance to the next sector while the back garden sector is being watered.

Once all sectors have been watered, the sector counter turns off Q2, thus turning off supply to the solenoid drivers Q4 and Q5.

The system will not restart until another day select pulse is received from the output of IC5, or the SET switch is depressed.

Construction

Fig.3 shows the PCB layout and Fig.4 shows the component layout. All components including T1 fit neatly on to the printed circuit board, and wiring to the



A look inside the controller case, showing the general layout.

PARTS LIST

1 PC board (100 x 180mm)
1 Zippy box (160 x 113 x 196mm)
3 SPDT mini toggle switches
1 1 pole 12 position rotary switch
1 SPST pushbutton switch
2 Ultra miniature 12V relays (DIL)
1 6-pin DIN panel socket and matching line plug
1 Transformer 240/24V CT 5VA (PCB mount)
1 knob

Sundry hardware, rub-on lettering, clear spray, 4 x PCB fuse clips, 1 500mA and 1 x 250mA cartridge fuses, hook up wire, LED bezels, flex cord and plug.

Resistors

RV1 10k 10-turn trimpot
All 1/4W carbon film:

R1,2,13	10k
R3	1k
R4,12	1.2k
R5,7	12k
R6,8	1.5k
R9	2.2k
R10	390k
R11	100 ohms
R14,15	15k
R16,17	820 ohms

Capacitors

C1	2500uF 25VW electrolytic
C2	22uF 16VW tag tantalum
C3	10nF met. polyester
C4,6,7	0.12uF met. polyester
C5	1nF ceramic
C8	1uF 25VW tag tantalum

Semiconductors

IC1,8	4020 14 stage binary counter
IC2	4040 12 stage binary counter
IC3	4001 Quad 2 input NOR gate
IC4	4012 Dual 4 input NAND gate
IC5,6	4017 Decade counter with 10 outputs
IC7	555 Universal timer
IC9	4013 Dual D type flipflop
D1,5,6	1N4004 silicon diode
D2,3,4	1N914 silicon diode
LED1	5mm red LED
LED2,3	5mm green LED
Q1,2,3	BC547 NPN silicon transistor
Q4,5	BC557 PNP silicon transistor
VR1	7815 regulator IC

switches, LEDs and 6-pin panel socket is achieved using hookup wire to the PCB pins.

Care should be taken in fitting the components to the PCB before soldering, as many are polarised.

In working through the circuit you may notice that I have omitted a main power switch. This is because once you have the system up and running it isn't really necessary to turn it off – but if you do, all that is required is to turn things off the power point.

The completed circuit board assembly fits neatly into the standard zippy box that measure 60 x 113 x 196mm. Once assembled the controller forms a neat, compact unit that can be either mounted on a wall or left as a transportable unit.

The front panel artwork (see Fig.5) is also flexible, to suit varying requirements. For the prototype unit pictured I used white rub-on lettering on the black plastic cover, applied after the mounting holes for switches and LEDs were drilled. The entire lid was then sprayed with a couple of layers of clear varnish.

Setting it up

Once construction is complete, it is time to set RV1 the duration timer adjustment potentiometer.

Make sure at this stage that the solenoid valves are not yet commected to the controller.

First turn the 'Day Select' switch (SW4) to 1. Then turn the unit on.

LED 1 should be flashing on and off, indicating that the 24-hour timer is working. If not, check fuse FS2 and the orientation of LED1, Q3 and IC's 1, 2, 3 and 4.

If it still doesn't flash check your soldering for shorts across tracks.

Press the 'Start' button (SW3), and LED2 (channel 1 indication) should come on. Note that if channel 1 lights up momentarily but then turns off, you should be able to pulse through using 'start' until it stays on – all that is happening is the day counter is being advanced more than one day.

If not check the orientation of LED2, LED3, Q1, Q2, Q4, Q5 and IC's 6, 7, 8, 9 and 10.

We can now set the duration timer. This can be set with a frequency counter if you are lucky enough to have one, or by a logic probe and stop watch. Straight out stop watch adjustments can be tedious (unless you are happy to wait around for every 5 minute duration). so it is advisable to use a logic probe in conjunction with a stop watch.

The required frequency from IC7, as determined earlier is 6.827Hz. So if you have a counter, simply look for this frequency at pin 3 of IC7 itself, and adjust RV1 until you get it.

Alternatively we can use a logic probe to detect a count of 64 on the Q6 output (pin 6) of the duration timer counter IC8 (4020). The time between low to high transition pulses appearing at this output when IC7 is running at 6.827Hz is about 9.4 seconds, so in this case adjust RV1 until the time between low to high transitions – measured using the stop watch – takes about 9.4 seconds.

Using these figures it is possible to fine tune our counter to provide delays of many minutes, while checking these times in seconds.

Once the duration time has been set using the above procedure, the solenoid drive circuitry can be checked.

First turn on SW1 and SW2. Then switch your multimeter to an appropriate AC volts scale (i.e., 30V or above) and measure the voltage at the socket pins on the front cover. Pin 6 is common, Pin 1 is channel 1 and Pin 5 is channel 2. The voltage on the active channel should be 24 to 30 volts, depending on the transformer used.

If you don't have this voltage check FS1 and the relay operation.

Once the above adjustments have been completed to your satisfaction it is time to screw down the cover and start the hard part.

That's right, you've actually got to get out there and run the irrigation pipework, not to forget the control wiring to the solenoid valve(s). That's the one part of this project that electronics can't make any easier – sorry about that! EA

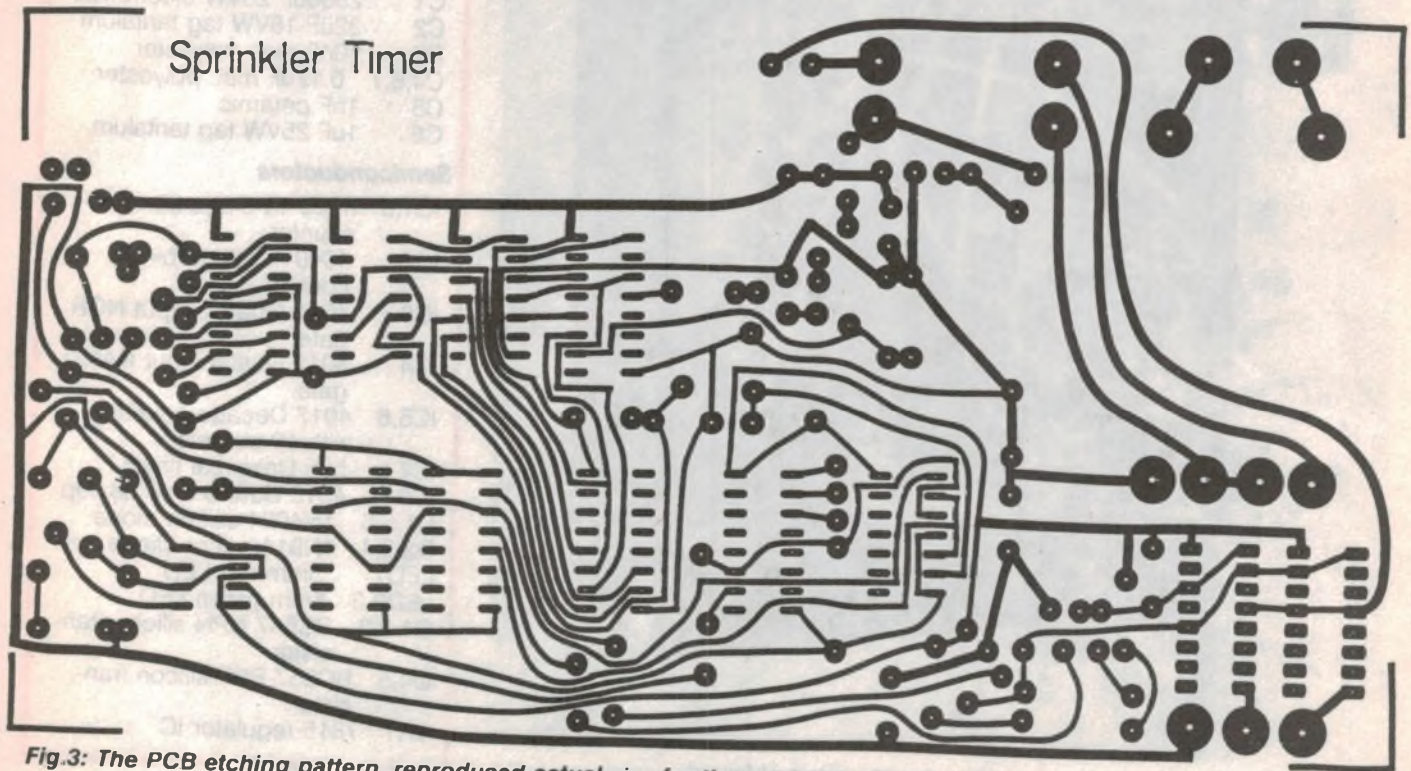


Fig.3: The PCB etching pattern, reproduced actual size for those who wish to trace it.

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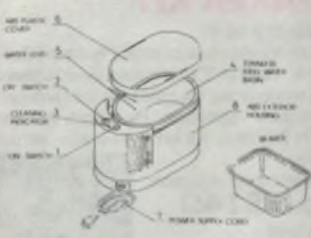

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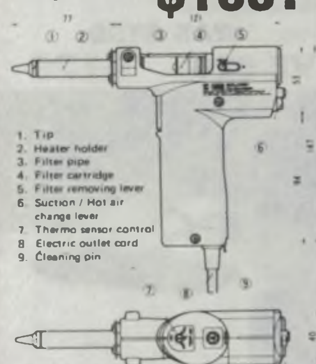

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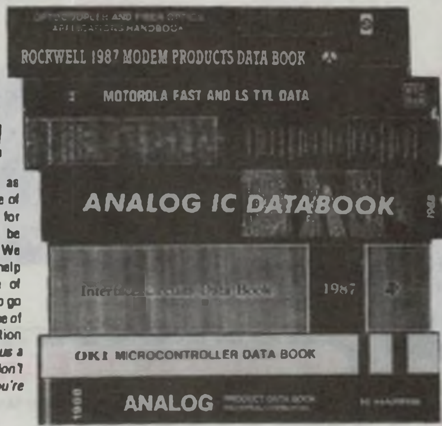

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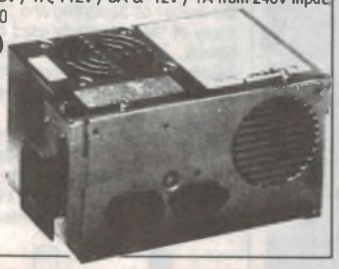

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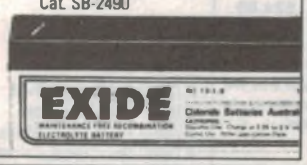

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(on goods of the same quality)

MINSTREL 2-30 SPEAKER KIT

Ref. Silicon Chip Feb '89
This is a co-operative speaker project between Silicon Chip and Jaycar. Using an 8" woofer and a dome tweeter with pre-built crossover unit the system has been acclaimed for its superb sound reproduction. The cabinets measure 480(H) x 300(W) x 290(D)mm. For further information see our 1989 catalogue.
Pair of speakers and crossovers
Cat. CS-2540 **$149**
Cabinets (pair)
Cat. CS-2542 **$129**

BUY BOTH FOR $250 SAVE $28

PIN POINT ULTRA-SONIC CLEANER

This great new product will clean an amazing range of products including jewellery, glasses, dentures, watches, relays, switches, connectors, PCB's, pens, camera filters etc. The ultrasonic cleaner uses a transducer generator to produce millions of activated microscopic cleansing bubbles which blow dirt, grease and grime off surfaces, and deep into cracks and holes. 240V operation, 3 minute timer, ultrasonic frequency 40kHz.
Cat. YH-5400 **WAS $199**
SAVE $20 $179

KNOB PACK

Another surplus deal. Japanese SATO brand knobs in different types all imperial. Also quantity of Rean knobs with different coloured caps these are metric. Pack includes minimum 50 knobs, generally more - majority Rean. We figure about $60 worth of knobs.
Cat. HK-7050
ONLY $10

TECHNICIANS BRIEFCASE

Another distress stock buy, well below normal price.
It's metal, hammer tone grey in colour, and has an ABS insert which sits nicely inside to hold all those components. It has 20 small compartments 50x55x35 deep mm and one large compartment to hold screwdrivers, cutters etc. The lid closes tightly, so components won't spill into the next compartment. It is well built, so will handle rough treatment. A handle is supplied along with a card holder for identification. Total size is 340mm wide x 240mm x 45mm thick.
Normal price would be about $25
We can offer these at an absolute bargain basement price of only **$12.95 each**
5 + $12 each Cat. HB-6320

SPRINGTIME IS BARGAIN TIME

MIXED SEMICONDUCTOR PACK

Guaranteed minimimum
100 units supplied but packs generally exceed this amount.
IC's, transistors, diodes, LED's, RAM etc.
Cat. ZP-8990
ONLY $10

J TYPE THERMOCOUPLE

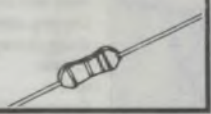
Save a fortune. Wholesale price $50 + tax

+Ve composition	Fe
-Ve composition	Ni 40-43% Balance Cu (Constantan alloy)
Cont. Temp. Range	-200°C to 870°C
Max Spot Reading	1100°C
Accuracy	0°C to 300°C ±3%
	300 to 760°C ±1°C

Cat. ZT-9400
Were selling for $20 NOW ONLY $10

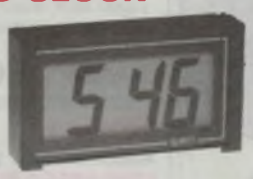
JAYCAR RESISTOR PACK

10 of each value of 1/4W 5% from 1 ohm to 10 M ohm.
850 resistors in all.
Save $22.55
ONLY $19.95
Cat. RR-1697



JUMBO LCD CLOCK

Huge, easy to read 20mm high digits. Unit measures 57 x 32 x 11mm and is supplied with a slip in bracket and double sided tape for easy mounting. Complete with light for night reading and battery. Ideal for cars, homes, boats, virtually anywhere.



Cat. XC-0220 **ONLY $7.95**

WIRE WRAP

Machine Pin IC Socket Strips
Snap off to any length to make IC sockets. Quality machine pin wire wrap pins.
$6.95 per length
10+ $6.50 per/l
Cat. PI-6472

MINI STEREO AMPLIFIER

This amplifier was originally supplied with a pair of 5 watt walkman speakers. We believe this amplifier has much more merit on it's own rather than accompanied with two very ordinary speakers, which effectively doubles the price. The amplifer is battery operated (requires 4 x AA) or can be used with a DC 6V external source. Its input and output connections are via 3.5mm stereo sockets. One for in, one for out. It has 3 leds for each channel to monitor output, a high pass and low pass filter switch and an on/off switch with LED indicator. Size 150 L x 70 D x 225 H mm. Ideal for walkmans, or anywhere a low power battery operated amplifier is required.

SPECIFICATIONS

Output	0.5 watt per channel 8 ohms
Input & Imp	600 ohm
Band Width	120 H2 - 20 Kh2 - 3dB
Voltage Gain	8 dB +/- 1 dB (walkman only)
Input voltage	250 mv + power output 30 (walkman)

Cat. AA-0350
$29.95

C & K SWITCH BARGAIN

C& K Brank 7103 SPDT Centre Off PC Mount. Another surplus stock buy. As pictured, but with longer actuator length 12mm. Switches vertically. These are normally worth over $4 each. Save a bundle.
STOCK UP NOW

1 - 9	$1.95 ea
10 - 99	$1.65 ea
100+	$1.50 each

Cat. ST-0563

STEREO 1/2 OCTAVE GRAPHIC EQUALISER KIT

Cat. KC-5055
Ref. Silicon Chip August 1989
This project enables you to equalise your room or disc or other source etc. with great precision. Until recently you had to buy TWO mono equalisers to do this task. The Silicon Chip people have come up with a state-of-the-art design featuring close tolerance capacitors and superior gyrator performance. Headroom is over 100dB. Distortion? Negligible 0.001%. With TWO controls per octave you have a precision Hi-Fi insturment that covers 28Hz. 20 Slider controls per channel with Eq. out for dubbing tape ±2dB per control. 240V powered. 18" 2 unit rack configuration. The Jaycar kit is complete down to the last nut and screw.
$349

DMM's

Direct import - one hand operation
Frequency counter
Capacitance meter
Logic Probe
10 amp

Cat. QM-1400
$99.95

SEE REVIEW EA JUNE

Cat. QM-1410 20 ranges
$59.95 Diode checker

IN4003 DIODES

1 Amp 300 volts
Save $$$$$
50 for $3
100 for $5
STOCK UP NOW
Cat. ZR-1003

METRONOME

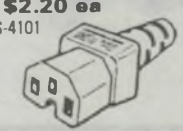
A must for people learning music.
Fully self contained electronic style.
Tempo is variable from 40 to 208 beats or times per minute.
Switchable between audio sound and a Red LED
Supplied with an earphone for private use. Battery operated.
Size 60 x 108 x 30mm
Cat. QM-7240
$39.95

The Sensational 30 piece Engineers' Driver Set

Here's what you get:
5 Slotted bits 0-1, 3-44, 5-6, 8-10, 12
2 Hex bits 3/32", 5/64", 7/64", 1/8", 8/84"
4 Phillips bits No. 0,1,2 & 3
4 square Recess bits No. 0, 1, 2 & 3
6 Torx bits T10, T15, T20, T25, T30, &40
2 Pozidrive bits No. 1 & 2
1 x 1/4" Drive Socket Adaptor
1 x 1/4" Drive Hex Bit Holder
And it's all housed in a sealable, tough, plastic case.
Cat. TD-2000
$19.95

IEC LEAD SPECIAL

Consists of a black 3 core power lead 1.5 mt long with and IEC plug on one end and nothing on the other.
2mt ones sell for $6.95
ONLY $250
10+ $2.20 ea
Cat. PS-4101



RGBI TO PAL ENCODER/ MODULATOR KIT

Ref. EA August 1988
Here's a kit for a low cost RGBI to PAL video encoder and RF modulator, suitable for use with an RF signal on a suitable TV channel, it allows a standard colour TV receiver to be used as a colour monitor for games etc. Kit includes PCB box and all specified componants except those for optional power supply.
Cat. KA-1720 **$39.95**

SPRINGTIME IS JAYCAR TIME

ELECTRONIC SENTRY

A complete burglar alarm in a PIR. What a great idea. Basically, it looks like a standard PIR but it has a keyswitch on the front. It's completely self contained and needs no installation. Can be wall mounted or free standing. Incorporates built in sound maker giving a scream in excess of 95 dB. Battery operated. Ideal simple burgler alarm for homes, units, caravans, garages, boats, shops offices, etc.

SPECIFICATIONS:

Installation	Free standing or wall mounted
Operation	By key
Normal Operating Height	0.5 - 2 metres
Operation Power Requirement	9V Alkaline battery
Standby Arming Delay	2 minutes
Alarm Period	1 minute
Siren Volume	In excess of 95 dB
Reset and Rearm	Automatic
Low Battery Indication	Short 'Beep' at 10 seconds interval

Cat. LA-5015 **$99.95**

3 IN 1 ALARM CHRONOGRAPH

Incorporates
- Hand held stop watch
- Clip stop watch
- Alarm chronograph wrist watch
- Whistle

Features
- Quartz security
- 1/100 second chronograph with lapse time
- Display hours, minute, seconds, month, date and day flag
- Alarm and hourly chime function
- Battery included

Cat. XC-0200 **ONLY $9.95**

TORAS MINI DRILL

Available once again. Two models.

LOW SPEED MODEL

Operates on 4 x AA batteries of DC voltage 6 - 12 volts 1 AMP Supplied with three chucks 1 x 0.4 - 1.5mm, 1 x 1.7 - 2.9mm, 1 x 2.8 - 3.4mm and three drill bits, spanner and tommy bar. Two speed 1100 RPM and 550 RPM. Torque 100gm/cm. Dimensions 43 x 230mm.

Cat. TD-2470 **$39.95**

HIGH SPEED MODEL

Operated from 6 VDC - 35 VDC 1 - 5 AMP. Supplied with 3 chucks and 3 drill bits. Spanner and tommy bar same as supplied in Low Speed Model. Speed 3500 - 30,000 RPM depending on voltage. Torque 150 - 800gm. Dimensions 42 x 105mm.

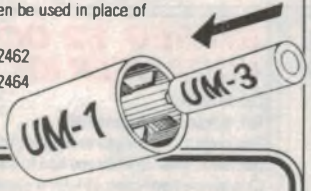
Cat. TD-2475 **$29.95**

NiCad BATTERY ADAPTORS

Why buy expensive C and D size NiCads when these adaptors allow you to use low cost AA NiCads instead.

These adaptors look like a normal battery except that they are hollow, and an AA NiCad can be inserted inside. These can then be used in place of the C or D NiCads.

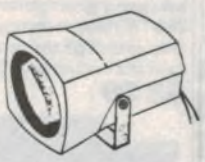
C size Pkt of 4 **$4.95** Cat. SB-2462
D size Pkt of 4 **$4.95** Cat. SB-2464
AA NiCads 500mA/hr **$3.50 each**
4 for $12.50 Cat. SB-2452



SIREN MADNESS

Another distress stock purchase which saves you lots of money. This time three sirens.

SCREAMER BARGAIN



Don't miss out. Grey in colour. Made in Italy. Unbearable sound. Save $5 over normal unit. Size: 57L x 33Hmm. Operates on 12 volts. Ideal for burglar alarms inside car and houses.

Cat. LA-5254

ONLY $12.95 10+ $11.95 ea

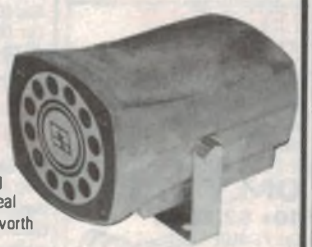
SCREAMER HORN

We used to sell this unit years ago for $35. Today, it would cost about double that. Ideal for car alarms and home burglar alarms. It's very loud, the specs say 112dB but we think it's louder than that. It has a nylon case and the noisemaker is a nylon 4" speaker. It's weatherproof and operates from 8 - 12 volts. Current drain 2 amps and the frequency is 1200 - 1500Hz oscillating. Supplied with mounting bracket. Size 110 x 100mm.

GIVEAWAY PRICE - ONLY $25 ea

Cat. LA-5262

LARGE PIEZO SCREAMER



Not unlike our Tweety Pie, this unit is larger (80 x 105mm) and is housed in a zinc die cast body. This is rare as most these days are plastic. Sound level is 124dB. Operating voltage 8 -12 volts, current drain 350mA. Ideal for car and home burglar alarms. Normally worth about $39. A bargain at $25.

Cat. LA-5265

ONLY $25

DRILL MADNESS

Are you sick of paying high prices for mini PCB drill bits? We were. Now you don't have to pay outrageous prices anymore. Jaycar's direct imports save you money.

DRILL PACK

Includes all those common ones.

• 1 x 35mm - for PC supports, relays • 2 x 1.2mm - for PC pins, hookup wire • 3 x 1mm - for resistors, capacitors etc • 4 x 0.8mm - IC's etc.

TOTAL 10 DRILLS FOR ONLY $12.95

Cat. TD-2400 - WERE SELLING FOR $24

MINI DRILLS IN PKTS OF 10

- 0.8mm x 10 (Cat. TD-2420)
- 1mm x 10 (Cat. TD-2421)
- 1.2mm x 10 (Cat. TD-2422)

ANY PACK ONLY $9.95

LOWER PRICES ON SINGLE BUYS

- 0.8mm Cat. TD-2408 SAVE 70¢
- 1mm Cat. TD-2410 SAVE 90¢
- 1.2mm Cat. TD-2412 SAVE 90¢

ANY ONE ONLY $1.50

UTILUX UX HIGH POWER AUDIO CONNECTORS

Another surplus buy

Utilux have developed this revolutionary connector system for the professional audio industry.

There are two connectors, one line and one panel type. The line connectors are haemophrodite. Fits on jumbo speaker cable perfectly. You would normally pay about $10 each for these.

Specs:

- Mechanical: cable clamp withstands a cable pull out force of 30 Newtons
- Material contacts: copper iron alloy silver plated
- Body Shell: zinc alloy die casting chrome plated
- Electrical: Rated at 30 Amps continuous at 100V maximum

LINE CONNECTOR $2.95 10+ $2.50
Cat. PP-1080

PANEL CONNECTOR $2.95 10+ $2.50
Cat. PP-1082

1.5V BATTERY TESTERS

The latest in battery testers. Consists of a very flexible piece of plastic with a conductive strip on the rear. Simply place over the battery terminals and the indicator will show if the battery is good, reasonable or bad. Re-useable. Every desk drawer, workshop, toolbox needs at least one. And at the price - who cares.

5 different designs available.

ONLY 65 CENTS EACH
OR 4 FOR $2. Cat. SB-2350

A SPRINGTIME BARGAIN

INCREASED "HC" RANGE

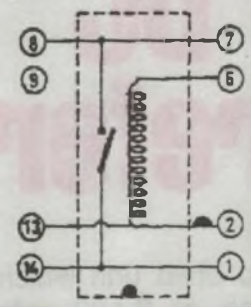
Cat		1-9	10+
74HC00	ZC4800	75	65
74HC02	ZC4802	75	65
74HC04	ZC4804	75	65
74HC08	ZC4808	75	65
74HC10	ZC4810	75	65
74HC11	ZC4820	75	65
74HC30	ZC4822	60	50
74HC32	ZC4823	90	80
74HC42	ZC4826	2.75	2.50
74HC74	ZC4830	1.10	1.00
74HC86	ZC4835	1.10	1.00
74HC90	ZC4838	1.10	1.00
74HC139	ZC4850	1.25	1.10
74HC157	ZC4853	1.25	1.15
74HC174	ZC4856	1.40	1.30
74HC240	ZC4860	3.20	3.00
74HC241	ZC4861	2.75	2.55
74HC244	ZC4863	2.75	2.55
74HC368	ZC4870	2.95	2.70
74HC373	ZC4874	2.95	2.70
74HC393	ZC4880	2.95	2.70
74HC4075	ZC4896	95	85

REED RELAY BARGAIN

This time a 6 volt reed relay. It will fit into a 14 pin IC socket. These normally cost $5 each. Grab one while you can.

1-9 $1.95
10-99 $1.65
100+ $1.50

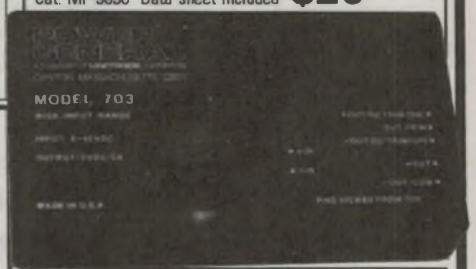
NORMALLY OPEN
Cat. SY-4040
NORMALLY CLOSED
Cat. SY-4041



D.C. - D.C. Power Converter

Made in USA by Chintrode Corp. This high-tech military style module converts any D.C. volts from 8 - 40 into 5VDC @ 5A.
The unit is designed for military environments (similar ones go in the F/A18).
They sold for $165 each in quantity a few years ago. You can grab one for only $20!!
External dimensions 65 x 116 x 21. PCB pins enable it to mount directly on to a P.C.B.

Cat. MP-3030 Data sheet included **$20**



LOW COST MAINS FILTER KIT

Refer EA Oct 89
Uses our 4 AMP mount mains filter. Kit also includes PCB, 2 varistors, fuse holder and fuse. Ideal kit to mount inside equipment. Short form kit

Cat. KA-1722
$18.95

DELUXE BLACK RACK CABINETS WITH HANDLES - TAKE 15% OFF FOR OCTOBER

Quality and design functionability at a down to earth price. Give your equipment a real 1st class appearance. Removable top and bottom panels, black finish with high quality brushed anodised front panel. Handles and rubber feet suppplied along with screws, nuts, etc, to assemble.
SEE CATALOGUE FOR ALL DIMENSION DETAILS - page 46

Front panel width - 305mm		Front panel width - 481mm	
Cat. HB-5380	$39.50	Cat. HB-5382	$49.50
5+ $36.50 each		5+ $46.00 ea	
Front panel width - 401mm		Cat. HB-5383	$65.00
Cat. HB-5381	$49.50	5+ $61.00 ea	
5+ $46.00 ea		Cat. HB-5384	$75.00
		5+ $70.00 ea	

Copper PCB Tin Plating Solution (ER-18) Electrolysis

TINNIT is designed to plate bare copper circuit boards to enhance solderability. The 450ml size of TINNIT will plate up to 0.4 metres of copper with approximately 0.1mm of bright tin. Plating is complete after about 10 minutes in a fresh solution. Adhesion and solderability are excellent. No electricity is required. TINNIT has been successfully used to plate brass, bronze, iron and some carbon steals. The material is supplied as a dry mixture with an indefinite shelf life. When mixed with water, the solution has a life of approximately two months.

Cat. NC-4276 **$11.95**

NEW - 6 PIN IC SOCKET for optocouplers Cat. PI-8505 20¢ ea 10+ 18¢ ea

3mH SUBWOOFER CHOKE

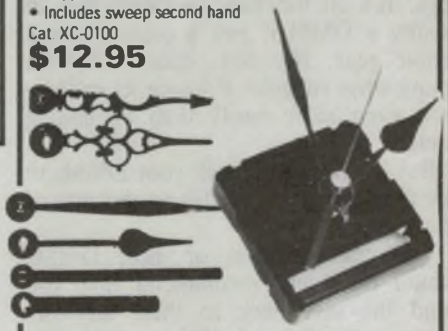
Ideal for out twin voice coil subwoofer special (see Silicon Chip last month) or any subwoofer for that matter.

Cat. LF-1300 **$14.95 each**

CLOCK MOVEMENT

- Very compact 56 x 56 x 15mm
- Self starting one second stepping motor
- Powered by 1 x AA battery that lasts about 1 year
- ±15 second/month accuracy
- Supplied with three sets of hands
- Includes sweep second hand

Cat. XC-0100
$12.95



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Jaycar will purchase your surplus stocks of components and equipment.

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Construction Project:

A simple DC voltage reference

Here's the design for an easy to build unit which provides a very stable and accurate source of 8.182 volts DC. This makes it ideal for checking the calibration of your digital or analog multimeter – especially as it will cost you less to build than sending your meter back for calibration!

by JIM ROWE

When voltages need to be checked in a circuit you're working on, you reach for your trusty digital multimeter – right? And when it tells you that the voltage in a certain part of the circuit is say 5.02 volts, you normally tend to take this reading at face value. After all, the figure is there on the display for all to see, in crisp and seemingly unambiguous grey-black or glowing red digits.

Somehow, the readings given by a DMM seem more accurate than those produced by an old-fashioned analog multimeter, simply because the DMM is capable of giving higher resolution readings. It's all too easy to forget that in reality a DMM is just a piece of electronic gear, like any other – and in many ways capable of losing its calibration even more easily than an analog meter.

But how do you check your DMM, to see if its readings are still as accurate as they seem?

The manufacturers of most DMMs would no doubt recommend that you send the unit back to their servicing centre, or that of their agents, for checking against known standards of voltage, current and resistance. Either that, or you could take it to an independent standards lab, for the same procedure.

Nowadays most standards labs, and many of the larger private servicing organisations have special instruments known as 'calibrators', which are used for this very purpose. A calibrator is essentially a programmable source of voltage, current and resistance, the values of which may be set to an extremely high level of accuracy and reliability.

Needless to say, calibrators don't come cheaply. Nor does any of the other standards-lab gear – or the people needed to drive it properly. As a result, sending your DMM back for a recalibration job can be a pretty expensive exercise. In fact for one of the common low-priced DMM's, it would probably cost more than the instrument is worth.

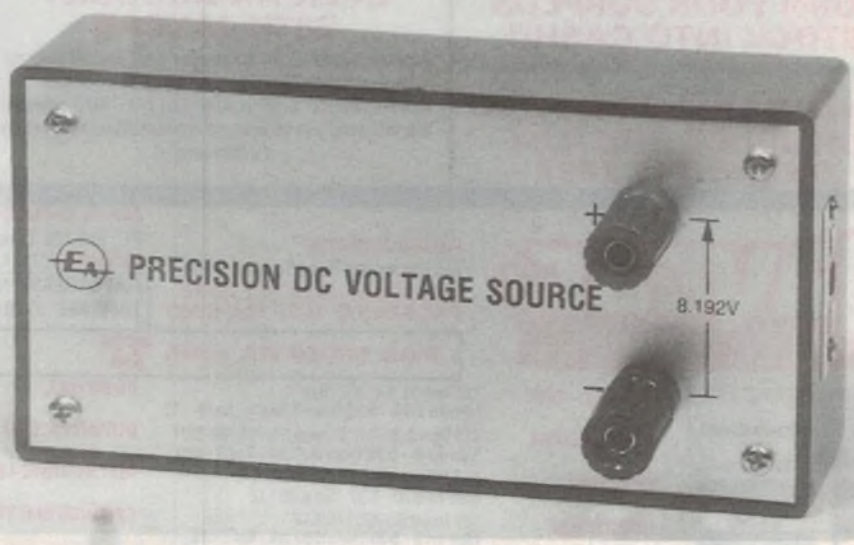
Luckily there *are* cheaper alternatives. For checking the resistance ranges you can often use selected 1% or better high stability resistors, whose values have been measured on known high-accuracy instruments, and which are kept carefully tucked away in a drawer for reference use. With care these can be used to perform checking to within about 0.1 – 0.2%.

Providing you have a DC voltage source which is also accurately known, these resistors can also be used to provide accurately predictable currents, for checking current ranges. And of course an accurate DC voltage source also lets you check the voltage ranges as well.

The traditional low-cost source of a reasonably accurate DC voltage has been a mercury cell. These have a well-known and quite accurately defined terminal voltage, at a standardised temperature of say 20°C.

For example a one-month old mercury cell has a terminal voltage of very close to 1.3566 volts, falling slowly to about 1.3524V after a full year. So if you buy a reasonably fresh mercury cell, it would be quite reasonable to assume that its voltage at 20°C would be within about 2mV of 1.354V – without knowing its exact age since manufacture. This corresponds to an accuracy of about 0.15% – not bad at all, for an outlay of only a few dollars.

Silver oxide cells can also be used for the same purpose, having a stable terminal voltage very close to 1.55V. Even the newer lithium-manganese cells are



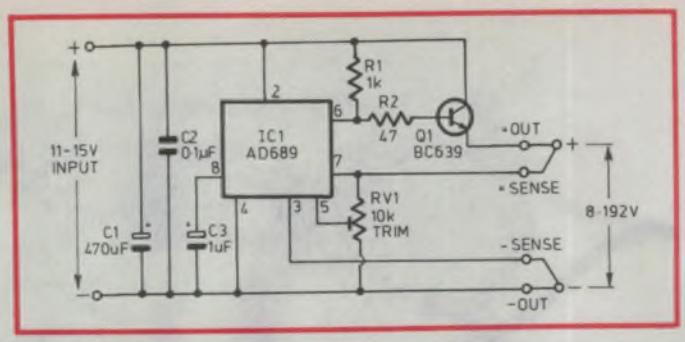


Fig.3: Final circuit for the voltage reference, which uses Q1 to boost its current capability.

capable of being used as a reference source, with a very long shelf life and a terminal voltage very close to 3.06V.

Of course batteries of any kind have a tendency to obey Murphy's Law, and turn out to have quietly expired before you need them. And although mercury, silver oxide and especially lithium cells have quite a long life, particularly if you use them purely as a voltage reference, they certainly aren't immune to this problem.

Happily in the last few years, the semiconductor industry has developed another relatively low-cost source of stable and accurately predictable DC voltage: the *precision monolithic voltage reference*.

This is basically an IC chip, and a little like one of the common 3-terminal regulator chips – in that it produces a regulated output voltage when fed with a suitable source of unregulated power. Only in this case the chip is more carefully designed than a normal 3-terminal regulator, to produce a very accurately defined and highly stable output voltage.

The precision reference chip used in this project is the Analog Devices AD689, which uses a special highly stable 'buried Zener diode' as its internal voltage reference, coupled to an op-amp comparator with high-stability thin film resistors which are laser-trimmed during manufacture. This allows the chip to deliver a very accurate 8.192 volts – within +/–8 millivolts (0.1%) untrimmed, and with a temperature coefficient of less than 15 parts per million per degree Celsius (ppm/°C). This corresponds to a drift of less than 125uV per °C.

The output voltage is also regulated to within +/–200uV per volt of input voltage change, over a permissible input voltage range of between 10.8V and 36V. Load voltage regulation is also impressive, at less than 100uV/mA for loads of anywhere between 8.192mA sourcing and 8.192mA sinking. In other words, the output impedance is 0.1 ohms for loads in this range.

Other figures of interest are a long-term drift of only 15ppm per 1000 hours of operation, and an output noise of typically only 2uV p-p between 0.1Hz and 10Hz.

Why an output voltage of 8.192V? Good question. The answer is that like many similar devices, the AD689 is designed for use mainly as a reference voltage source for precision digital-to-analog and analog-to-digital converters. For this sort of application, it's convenient to have the reference voltage set to some convenient binary multiple. In this case the AD689 is intended to go with 12-bit DACs and ADCs, and the figure of 8.192V will give a level of 2mV (8.192V/4096) for the weighting of the least significant bit (LSB).

For our present application, the exact voltage level has no particular significance, of course – apart from the fact that it is accurately predictable and highly stable. As it happens the voltage can also be trimmed even closer to 8.192V, if you have the means to calibrate it in the first place. It can even be trimmed to 8.000V instead, if you prefer.

The internal circuitry of the AD689 is shown in Fig.1. Internal op-amp A1 is used both to amplify the voltage drop of the buried Zener diode, and to allow comparison with the 'force' output (pin 6) via separate active and ground sense pins (pins 7 and 3).

Fig.2 shows the most basic way that the AD689 can be used, with unregulated DC voltage input (10.8 – 36V) applied at pin 2. Pins 6 and 7 are joined at the load end, to ensure that the chip can compensate for any voltage drops in the active output lead. Similarly the ground sense pin 3 is connected directly to the ground end of the load, for the same purpose. A capacitor may also be connected between pins 8 and 4 to further reduce the noise output, if desired.

A 10k trimpot may connected between pins 6, 5 and 4 as shown, in order to trim the AD689 to exact voltage using a known accurate meter or calibrator. However if such an instrument is not available, simply leaving the pot out will give the chip's own basic accuracy of (8.192V +/–8mV).

Needless to say, this basic circuit can only source or sink quite small currents

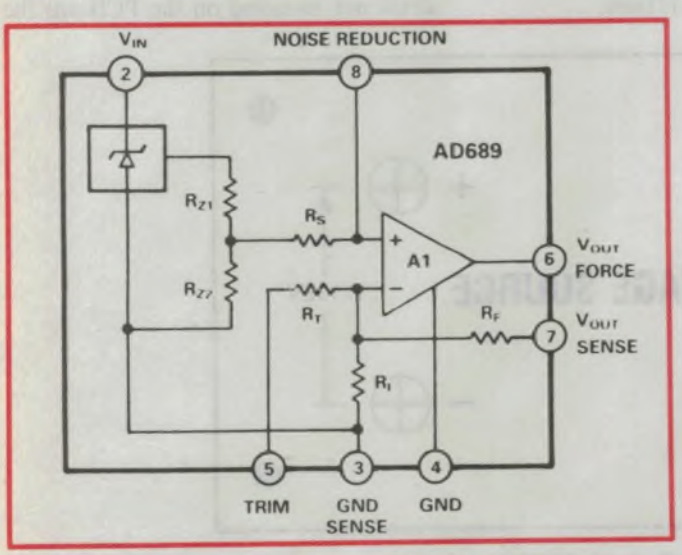


Fig.1: A simplified internal circuit for the AD689.

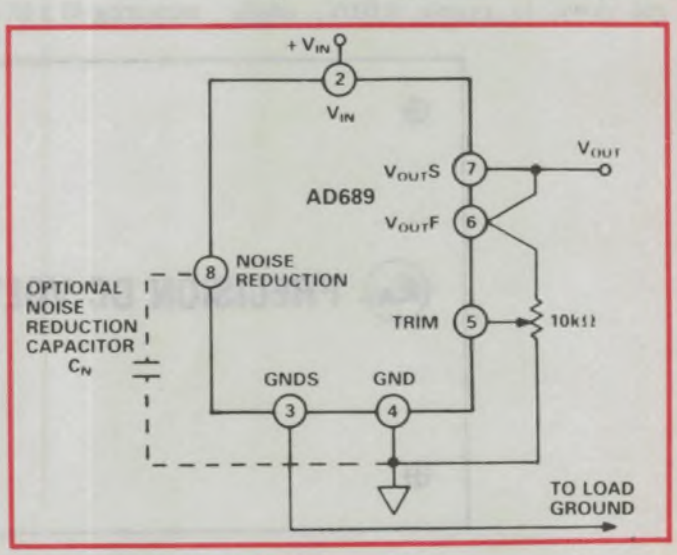


Fig.2: How a pot can be used for optional fine trimming.

– within the +/–8mA range for the AD689 itself. However this range can be extended by taking advantage of the chip's remote sensing capability, and this is what we have done in the final circuit as shown in Fig.3.

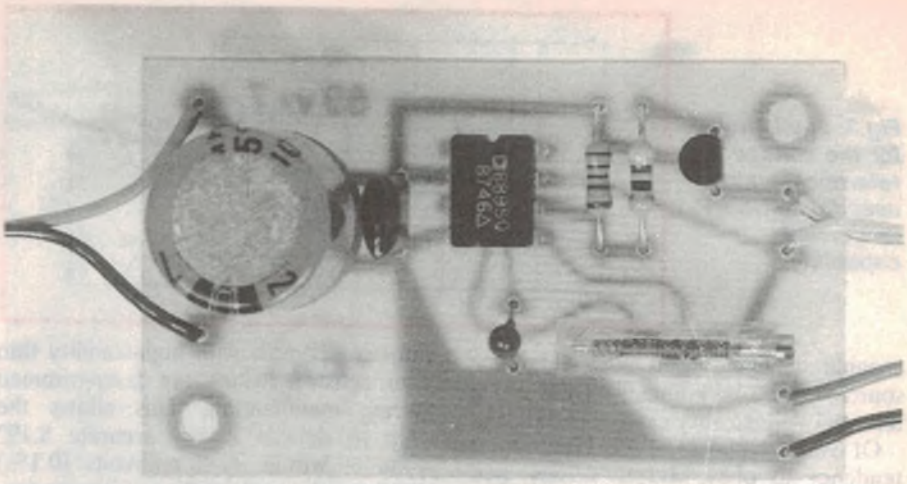
Here transistor Q1, a low-cost BC639, is used to provide additional output current capability, connected as an emitter follower. And because the AD689 sensing input (pin 7) is still connected to the load, now in Q1's emitter circuit, this current boosting is achieved without any deterioration in the circuit's accuracy. Pullup resistor R1 helps the AD689 provide Q1's base current, ensuring that the chip is not called upon to operate outside its working output current range (+/–8mA) even for load currents of up to at least 100mA.

The circuit is designed to operate from a standard DC plug pack power supply, producing a voltage between 11 and 15 volts. Capacitors C1 and C2 are to provide additional filtering, to make sure that ripple and noise on the DC input don't take the instantaneous input voltage below the minimum of 10.8V required by the AD689. And C3 is to reduce the chip's own noise contribution.

10-turn trimpot RV1 is basically an optional refinement, as noted earlier. Simply leaving it out will give you the chip's own basic accuracy, or an output voltage within 8mV of 8.192V. In other words, a tolerance of 0.1% – which should be quite sufficient for many purposes.

Fitting the trimpot lets you 'tweak' the output precisely to 8.192V, giving considerably higher accuracy. In fact if you prefer, you can even pull the output down to exactly 8.000V, which some readers may find more convenient. The pot actually allows the output voltage to be adjusted anywhere between about 7.95V and 8.85V, without disturbing the chip's stability significantly.

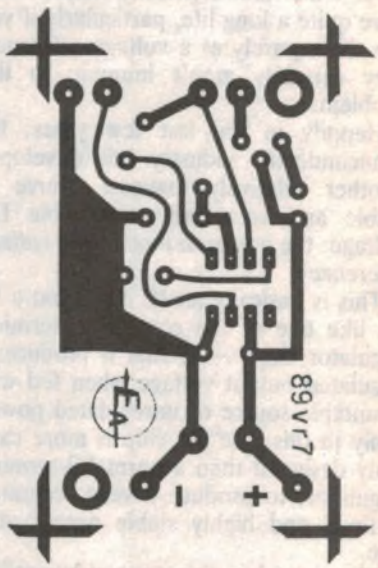
The only catch is that in order to set the output voltage accurately, once you've added the pot, you need at least temporary access to a suitably accurate meter – say one with an accuracy of at least 0.05%. So if you do have some way of getting access to such a meter, for a short time, by all means add the pot. But otherwise, it's probably best left out.



A close-up of the wired PCB for the voltage reference, to guide you in wiring it up.

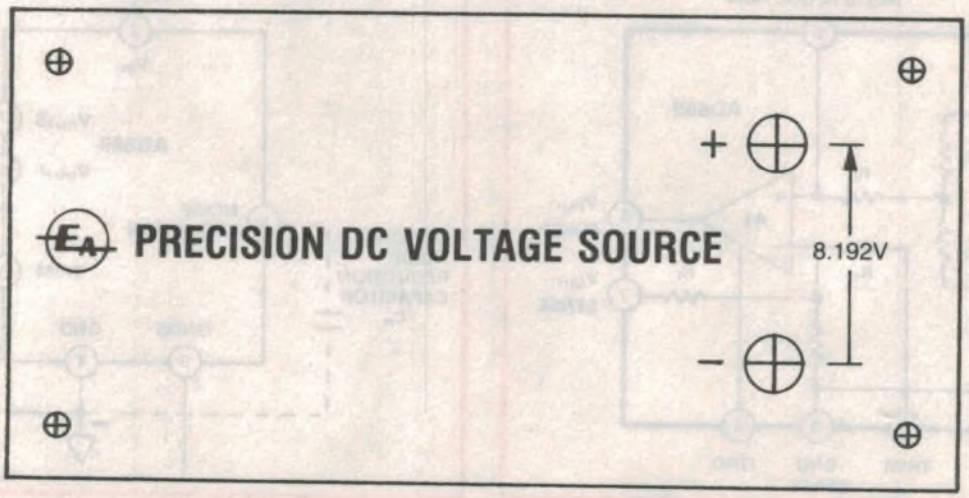
Construction

The complete circuit is built on a very small PC board, measuring only 62 x 37mm and coded 88vr7. The board is designed to slot vertically inside one of the readily-available medium-sized jiffy boxes, the size usually coded UB3 and measuring 41 x 68 x 131mm.

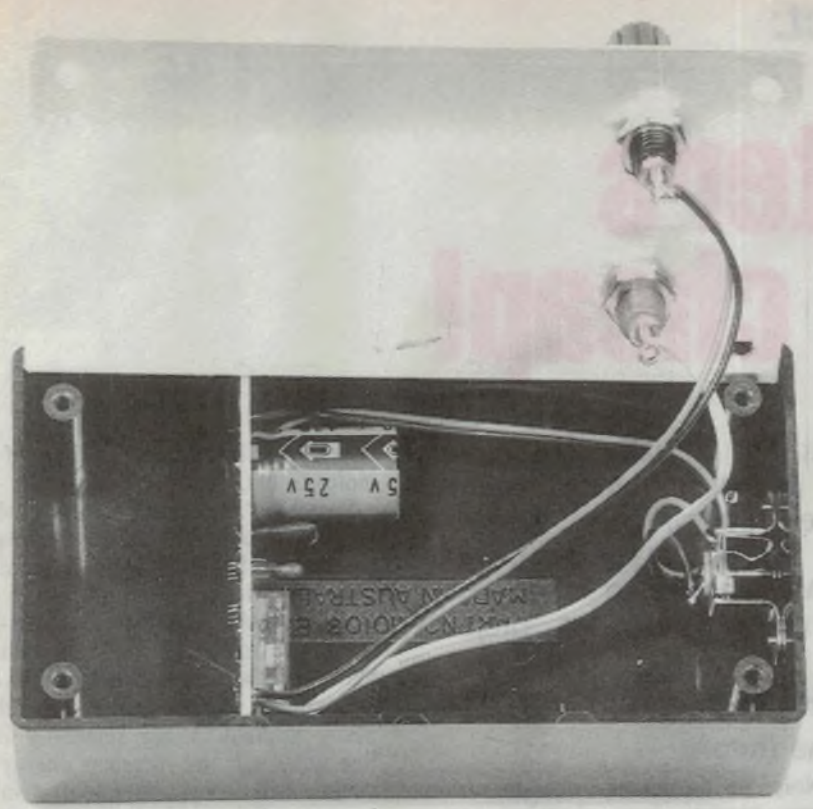


The PCB etching pattern, actual size.

The few parts involved fit very easily on the board, as you can see from the pictures and wiring diagram. The only items not mounted on the PCB are the



Front panel artwork for the unit, again shown actual size.



How it all goes together. Note the twin wires going to each output terminal from the PCB, for accurate sensing.

output terminals, which mount on the front panel, and the DC input socket which mounts on the end of the box.

Note that the PCB provides separate source and sense connections for both the positive and negative outputs. I did this mainly to allow the board to be used for remote sensing applications, where it may be important to ensure that the AD689 can control the voltage right at the load – compensating for voltage drops in the connecting leads.

In this case there's probably no need to worry about drops in the leads, so the two wires from each pair of pads can simply be joined together at the actual output terminals, as suggested on the circuit schematic of Fig.3.

However if you wish to make your unit capable of providing greater accuracy when long leads are used (particularly for meters drawing significant current), you may wish to provide it with four separate terminals, two for output and two for sensing. The positive pair and the negative pair can then be linked for normal use, but unlinked to allow the use of separate source and sensing cables when required. In this case the 'positives' and 'negatives' would be linked right at the load.

The PCB is also provided with a pair of 3mm mounting holes, to enable it to be mounted on pillars for other types of boxes.

Incidentally there's no reason why this voltage reference can't be powered from batteries, if you prefer. The actual operating current drawn by the circuit itself is typically less than 5mA, to which must be added the current drawn by the load, of course. But in many cases this will be a few microamps, so you could probably power the unit from a set of eight AA or even AAA size cells.

Another approach might be to power it from a pair of lithium-manganese 9V batteries, connected in series. These are not cheap, but would probably give a lifetime of around 8-10 years.

To adapt the circuit for use on the 18V provided by two lithium batteries, you'll only need to make two changes: use a 25VW electro for C1, and change R1 to 1.5k. But note that the circuit would only be able to deliver load currents of less than about 50mA, because the power dissipated by Q1 would be higher due to its higher voltage drop.

A final word, about availability of the AD689 chip. This should be available through the usual stockists, although they may not already have it in stock. In case of any problems, the Australian distributors for Analog Devices are Avisun Pty Ltd, of 11-15 Alexander Street, Crows Nest 2065 or phone (02) 438 3900.

Analog Devices actually produces a number of different 'grades' of AD689, with different tolerances and temperature drift figures. The grade of device I recommend for this project is the AD689K, with +/–8mV tolerance and 15ppm/°C drift. This is quite good enough for most purposes, but there's a grade called the AD689L with even tighter specs (+/–4mV and 5ppm/°C) if you don't mind paying a higher price.

PARTS LIST

1 Plastic utility box, 41 x 68 x 131mm
1 PC board, 62 x 37mm, code 89vr7
1 DC input socket, to suit plug-pack connector
2 Screw terminals, 1 red and 1 black

Semiconductors

1 AD689K voltage reference IC
1 BC639 or similar NPN transistor

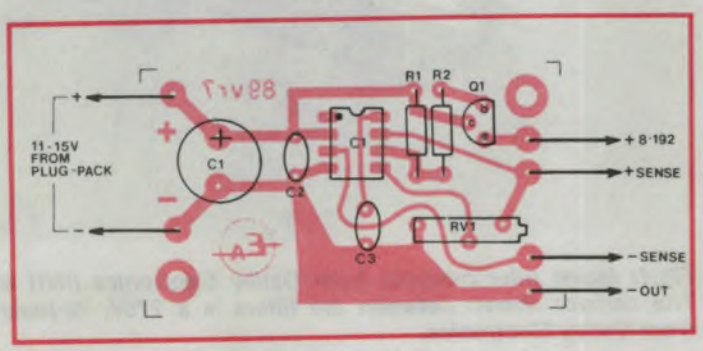
Resistors

1 47 ohms 1/4W metal film
1 1k 1/4W metal film
1 10k 10-turn trimpot (optional – see text)

Capacitors

1 0.1uF metallised polyester
1 1uF 16VW tag tantalum
1 470uF 16VW or 25VW RB electro

Hookup wire, screws etc.



The wiring and PCB overlay diagram, again to guide you in putting it together.

Construction project:

Mains filters — on the cheap!

If you shop around, it's not hard to find a ready-made mains filter module suitable for use as a part of a protection system for your electronic gear. Many electronics shops currently have one or more for sale, at prices that make them a bargain. But are they any good? We decided to check some of those currently available, and develop them into projects while we were at it.

by PETER PHILLIPS

Mains filters of some type or another have been around for years. Hifi enthusiasts have long sought the perfect filter, to eliminate the random thumps and clicks that permeate the music as nearby appliances switch on or off. As recently as July 1988, we presented a mains filter of the build-it-yourself variety, designed with the audiophile in mind.

The use of personal computers has made the need for mains filtering even more important, as losing a night's work (why didn't I save it?) is far more upsetting than mere noises from a loudspeaker.

However, there is another aspect to mains filters that often goes without mention – how do they handle rejection of a potentially damaging mains spike, due to say lightning? I decided the time had come for some form of filter/protection device after a recent round of thunderstorms that had more than their fair share of lightning. After all, losing a night's work is nothing compared to losing the whole computer, or the video, the TV, the hifi and so on.

As a result, I started looking around to see what was available, with an eye to cost and ease of building the device. I was immediately attracted to the 'specials' being offered by some suppliers, as I wanted to build several filters, not just one for the computer. I also wanted a varistor to go with the filter, although these are usually stock items anyway. But before examining the results of my shopping expedition, it's interesting to look at mains filters in general.

The theory

Noise on the mains comes in various forms, ranging from electrical supply authority induced control tones, through switching transients to the nastiest of all – the spike due to lightning. Control tones are not such a problem, as they usually appear late at night and do not seem to unduly affect electronic equipment. In any case, a mains filter is unlikely to be much use anyway, as the tones are often less than 1kHz, which is beyond the filtering capabilities of most mains filters.

Switching transients *are* a problem, and often contain sufficient energy to become audible through a sound system, or to hang a computer. The transient is usually caused by the back-EMF resulting from switching an inductive load, and the transient is likely to be at a maximum during appliance switch *off*. Many appliances are relatively inductive, although the transient energy produced will vary, depending on the amount of inductance and the phase angle of the AC cycle at the time of switching.

The energy of the transient is contained within the switching pulse or 'spike', which is often too fast to see with a scope. The energy is actually contained in the *edge* of the spike, in the form of high frequencies. The sharper the spike, the greater the range

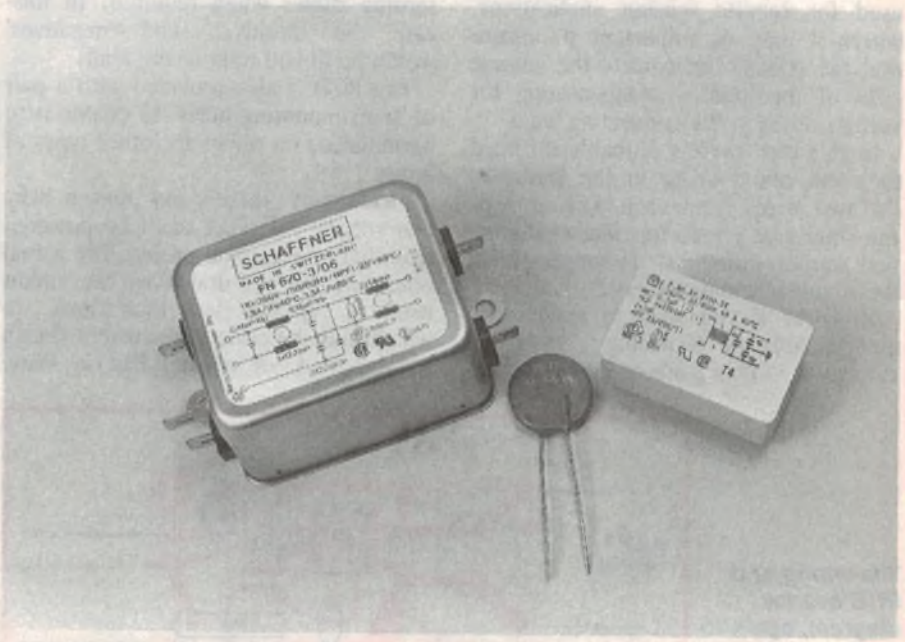


Fig.1: Mains filter modules from Oatley Electronics (left) and Jaycar (right). The varistor shown between the filters is a 275V, 40-joule device available from Oatley Electronics.

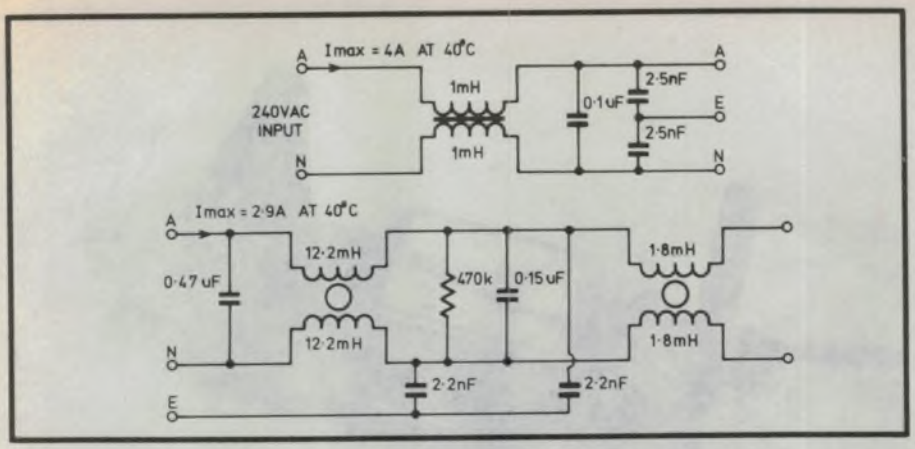


Fig.2: The internal circuitry of the filter modules. The Jaycar unit is shown in (a), the Oatley Electronics version in (b). Both modules have their internal circuit drawn on the case.

of frequencies, and the higher the spike, the greater the energy.

The aim of a filter is to prevent the spike from passing into the appliance, by filtering out the various frequencies before they reach the appliance. Because there will still be a few lower order harmonics present after filtering, some portion of the transient will still be passed on, but the overall energy will be reduced.

A lightning spike is a different proposition however, as the height and duration of the spike can be substantial. The problem now is capacitance, as the high-energy, high-frequencies are passed on through the various stray capacitances, often bypassing the filter altogether. So, on its own, a filter is not much use in handling this sort of spike and a varistor is required to clip the spike and to dissipate most of the energy before it can do any damage.

In fact, the amount of damage done by lightning is considerable. According to some servicemen I have spoken to, lightning damage rates as one of the highest causes of equipment failure. The actual lightning strike does not need to be right outside your house; in fact it can be quite some distance away, and still create a sufficiently high energy spike to kill a video recorder or any electronic equipment.

Of course *nothing* will protect you or your property from a direct lightning strike – except perhaps a full-scale lightning arrestor installation. What we're talking about here is protection against the spikes produced by strikes some distance away.

The best protection is to completely unplug everything during a thunderstorm – but the next best thing is a varistor. In fact, suppressor units that simply contain a varistor are readily available, and these devices provide some degree of protection against the ravages of lightning. But they don't filter out the transients that can destroy your music or wreck a night's work on the computer.

So what is needed is a suitable mains filter/varistor combination.

Filter designs

Any filter is essentially a circuit that will pass a certain range of frequencies, and reject others. A mains filter is simply a device that acts as a low pass filter, excluding frequencies above a certain value. However, a mains filter also needs to be able to pass substantial currents, say 2 amps or more. This makes the design somewhat more difficult than that for an RC filter, and requires the use of inductors.

The essential components of a mains filter are therefore an inductance and a capacitance, usually in the form of an 'L' or 'pi' configuration filter arranged in a number of sections. Filter design theory of any type is often quite involved, and beyond the scope of this article. However, in general terms, the effectiveness of the filter will depend on the value of the components, the circuit configuration, the type of components and the type of housing.

Almost all filters use a balanced circuit configuration, meaning both the active and neutral lines pass through series inductances. Parallel capacitors are used in various ways, either connected between the active and neutral lines, or from both lines to the earth terminal.

Many filters use a toroid as the inductor core, shared by both inductors. This has the advantage of giving a higher value inductance for a given size, but can give problems due to core saturation.

The capacitors need to be low inductance types, (usually polycarbonate) and rated at mains voltage. The value of the individual capacitors will necessarily be limited by the physical size of the case containing the filter, and typical values range from a few nanofarads to 1uF.

The housing of a mains filter is usually made of metal, although some versions use a plastic moulding in which the filter circuitry is embedded. A metal case offers shielding against re-radiated energy and physical protection, should something go wrong inside the filter.

Having had a brief look at the needs and design criteria of a mains filter, now let's look at two devices currently available.

Bargain filters

After examining catalogs and related literature, I obtained mains filter modules from Jaycar and Oatley Electronics. I was too late for the version being sold by Sheridan Electronics as they had none left, which demonstrates how popular these devices are. My interest was only in those filters that qualified as a 'bargain', meaning they had to be selling for less than $20.

The two filter units I obtained were physically rather different, as shown by the photo in Fig.1. The internal circuits

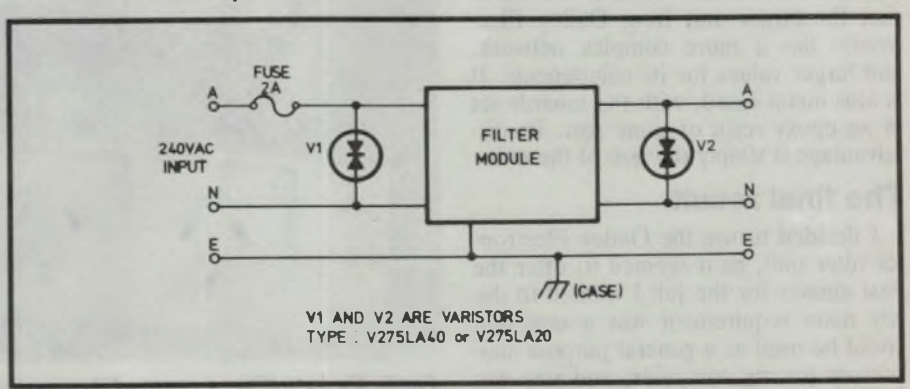


Fig.3: The circuit diagram of the complete filter/suppressor unit. Varistor V2 could be deleted if required, although it's nice to know two devices are present to kill that lightning spike.

of both are shown in Fig.2, which shows their electrical differences. It doesn't take an expert to deduce that the unit from Oatley Electronics is likely to be a more effective filter, although the Jaycar version is smaller and suitable for mounting on a PCB.

In an attempt to be objective, I decided to see how both units would perform with a frequency response test. Although I connected a 100 ohm load across the output of the filter under test, I found the effects of resonance played havoc with the tests. Basically, the Oatley Electronics unit showed a series resonance (lowest impedance) at around 70kHz, and the Jaycar unit had its series resonance point at 175kHz.

The frequency response test showed, in a sort of fashion, that the Oatley Electronics unit had a lower cutoff point (around 10kHz) than the Jaycar unit, which didn't really roll off until 200kHz. However this can be deduced easily enough by a bit of maths, so there's nothing startling in that.

I also tried a common-mode noise rejection test, but again the tests were inclusive. Common mode noise rejection is a possible problem if the inductor core becomes saturated, and obviously the larger the core the better. If both coils share the same core, such as a toroid, then common-mode noise will magnetise the core in the same direction, giving saturation relatively easily.

The Jaycar unit seems to have both inductors on the same core, according to the circuit diagram, suggesting a toroid has been used. The Oatley Electronics unit actually shows a symbol indicating a toroidal construction for both its inductors.

OK, so I could not objectively determine if one unit was better than the other, so an analysis of their circuitry was all that was left. Here it is obvious that the larger unit from Oatley Electronics has a more complex network, and larger values for its components. It is also metal cased, with the innards set in an epoxy resin of some sort. Its disadvantage is simply the size of the unit.

The final result

I decided to use the Oatley Electronics filter unit, as it seemed to offer the best answer for the job I wanted to do. My main requirement was a unit that could be used as a general purpose suppressor for my computer, and size was not an issue. The Jaycar unit seems best suited for inclusion in the power supply of the equipment, as its PCB mounting

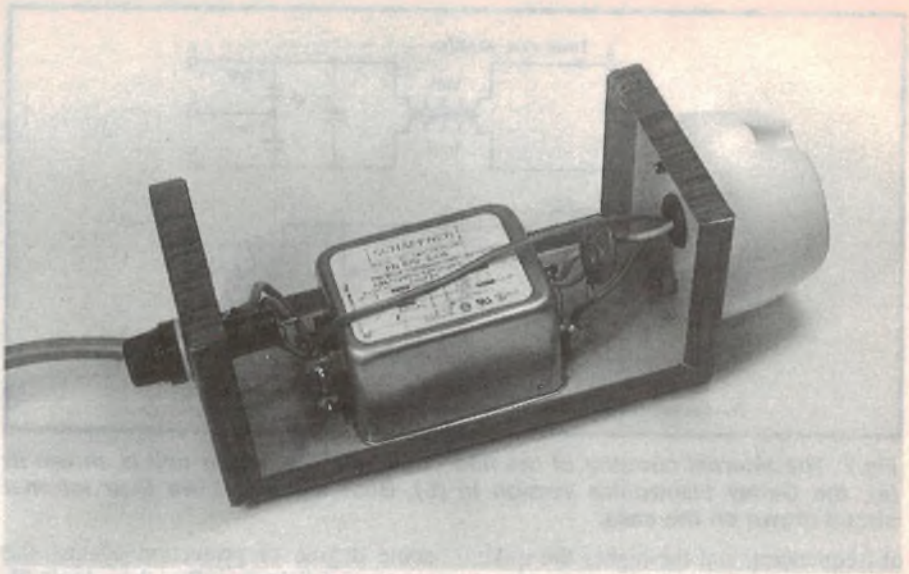


Fig.4: This photo shows the assembled unit, with the case cover removed. Anchor the incoming mains cord, and connect the active (brown wire) to the end connection of the fuse holder. Also make sure everything is well earthed.

feature makes it ideal for this.

As the accompanying photos show, there are various ways of making a filter unit. The electronics is simple enough, although there are a few points worth making. Firstly, because the unit must not only reject transients but give a measure of protection in the event of a lightning strike, a varistor is needed.

There a various types of varistors on the market, usually rated according to their breakdown voltage and their energy dissipating capabilities. For a 240V application, it is usual to employ a 275V (RMS) breakdown varistor. The principle of operation is very basic: when the voltage across the varistor exceeds 275V RMS, it conducts, giving a path for the transient that has created the over-voltage situation. In other words, for the duration of the transient, the varistor represents a short circuit across the mains!

Being one who feels a bit edgy about short circuits across the mains, regardless of the duration, I decided to add a fuse to the unit. Then, feeling secure with the fuse between the unit and the state power grid, I added another varistor, giving one across the input of the

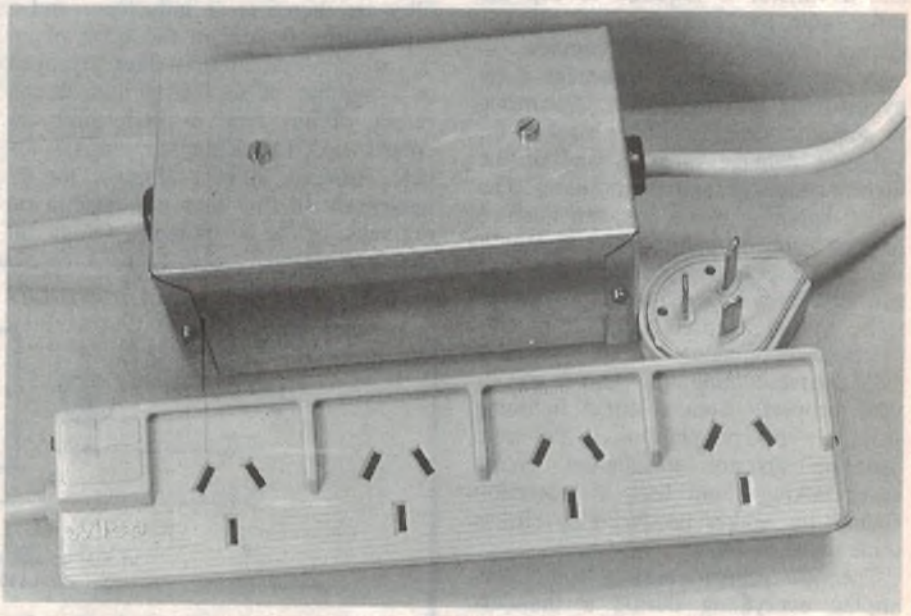


Fig.5: By inserting a mains filter in the lead of a multi-outlet board, protection can be provided for a number of appliances. The total load from the board will be limited to around 3A, which should be adequate for a TV, video and hifi combination.

filter unit and another across the output. Oatley Electronics also stock a 40-joule varistor, and I chose this one rather than one of the usual 20-joule devices in the belief that 'bigger joules is better'.

And that's it – no PCB, just point to point wiring and 10 minutes to perform the connections. The circuit diagram is shown is shown in Fig.3, which, as you can see, is all very simple.

The housing of the filter is another matter, and I resorted to actually making a case from Marviplate. However, commercially made cases are available and any of these are equally suitable. I decided against a plastic box, as somehow the idea of energy dissipation and plastic doesn't appeal to me. Also, the added shielding against re-radiated energy is another safeguard.

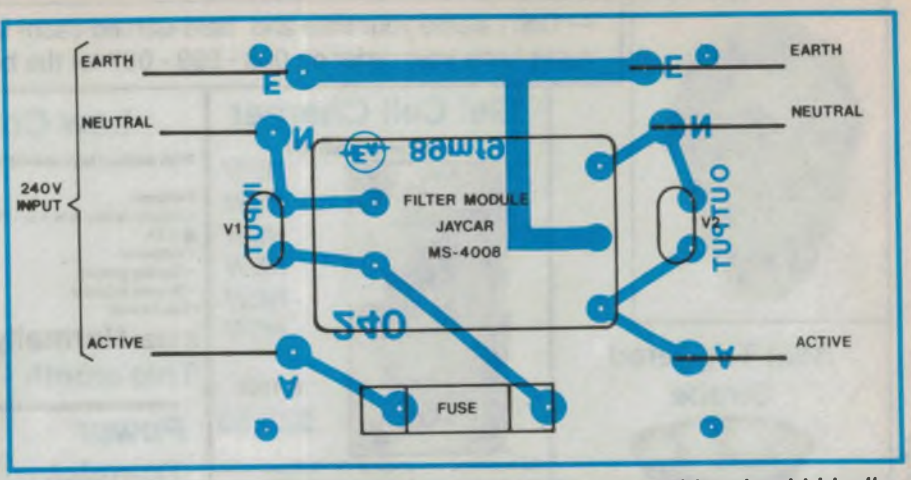
One important aspect is earthing, and it is essential that a good earth connection be made between the case of the mains filter and the metal box. The photo of Fig.4 shows the unit now protecting my computer, and the photo of Fig.5 shows another variation of this idea involving a multi-outlet board.

It is usual practice to fuse the active lead from the mains, and the active wire from the power point should be terminated at the *end* connection of the fuse holder. The earth wire should ideally be connected straight through to the outlet of the filter, with a second wire earthing the case. Keep the gauge of the earth wire at least equal to that used in the three core flex.

The alternative arrangement shown in Fig.5 uses a multiway outlet board, with the filter interposed in the power lead. This requires cutting the flex and reconnecting the earth wires inside the box, at the point of earthing the case. Naturally, the appliances connected to the outlet board will still send transients to each other, but at least noise from the outside world will be greatly reduced.

PARTS LIST

2 Varistors, either V275LA40 or V275LA20
1 Schaffner mains filter unit (Oatley Electronics), OR PCB mount mains filter unit (Jaycar cat MS-4008)
1 Fuse holder and 2A fuse, or M-205 PCB mount fuse holder and 2A fuse
1 PCB coded 89mf9, 75 x 65mm (for Jaycar filter unit)
Metal case to suit, 240V three pin plug, socket and flex, etc.



The PCB layout for the Jaycar mains filter unit. The fuse holder should ideally be protected from accidental contact with some form of insulated covering.

Does it work?

Since having had the filter unit connected to the computer, I have experienced no further 'hangs'. I have a colour TV set very close to the computer, and I can now turn the TV on and off with no apparent problems. This was not the case before fitting the filter, and it seems I have overcome this problem at least.

I am now tentatively awaiting the next thunderstorm, although I will probably chicken out and unplug everything anyway. But if I am absent, at least I now stand a chance of coming home to an operative computer.

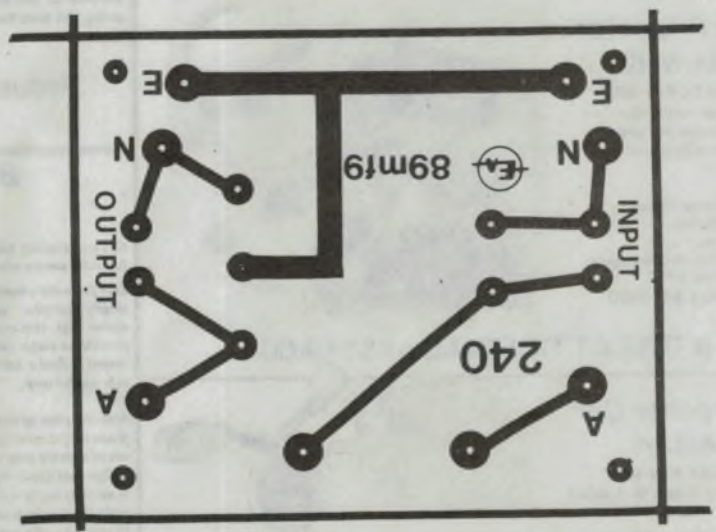
But what about the Jaycar unit? I have developed a PCB design for this unit, containing all the necessary terminations for the varistors, fuse and filter unit.

Although space is provided for two varistors, one is probably enough anyway. If you only use one, make it V1 and delete V2. The fuse holder is an M-205 PCB mount type, and the maximum fuse size should be 3A, although I have used a 2A size to be on the safe side. The board can be mounted on standoffs; one in each corner as per the pads on the PCB artwork.

The completed unit could be mounted in a box and used as already described, or incorporated in existing equipment. Its main feature is compact size, although it probably won't deliver quite the same degree of suppression as the Oatley Electronics unit. However, it should provide adequate suppression for many uses, and the varistors will help protect against mother nature.

Clamp the cables inside the box, regardless of which unit you make, to prevent any nasty accidents due to unintentional strain on the leads.

Either version provides a simple and straightforward project, but one that could save you a lot of problems. EA



The PCB artwork for the Jaycar mains filter unit is shown full size, for those wanting to make their own.

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(See EA Nov '87)

Calling all servicemen and bench technicians

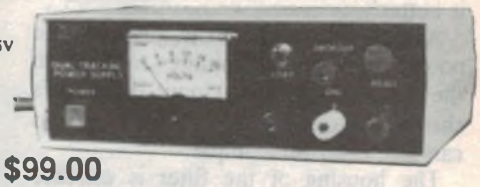
This unit simply clips across the DC Fuse holder. Offers protection adjustable from 0-10A in two ranges. In essence it's an adjustable DC circuit breaker.

Features:
Fast blow - slow blow setting
Manual reset button
LED fuse tripped indicator
Operates off 1 single 9V battery (not supplied)
Two current settings easily adjustable via a pot and calibrated scale.

K 2535 Normal Price is $39.50
This month $34.50

Low Cost Dual Tracking Supply

With memory logic and OP Amps (See SC Jan '88)



Features:
- Adjustable output to + or - 18.5V @ 1.7A
- Voltmeter
- Floating ground
- Dropout indicator
- Load switch

K 3325 **Normally $99.00**

This month - a CRACKING $90.00

Power Transistor Tester

(See EA May '88)

K2532 Normally $24.95

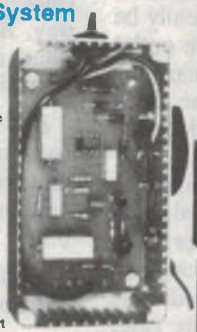
This month only $19.95

Designed for bipolar transistors with a continuous collector rating of at least one amp. Super simple operation allows for testing current gain & Vbe of all popular power transistors, even power Darlingtons. Suitable for both N.P.N. & P.N.P. types. Altronic kit comes complete with silk-screened box.

Save $5.00

High Energy Ignition System

(See SC May '88)



This state-of-the-art electronic ignition system uses the same semi-conductors as found in modern motors cars. Extends the life of plugs and points. Increase power and improves fuel economy. Compatible for 4, 6, and 8 cylinder engines. Install one into your car and start saving $$$ from the very first day.

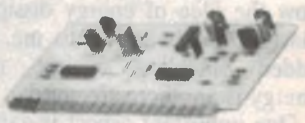
K 4015

Save $10.00

Reduced from $49.50 to $39.50

Twin Range LED Tacho

(See ETI Aug '80)
0-1000 RPM/0-10,000 RPM



Unit suitable for 1, 2, 3, 4, 6 and 8 cylinder vehicles, 2 stroke or 4 stroke. Fully compatible with conventional CDI and transistorized ignition systems. Includes protection circuitry to prevent noise and high voltage spikes from the points and the coil damaging the electronics.

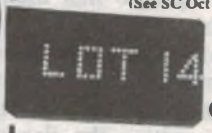
Display flashes when over-revving occurs. Only 3 connections required to the electrical system.

K 4324 Was $32.50

This month only $25.00

LED Light: The House Number

(See SC Oct '88)



K 1960 Normally $59.95 Only $40.00

Save $19.95

The LED light makes your house easily recognisable at night by illuminating your house number. Virtually any number can be configured easily, including alpha-numeric combinations, making it extremely versatile and suitable for most applications.

Operates off low voltage plug pack
Automatic switch-off after 4-5 hours
Altronic Kit is complete with 64 LEDs supplied.

Bonus Offer

We will include a set of 4 Car Alarm WARNING stickers ($3.95 value) ABSOLUTELY FREE with every Car Alarm Kit ordered this month.

The Protector Alarm Kit

(See SC Feb '88)

This refined car burglar alarm has about every feature you could possibly want to keep would-be thieves away.

Features:
Internal & External Sirens
Dash Lamp Flasher
Battery back-up
Delayed and Non-delayed inputs
Easy to build and install

K 4370 Was $129.00

NOW a GREAT SPECIAL at $119.00

Screecher Car Alarm

(See EA Aug '86)
Ear Splitting 110db Modulated Tone

Now our top selling car alarm. Two sensor inputs - normally open and normally closed, enable simple connections to door, bonnet, boot light, switches etc.

K 4360 **Great Value $39.95**

Build A Sub-Woofer Adaptor

(See EA May '89)

Get an amazing bass improvement for your stereo system.

This fantastic adaptor simply "samples" your stereo amp. output and provides a single channel output to feed a separate sub-woofer amp.

Also includes an out of phase output enabling the use of a stereo amp in a bridge configuration for those who really want to rattle the floorboards. Unwanted audio spectrum is removed with the Frequency Control (Cutoff threshold adjustable 60-130Hz)

K 5560 Kit (less plug-pack) **$29.50**

M 9020 12V AC/AC Adaptor) $16.50

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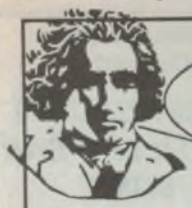


Psssst...! Listen to this!
The really exciting news is that all of these speakers are available at such a low discount price for this month - but be quick - stocks are limited.

Ultra High Power Capacity
Polypropylene Bass Drivers

Our ALL NEW "Black" polyprop cone Bass Drivers exhibit quite astonishing low register reproduction. Power ratings quoted are conservative. Not the cheapest but definitely the BEST VALUE we know of - ANYWHERE.

15" (375mm) WOOFER
Huge 120 Watts RMS
Massive 200 W Max.
C 3075
Normally $129
NOW ONLY $99
YOU SAVE $30

12" (300mm) WOOFER
100Watt RMS 150W Max.
C 3070
Normally $99
NOW ONLY $89

10" WOOFER
60Watt RMS
100W Max.
C 3065
Was $69.00
NOW ONLY
$49.00

HUGE SAVINGS ON SPEAKERS

8" WOOFER
60Watt RMS 100W Max.
C 3060 Was $49.95
Now $39.95 SAVE $10.00

61/2" WOOFER/Midrange
30Watt RMS 50W Max.
C 3055 WAS $29.95
NOW ONLY $24.00

61/2" Mid Range
30Watt RMS 50W Max.
with sealed frame
C 3045 Was $27.50
NOW YOU SAVE AT $22.00

SA-70
8" Woofer/Dome Tweeter
(Sealed Cabinet)

2-Way kit complete with crossovers and cabinets
70W RMS power handling. Cabinet
Size: 250D x 260W x 490Hmm

C 3260 **WERE $499 pair**

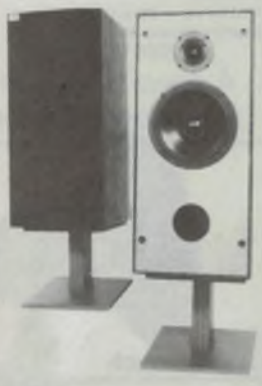
SAVE $100
NOW ONLY
$399 A PAIR

TOP QUALITY

SA-50
5" WOOFER/Dome Tweeter

2-Way bookshelf kit with cabinets and crossovers.
30W RMS power handling.
Cabinet size:
210D x 170W x 260Hmm
C 3250 WERE $399pair

SAVE $100
NOW ONLY $299 A PAIR



SA-100
8" Woofer/Dome Tweeter
(Bass reflex)

2-Way kit complete with crossovers and cabinets
100W RMS power handling Cabinet
Size: 338D x 290W x 640Hmm

C 3270 **WERE $799**

SAVE $200
NOW ONLY
$599 A PAIR

SA-130
10" WOOFER
3-WAY REFLEX

Complete with crossovers and cabinets.
130W RMS power handling.
Cabinet size
368D x 300W x 940Hmm

C 3280 WERE $1,199pair

SAVE $200
NOW ONLY $999 A PAIR

Ideal for "live" recording, our NEW Audio Mixing Console has truly sophisticated features:
- PA mixing
- Fantastic tape recording
- Stereo/mono VCR recording
- R/L 5 band graphic equalisers
- Talkover facility
- Separate headphone level control
- Patch switch bank
- Individual controls for Microphone, Phono 1&2, Aux. line 1&2, and Master slide level controls.

Blend up to two magnetic or crystal turntables, two tape decks and two microphones - all at once!!

FULLY PROFESSIONAL SPECS:
Input - Mic 1: 0.5mV, 600 Ohms, Mic 2: 0.5mV, 600 Ohms (Low Imp.), 2.5mV, 10kOhms (low Imp.); Phono 1&2 (Mag.) 3mV, 50kOhms; Phono 1&2 (Cry.), 150mV, 100kOhms; Tape/Tuner 1&2 150mV, 100kOhms
Equaliser - 5 frequency bands: 60Hz, 250Hz, 1kHz, 4kHz, 12kHz - Boost Cut Range, plus or minus 12db @

PROFESSIONAL STEREO CONSOLE MIXER

A 2570
$499.00

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HEADPHONES

Brilliant Digital Headphones

Incredibly Comfortable

Utilizes newly developed flat disk vibrator copper clad aluminium wire voice coil and Samarium cobalt magnet. The resultant reproduction is outstanding.
Impedance 45 Ohms,
Max. Input 400mW,
Freq. response 20Hz to 20kHz.

C 9010
Normally $39.50

Now an amazingly low $25.00
Save more than 36%

NEW TOP VALUE

Why pay $400 or more for a David Clark set?

AVIATORS HEADSET WITH OIL FILLED EAR CUSHIONS

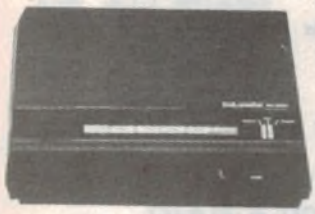
- High performance, noise attenuating earphones.
- Noise cancelling microphone
- Cushioned head pad
- Super sturdy
- Great performance
- Superb, professional pilot's headset will last a lifetime with reasonable treatment.
- Includes standard aircraft jacks.

C 9070 **ONLY $169.00**

(Exclusive to Altronics and Pacific Aviation outlets in Australia - sorry, not available from Altronics dealers.)

CALLMASTER DUAL TAPE TELEPHONE ANSWERING MACHINE

Why pay $299.00?



Features:
- Outgoing message variable from 30 to 120 sec.
- Announcement-only mode
- Incoming message is voice controlled
- Incoming call can be monitored
- Rapid erase
- Has built-in microphone - great for dictation

A 0512 **$179.00**

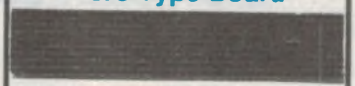
Mini Alarm

Great for door, window, cupboard, swimming pool gate etc
Unit fixes to stationary surface while magnet fixes to moving part. When set off the unit emits an ear piercing schreeech , (90db at 30cm), simply switch on to arm.

Operates on 9V battery
S 5315
Normally $16.00

This month only $10.00
Save an incredible 37.5%

Vero Type Board



Alpha-numeric grid. Pre-drilled 0.9mm, 2.5mm spacing x 95mm wide.
H 0711 95 x 304 $5.95 This month $5.00
H 0712 95 x 152 $3.50 This month $3.00
H 0714 95 x 76 $1.95 This month $1.50

12" Guitar/Piano Loudspeaker

Massive Magnet and Sturdy Diecast Frame

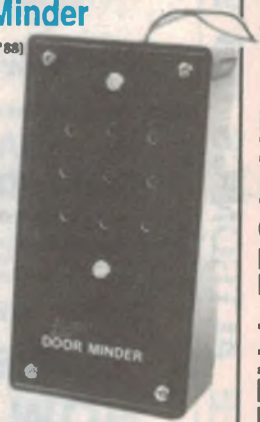
C 3100
$160.00 each or
$300.00 a pair

This impressive new 12" speaker will enhance any musical instrument Amp system. 97db SPL at .5M. Designed principally for guitar and piano, this reproducer will handle 200W intermittently or 150W continuous. 8 Ohm, 50mm voice coil, MASSIVE 4kg magnet.

Fantastic Value!

Door Minder

(See SC Feb '88)



This project will sense a door opening in a large or small room and sound a two-tone chime. It does not have to be anywhere near the doorway as it uses an ingenious sensor to detect the pressure change caused when the door opens.
Ideal for use in office, shops, doctors surgeries, chemists etc.

K 1915 Was $45.00
A special bargain this month $39.00

Economy Series Weatherproof Re-Entrant Horn Speaker

8 Ohm

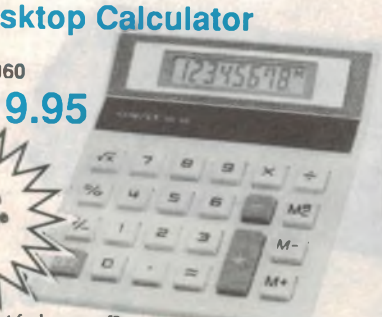
C 2015 10 Watt PVC
For one month only, reduced from $15.95 to $10.00!
Buy 6 or more for only $9.00each

Weatherproof Horn Loudspeaker

Professional Horn Speaker for 100V line PA systems. Multiple input transformers enables 5 power settings between 1.25 and 100Watts.
Excellent efficiency and sound clarity.
C 2027 Normally $69.00
During October only $60.00
6 or more $50.00 each Save $19.00 each

Solar Powered Desktop Calculator

X 1060
$19.95



Perfect for Home or Office

Perfect for home or office
- 8-digit mini-desk-top calculator • 3 key memory • Percent key with add on/discount calculation • Square root key • Large plus key Size: 123 x 107 x 23.5mm Weight 110g

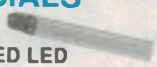
Solar Powered Pocket Calculator

Runs forever without batteries!

With positive feel push button, rubber keys.
• 8-digit display • Standard four function • Full memory calculation • Chain multiplication and division • Auto-constant calculation • Square root key

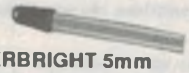
X 1050 **$14.95**

LED SPECIALS



Z 0140 3mm RED LED
Were 20c each Now 10c each, 10up 8c each

Z 0150 5mm RED LED
Were 18c each Now 10c each, 10up 8c each



Z 0149 SUPERBRIGHT 5mm RED LED
Were 40c each Now 30c each, 10up 25c each

HEAVY DUTY PCB RELAYS

NEW NEW NEW PRODUCT

- Low profile only 25mm high • 12V DC coil, • 1 x CO, 5A
S 4077 $5.00 each 10up $4.00ea
24V DC coil, 1 x CO, 5A
S 4078 $5.00 each 10up $4.00ea

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UHF 305MHz MICROPROCESSOR CONTROLLED WIRELESS SECURITY SYSTEM

Why spend hundreds of dollars installing cables and knocking holes in your walls? This UHF Alarm System uses no wires and installs in an hour or so.

Main Control Receiver

Features:
- Wireless reception of external or internal sensors or detectors
- Selectable home or away modes. Allows internal or external arming or just external to provide protected movement inside the building
- Built-in piezo electric siren gives different signals for different functions
- Sends signals down power line to activate one or more remote sirens

The main control receiver runs on 240V AC with a 12V 1.2AH battery for emergency back-up. All other units with the exception of the line carrier run on a 9V battery each. The average life expectancy is approx. one year. System works around 305MHz frequency where there is less chance of a false alarm. The range of the unit is normally 80 metres in open space.

S 5265 Take it with you when you move $349.00

MINIMUM FUSS MAXIMUM SECURITY

Passive Infra Red Movement Detector

Ideal for the loungeroom, family room or hallways. Mounts up on the wall or on top of bookshelves etc. Detects movement within area of 9M by 9M.

S 5280 $129.00

Remote Piezo Alarm

This unit is an optional line carrier receiver. Receives signal through 'AC' line i.e. it would ideally be located in, say, the roof space and plugged into mains power.

S 5290 $125.00

Front Door Keypad Control Unit

This handy accessory virtually duplicates the function of the Master Controller unit but at a more convenient location. System can thus be armed or disarmed without the need to go to the Master unit.

S 5285 $99.00

Hand Held Control transmitter Unit

Keep it at the bedside table — allows you to arm the house perimeters when you retire or you can take it with you when you go out, arming your system after you lock the door.

S 5275 $59.00

Detector/Transmitter Unit (Reed Switch)

Suitable for windows and doors

Consists of enclosed reed switch and removable enclosed magnet.

S 5270 $55.00

Complete System - Special Package Price

One S 5265 Main Controller
One S 5270 Reed Switch **S 5260 $599.00**
One S 5280 Passive I/R Detector
One S 5285 Wall Control Unit

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Construction Project:

TV-derived time & frequency standard – 2

Here's the second article describing our new standard, which allows you to generate frequency and time signals with an accuracy very close to that of a Rubidium Standard – within a few parts in 10^{11} – by phase-locking a local 10MHz crystal oscillator against the horizontal sync pulses of a TV network. This article deals with its construction.

by IAN POGSON

The prototype unit is housed in a Horwood metal box measuring 305 x 102 x 203mm, and I will assume that you are making your unit in the same case. Construction can best be taken in specific sections. It is a good idea to dispose of the easier or simpler ones first.

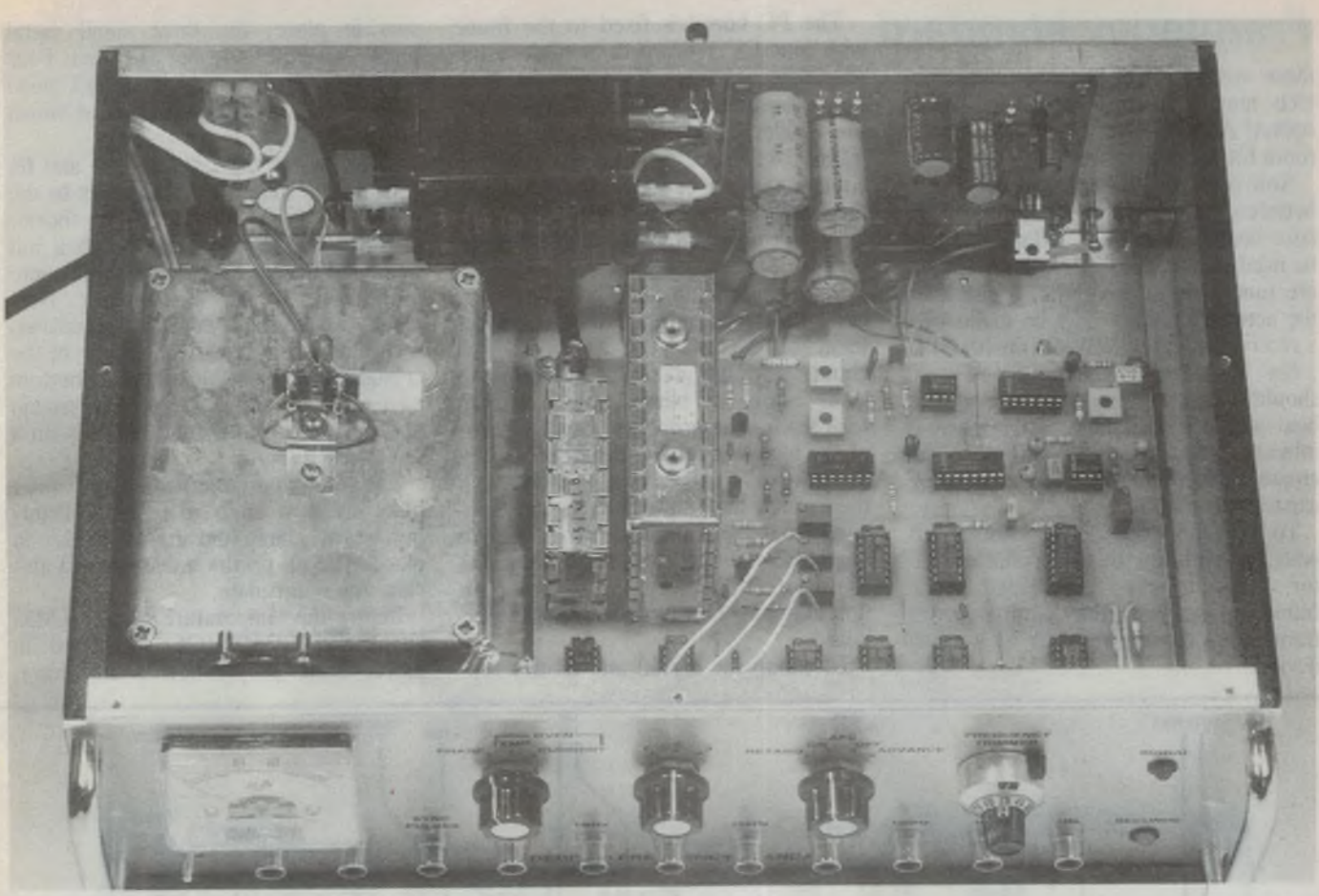
With the exception of the power transformer, all components for the power supply are contained on the PC board. The overlay shows the location of each component. Resistors, diodes, small capacitors, transistors and ICs should be assembled in that order, finishing with the larger electrolytics. A heat sink is also fitted to IC17. Having finished the power supply board, it may be put aside until later on.

The next job is to assemble the main PC board. This is a much larger unit and requires quite a bit of concentration in its assembly. Before proceeding, the board should be carefully inspected for any possible faults, such as broken or bridged tracks. Some holes may also need to be enlarged. Also, there are eight rectangular slots which are required for mounting the TV tuner and the TV IF modules. These should be carefully cut with a suitable small file, after some pilot holes have been drilled.

Fit the wire links first; there are 22 in all. Then come the small components, followed by the larger ones. Finally, the tuner and IF modules are soldered in place. Be sure to install all semiconductors and polarised capacitors with the correct polarity. I used sockets for the ICs, but these may be considered as optional. Having completed this board, it may also be put aside until later on.

We are now ready to take on the crystal oscillator and oven assembly. This is quite a detailed job and should not be treated lightly, as it is the heart of the project. Start with the assembly of the PC board. The previous comments regarding assembly again will apply. In this case, I used PC board pins for the terminations. There are 28 of these.

The coarse frequency trimmer capacitor (TC1) is mounted across two of the above-mentioned pins. On the proto-



An overall look inside the case, with the main board on the right and the crystal oven on the left.

type I used a Philips solid dielectric trimmer of 26pF (green) and shunted with an 18pF NPO ceramic capacitor. An alternative would be to use a larger capacitance trimmer without the need for a shunt capacitor. However, it would be less easy to adjust the oscillator to frequency.

With the PC board assembly finished, it may also be put aside for the time being.

A piece of aluminium or copper sheet should now be prepared. In a number of these units, I have used both copper and aluminium with equally satisfactory results. The drawings show the dimensions. Care should be taken when drilling the holes for mounting the crystal, so that they will be at the corner near the two pins for terminating the crystal on the PC board. The other holes at each end are to mount the MJE 3055 power transistors. Four holes are also needed to mount the PC board, and the dimensions may be taken straight from the PC board.

When bending the metal into the final 'U' shape, make sure that the bends are in the right direction. Note that the angles are not exactly right angles for the bends. They should conform to the angles of the diecast aluminium box, into which it will be fitted later on.

The drawings also show three small plates, to be prepared for mounting the crystal and its two sensing devices. Cut and drill two plates 30 x 19mm and another one 30 x 9mm.

As part of the construction procedure, it is actually wise to test the three units before proceeding with any further construction and assembly. The advantage of taking this step is that each board is easily accessible when this is required. Also, having got the units functioning as they should, you can then go ahead with confidence, knowing that the finished job will be functional and ready for final setting up.

Before proceeding further, the power supply, crystal oscillator and main PC boards should be thoroughly checked. Make sure that each component is in its right place, that polarities are correct and there are no solder bridges.

The following proceedings will, of course, be of a temporary nature. However, safety must be observed when dealing with the 240V AC mains. Also, each board should be placed on a table in a position relating to each other in a manner roughly similar to the final layout in the Horwood box. This will make temporary interconnections easier.

Connect a power cord to the transformer and leads from the transformer to the power supply PC board. Switch on and measure all the DC output voltages. As no current is flowing, some of the voltages will show a somewhat higher reading.

Assuming these tests are in order, the next step is to test the crystal oscillator circuits. We will leave the oven heater control circuits for the present.

An insulated jumper lead of hookup wire on the copper side of the board will be required from the +5V input point, across to the point near the 741 IC, as shown in the overlay diagram. Connect the lead marked 'S1 rotor' to +5V. Connect the lead marked 'VR1 rotor' to VR1 with its other two leads connected to earth and +5V, so that when the rotor spindle is turned clockwise, the voltage at the rotor increases.

With two short leads of stiff wire, connect the crystal as shown. If you solder the crystal pins, do so with care, preferably with a heat sink between the joint and the holder. Instead of soldering, I used a pair of contacts from an old miniature 7 or 9-pin valve socket. If

these are not available, substitute contacts may be used from say, a crystal socket! As will be seen later, there is no room for a complete socket.

Now connect the earth and +5V leads between the power supply and the oscillator board. Switch on, and a CRO may be used to check if the oscillator circuits are functioning. This done, a check on the actual frequency may be made with a receiver tuned to WWVH on 10MHz.

Set VR1 rotor voltage to +2V. It should be possible to adjust for zero beat with trimmer TC1. Although it is inlikely, you may need either to increase or decrease the value of the 18pF capacitor across TC1.

To test the oven heater control circuits, we will now fit the crystal oscillator board to the 'U' shaped metal frame, along with the heating power transistors, the crystal and its sensing devices.

The PC board is fixed to the frame with four 1/8" Whitworth or 6BA X 1/2" round head screws. Two nuts on each screw are used as spacers, to make sure the soldered joints clear the metal frame. As space is limited, only use enough spacing between the board and the frame to ensure sufficient clearance. Drop the board over the screws and secure with four more nuts.

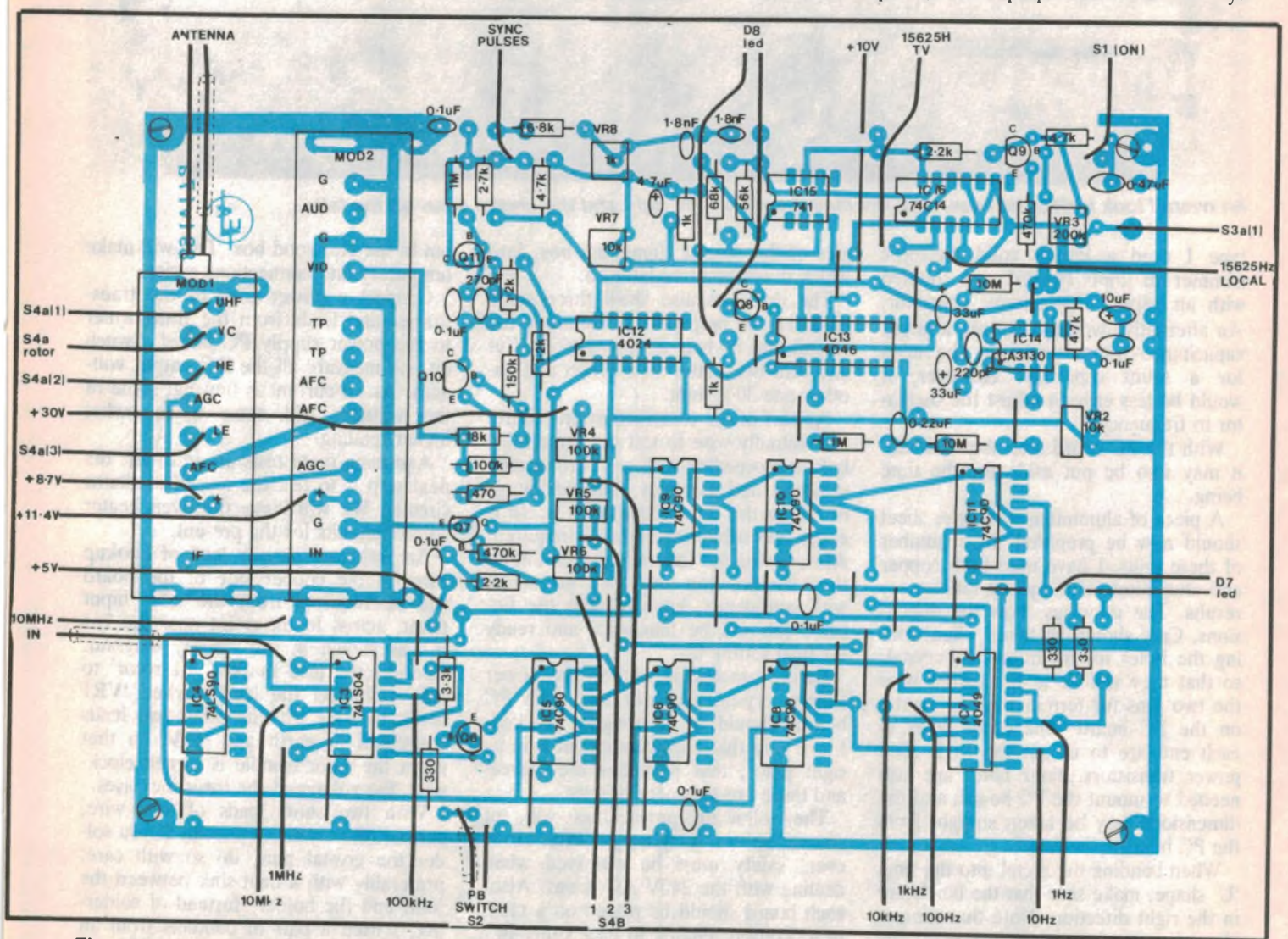
Before mounting the 3055 transistors, bend the leads at right angles and cut them off so that each dimension is about 2mm, to allow for soldering to leads across the bends. Solder hookup wire leads of appropriate length to each of the lugs. Fix the two transistors using the insulators and screws provided, and then check that the collectors are insulated from the frame. In the interest of neatness, the three leads of the 3055 transistor adjacent to the crystal position may now be run underneath the PC board.

To clamp the crystal and its two sensors in place, the three small metal plates referred to earlier are used. Four 1/8" Whitworth or 6BA round head screws are also required, two of which are 1/2" long and two 3/4" long.

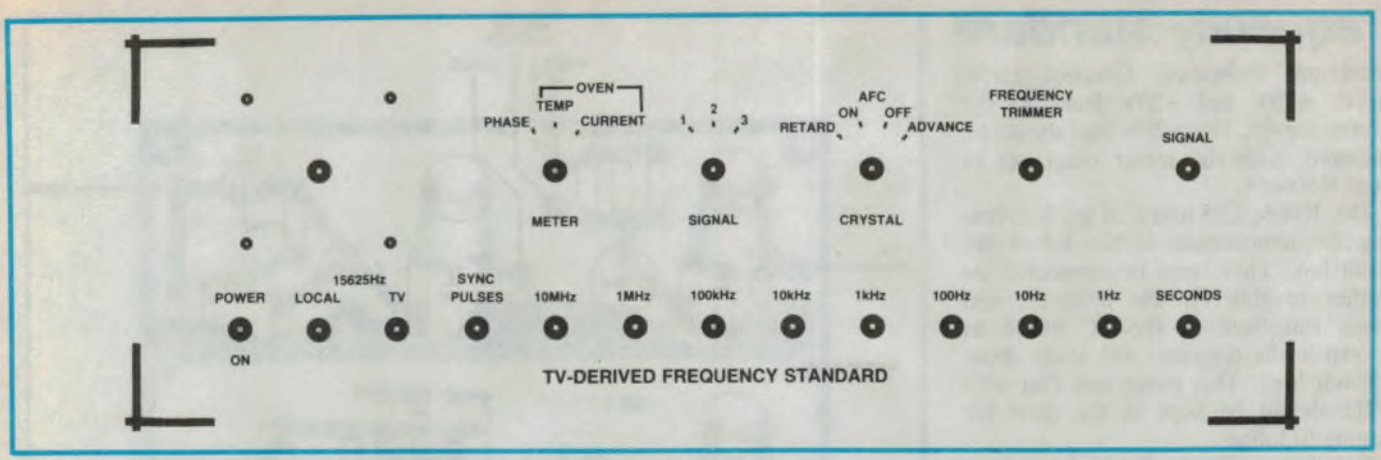
Take one of the larger plates and fix it using the four remaining holes to the inside of the frame, with the shorter screws at the bottom, each with a nut tightened firmly. Run a second nut onto each screw to act as a spacer. Now place the crystal between the screws, with pins facing down and the lip of the crystal holder just clearing the bottom edge of the plate. Drop the second plate over the screws and follow with a nut on each screw.

The screws on either side of the outer plate are now adjusted so as to firmly but gently clamp the crystal holder in place. The lip on the holder should also clear the outer plate.

Before the temperature sensors LM35 (IC1) and BC549 (Q6) are fixed in place, some preparation is necessary.



The parts and wiring overlay for the main PCB of the frequency standard.



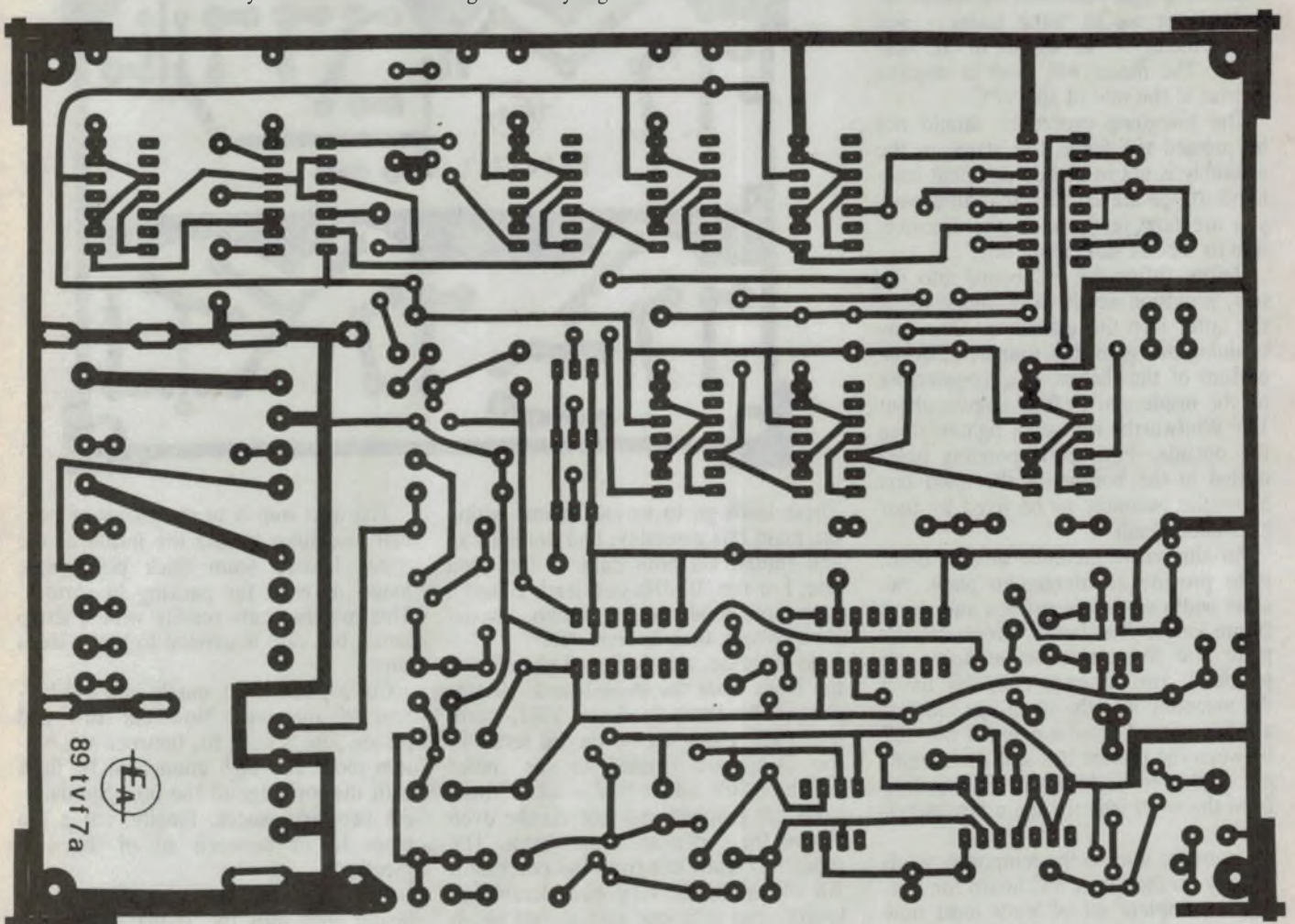
Full size prints of the front panel (here 50%) are available via the Reader Information Service, for $10.

These two items are clamped in place alongside each other. The case of the BC549 is thicker than that of the LM35 and so the radiused side, opposite the flat of the BC549, must be carefully filed down so that it is the same dimension as the LM35.

Three leads are needed on each of the above items. I used some rainbow cable. When fitting the leads, care must be taken to avoid any short circuits. Pieces of fine sleeving may be used for this.

The LM35 and the BC549 may now be clamped against the plate holding the crystal. Take the small plate and slip it over the two top screws, then run a nut on each. Now place the LM35 and the BC549 between the plates, with leads downwards, flats towards the crystal and with the BC549 nearer the outer edge. Gently tighten the nuts until the sensors are firmly held in place. The six leads may now be connected as shown in the diagram.

You should now be almost ready to test the oven heater control circuits. Run temporary leads for this. Connect R17 and VR2 as shown in the diagram, with leads about 150mm long. VR2 should be wired so that there is an increase in resistance with the adjusting screw turned anticlockwise. Set VR2 for



The etching pattern for the main PC board, shown here actual size.

maximum resistance. Connect earth, +5V, +10V and +20V leads to the power supply. The +20V lead should be metered, with the meter range set to read 0-500mA.

D6, R16A, C15 and C16 are for sensing the temperature of the lid of the oven box. These may be connected together roughly for the moment, and leads run back to the PC board as shown in the diagram, with leads about 150mm long. This group and that with VR2 should be kept in the clear for testing to follow.

Switch on. There should be only a few mA indicated on the 0-500mA meter. All being well, turn the screw on VR2 clockwise until the 0-500mA meter shows an increase in reading. Take this up to 100mA or so, and wait for a minute or two; the current should fall back.

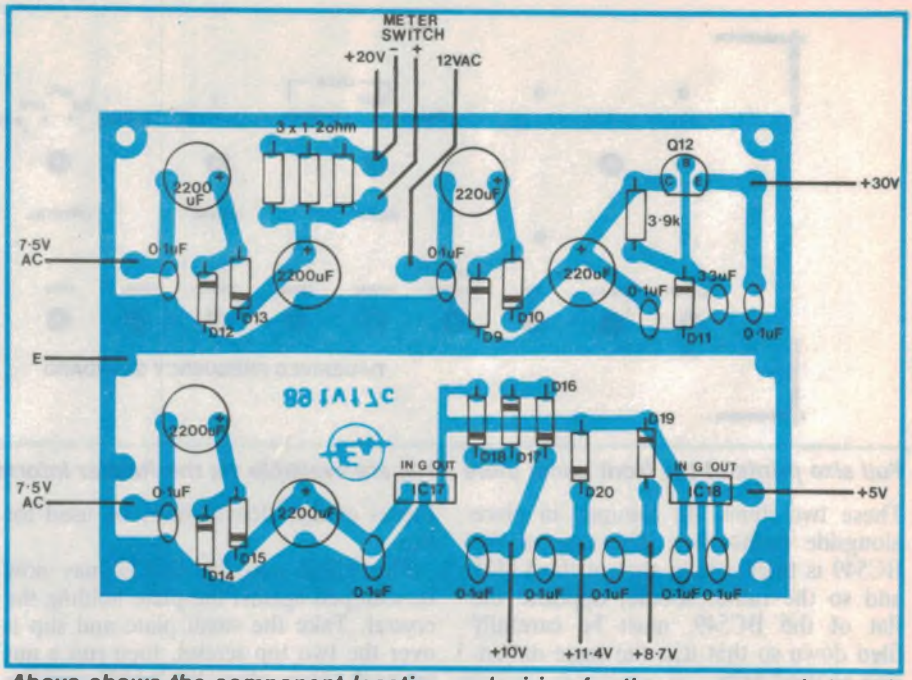
At this stage, if everything has taken place as described, it would seem that all is working correctly. If you wish, you may check the crystal temperature. Connect a high resistance voltmeter set to 0-1V or so, to 'temp meter -' and 'temp meter +' as shown in the diagram. The meter will read in degrees Celsius at the rate of 10mV/°C.

The foregoing procedure should not be pressed too far at this stage, as the assembly is not in its box and heat insulated. If you are satisfied that all is well, you are now ready to fit the assembly into its diecast aluminium box.

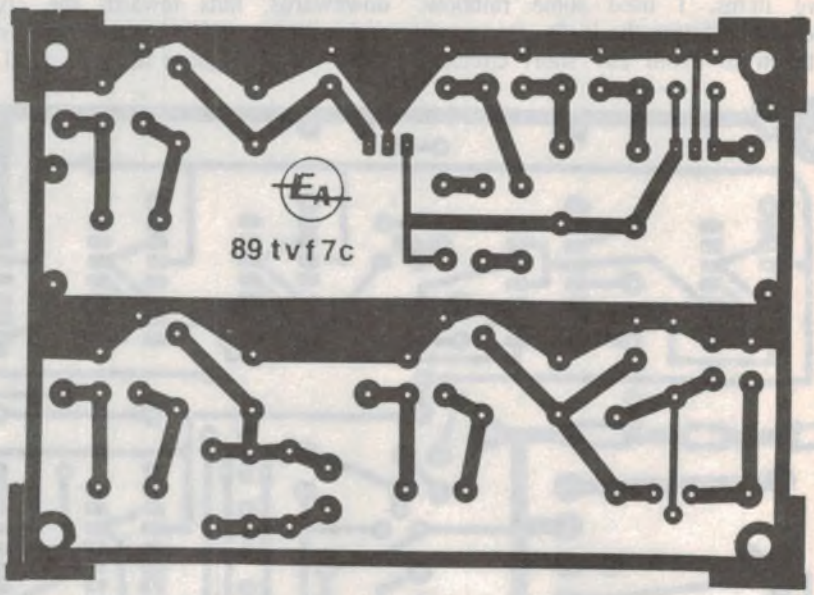
Before fitting the PC board into the box, provision needs to be made to fix the latter into the main box. One way of doing this is to drill four holes in the bottom of the diecast box, countersink on the inside and fit four screws, about 1/8" Whitworth, with nuts tightened on the outside. Four corresponding holes drilled in the bottom of the main box allow the assembly to be fixed by four nuts underneath.

An alternative method, which I used, is to provide an aluminium plate, the same width as the diecast box and about 20mm longer. The box is screwed to the plate and four more screw holes are provided, two at each end, for fixing the assembly into the main box. Just as a refinement, I fitted a piece of thin felt between the diecast box and the mounting plate, to reduce heat dissipation from the oven into the main box metalwork.

Returning now to the temporary leads already on the 'oven' PC board for testing, a complete set of leads must now be fitted for permanent installation.



Above shows the component location and wiring for the power supply board, with the board etching pattern itself shown below actual size.



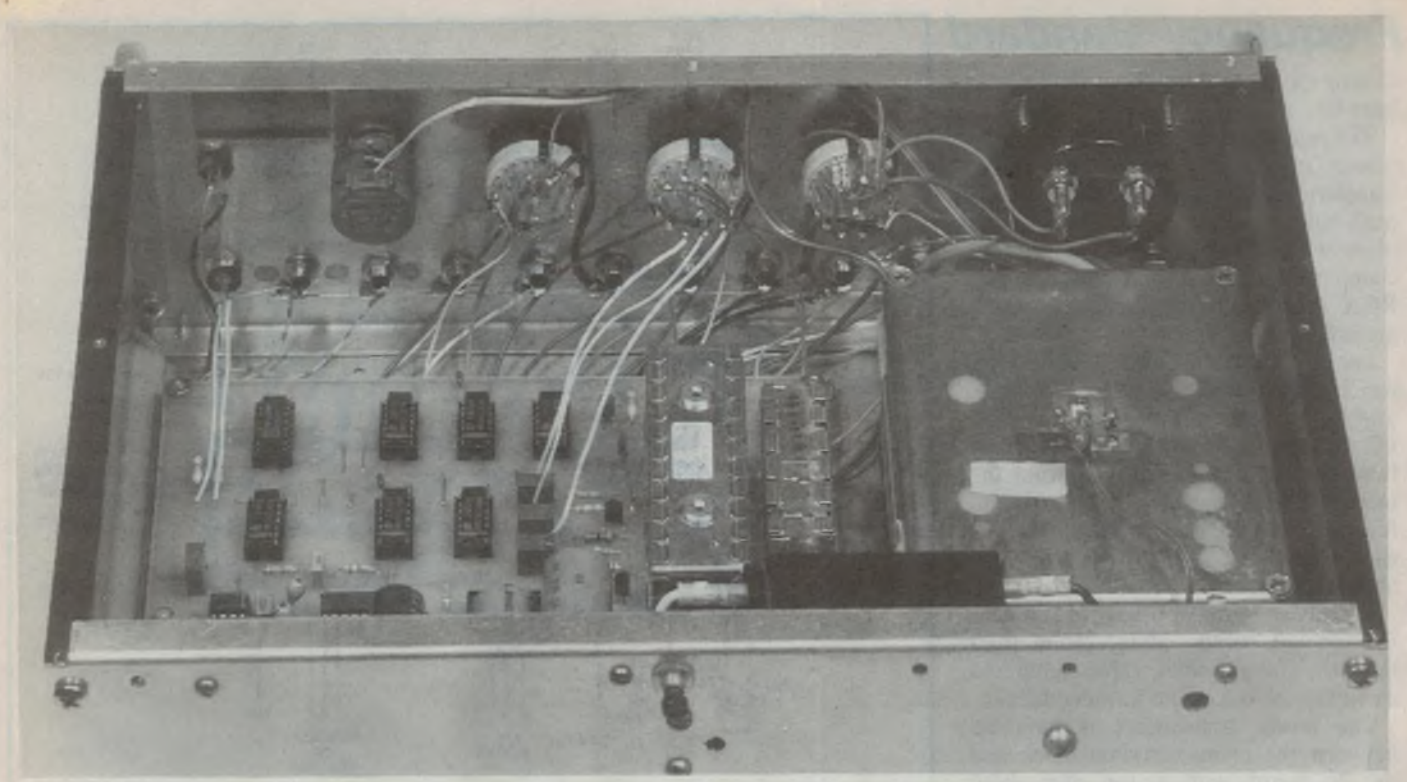
These leads go to various points within the main box assembly, and are split up and routed via both ends of the oven box. For the '10MHz out' lead, I used a piece of good quality audio coaxial cable, about 4mm in diameter.

As a guide, this is how I distributed the leads from the oven board. 10MHz out, +5V, three leads to VR1, earth lead to a solder lug on the lid screw of the oven box nearest to the meter switch, +20V and +10V – all of these leads are grouped and exit via the oven box at the end nearest the meter. The remaining leads exit from the other end. All of the leads vary considerably in length, and sufficient wire should be allowed for each.

The next step is to cut pieces of thermal insulation to line the inside of the oven. I used 6mm thick polystyrene foam, as used for packing in cartons. This material cuts readily with a sharp knife, but care is needed to make clean cuts.

Cut a piece to fit snugly into the bottom of the box. Now cut two end pieces, also a snug fit, between the bottom piece and high enough to be flush with the top edge of the box. Similarly, cut two side pieces. Finally, cut a top piece to fit between all of the side pieces.

Now drop the crystal oscillator and heater unit into the insulated box. A slot will need to be filed at each end of



Another view inside the case, this time showing the wiring to the front panel controls and connectors.

the box, to allow the leads previously mentioned to pass through. These slots may be more or less in the centre of each end, but the desired position should be determined and marked. The oscillator and heater unit and all the insulation need to be removed for this operation – or preferably, do it before they are fitted.

With the slots cut, the insulation and crystal oscillator and heater unit may be reassembled. Small cutouts will be needed in the insulation at each end, to allow the leads through. It may also be necessary to ease some material off the top piece of insulation as well.

I fitted VR2 and R17 to the crystal end of the box and towards the opposite corner. VR2 may be stuck to the box with rubber contact adhesive, with the adjusting screw uppermost. R17 is wired in series with one of the leads.

A hole is needed in the oven lid so that the crystal oscillator coarse frequency can be adjusted with trimmer TC1. Locating the position of the hole is rather tricky, as it must be directly over the trimmer. The hole may be about 3mm (1/8″) in diameter, or thereabouts, to accommodate an insulated alignment tool. Having drilled the hole in the lid, drill a corresponding hole in the top insulating piece. The hole in the lid may be covered with masking tape after coarse adjustment of frequency later on.

To complete the crystal oscillator oven assembly we still have to install the temperature sensor D6, with its shunting resistor R16A and bypasses C15 and C16.

To hold the diode in intimate contact with the box lid, I made up a small saddle of tinplate gleaned from a discarded jam tin. It measures about 14 x 28mm. The groove for the diode may be made by using a suitable diameter drill and fashioning the required shape in a vyce. Two mounting holes complete the saddle.

The saddle and diode are fixed to the middle of the oven lid with self-tapping screws and with insulated sleeving over the diode leads to avoid short circuits. When fixing, the diode should be just firmly held in place – not too tight.

As terminations for the diode, resistor and capacitors, I used an old 3-terminal tagstrip with the centre terminal for earthing and mounting via one of the saddle screws. The other two terminals are used for the diode, etc. If you are unable to obtain such a tagstrip, then some other standoffs may be used instead.

With the oven assembly now complete, it should be tested and adjusted before fitting it into the main box. Connect it to the power supply as for the preliminary tests. The S1 rotor lead will still need to be connected to +5V.

Switch on. The 10MHz output should still be close to frequency, but it will have changed now that the oscillator unit is enclosed in its box. The oven heater current should show about the same current as previously and then drop back to a low level. With a high resistance voltmeter connected across the temp meter + and – leads we are now in a position to run the oven up to approximately its working temperature.

Advance VR2 to give a heater current of 200mA or so, and observe the indicated temperature on the other meter. The process of advancing VR2 every few minutes should be continued until you have an oven temperature of about 48°C. Having achieved this, the oscillator and heater circuits should be left for one hour to stabilise.

After the circuits have been allowed to stabilise, the heater current should settle to a steady value, according to the ambient temperature. The actual current will vary considerably. With the unit still out in the open, the current will be much higher than when it is finally housed in the main box.

Now check the oscillator frequency, and zero beat it against WWVH, etc. by adjusting TC1 with an insulated tool. Provided you can tune the oscillator through zero beat, that is all that is necessary at this stage. Final adjustments can be made later on when all the subassemblies are fitted into the main box.

Preparation of the main case is next. This includes assembly of the front and rear panels, and if you wish to indulge in the refinement, a cutout in the bot-

tom of the box. More about that a little later on.

The rear panel has mounted on it the power supply PC board, the power transformer, antenna coaxial socket, push-button switch S2, mains terminal block with rubber grommet, mains cord clamp and earth lug. There are two RCA sockets on the prototype which are not used.

Looking from the inside on the back panel, the antenna socket is at the bottom right corner, with a solder lug. The PC board is located at about 30mm from the right end and 5mm from the top lip of the panel. It is mounted with four screws, using two extra nuts on each screw to stand the PC board off by about 4-5mm.

The mains terminal block is fixed near the top left corner, about 25mm from the end. The grommet, cable clamp and earth lug are below the terminal block.

The power transformer is mounted between the mains terminal block and the PC board, with its top edge about 5mm from the top lip of the panel. Room should also be allowed between the PC board and the transformer for the push-button switch S2, also near the top lip of the panel.

The front panel is next. Before fitting the Dynamark (Scotchcal) overlay, all holes should be drilled. The position for the frequency trimmer VR1 and its dial may need a small locating dimple or hole for the dial. This should be done before proceeding with the overlay.

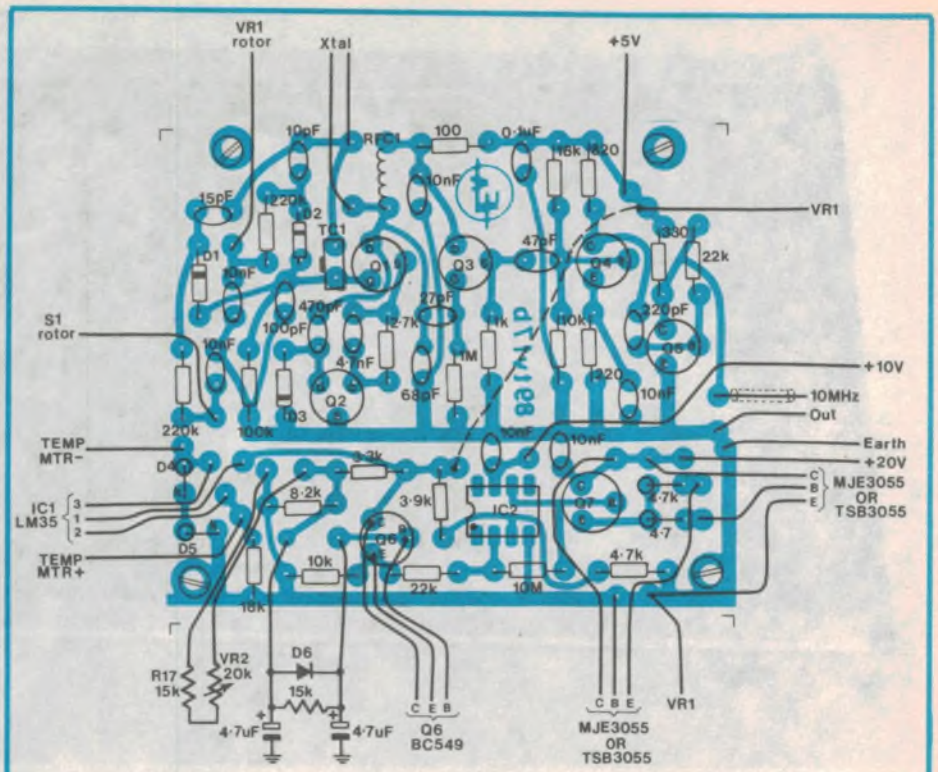
Fitting Dynamark overlays to panels can be very tricky, and calls for care and patience. Once the adhesive has 'grabbed' any part of the panel, it is difficult to remove – so it is important that they be properly aligned before contact is made.

With the overlay fitted, all the holes can be cut using a sharp knife. This should also be done with care as one slip and there could be a nasty scratch on your new panel!

Mounting the components on the front panel should be straightforward. When fitting the eleven RCA sockets, each earthing lug should be angled so that a piece of tinned copper wire can be run along and soldered at each lug. The toggle switch and the two LEDs are next. These are followed by the frequency trimmer potentiometer, the meter and the three rotary switches.

With the front and rear panels assembled, fix them temporarily to the box. This makes clear the space available for the oven assembly and the main PC board assembly. Place each in position and determine the location for each, allowing clearance around each unit as may be seen in the picture. Mark the four mounting holes for each unit, remove them and unscrew the bottom of the box to drill the eight holes.

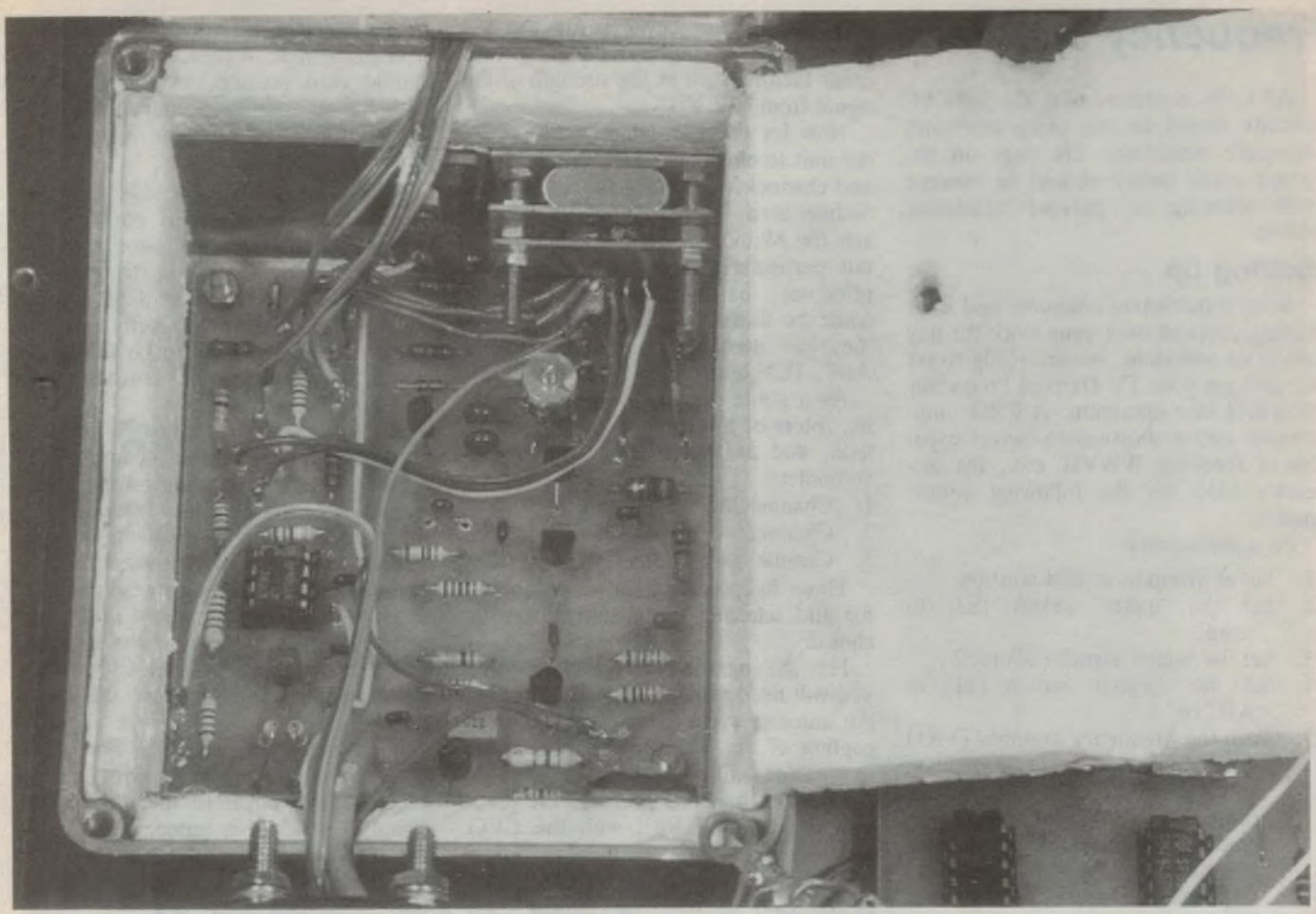
Earlier, I mentioned an optional cutout on the bottom of the box. I cut a rectangle under the position for the main PC board. This is worth the extra trouble, as it makes final wiring to the board much easier and allows easy access to the underside of the board if needed later on.



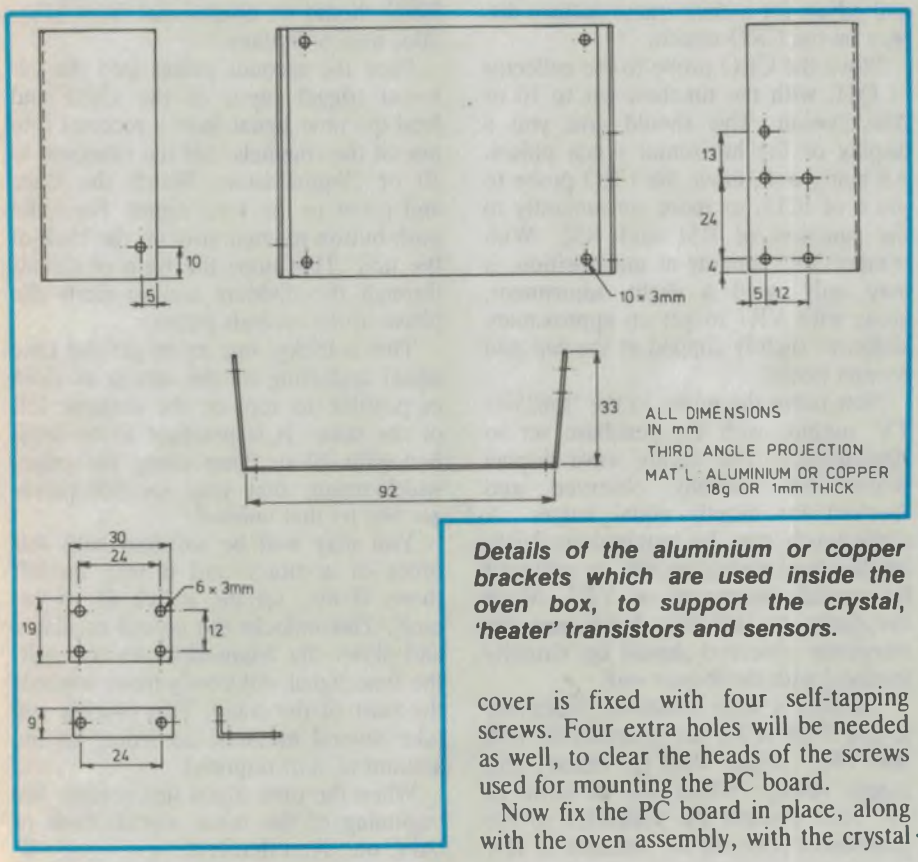
Details of the wiring of the oven PCB, above, and below the PCB pattern itself.

I made the cutout 160 x 110mm, which is a little smaller than the PC board. This is necessary to allow for the mounting screws for the PC board. I used a hand nibbler, which involved quite a bit of wrist exercise! Other methods may also suggest themselves.

Having made the cutout, we now need a cover for it. A piece of Formica or similar sheet may be used. Better still, a piece of copper laminate, as it restores the metal shielding which otherwise is lost. I used a piece of Formica sheet, but I plan to change it for a piece of copper laminate. The



A close-up of the inside of the oven, with the top insulation swung out of the way.



Details of the aluminium or copper brackets which are used inside the oven box, to support the crystal, 'heater' transistors and sensors.

cover is fixed with four self-tapping screws. Four extra holes will be needed as well, to clear the heads of the screws used for mounting the PC board.

Now fix the PC board in place, along with the oven assembly, with the crystal end nearest the back. The PC board needs to be stood off the bottom by about 8mm. I used screws 12mm long and with three nuts on each. The interwiring can be done by following the circuit details and the wiring diagrams. This process can be facilitated by removing the front and rear panels.

Two wires to the second LED and three wires from the trimpots to the 'signal' switch are the only ones above the main PC board. All the rest, I ran underneath in the interests of better appearance.

The lead to the push-button switch is run in insulated audio shielded cable. The lead from the TV tuner to the antenna socket is run with good quality coaxial cable. When fixing an RCA plug to the cable, shorten the centre pin to no longer than 8mm to suit the shallow socket fitted to the tuner module.

Three leads from the back of the oven, two to S3 (temperature) and one to the rotor of S1, I ran in rainbow cable. This was run along the side of the oven and held in place with masking tape. The three leads from the oven to the frequency trimmer were also run with rainbow cable.

All leads associated with the 240VAC circuits should be run using wire with adequate insulation. The lugs on the power on/off switch should be covered with sleeving to prevent accidental shock.

Setting up

With construction complete and after having checked over your work for any errors or omissions, we are ready to set up and put your TV Derived Frequency Standard into operation. A CRO, multimeter and a shortwave receiver capable of receiving WWVH, etc., are necessary tools for the following adjustments.

As a preliminary:

1. Set all trimpots to mid-position.
2. Set the 'meter' switch (S3) to 'temp'.
3. Set the 'signal' switch (S4) to '2'.
4. Set the 'Crystal' switch (S1) to 'AFC on'.
5. Turn the 'frequency' trimmer (VR1) fully anticlockwise, corresponding with OV at the rotor. This setting should also correspond with zero reading on the dial. Now advance the dial to read 400. This will correspond to a reading of +2V at VR1's rotor.

With these things done, switch on. Check all five separate DC voltages at the power supply. All but the 20V output should be close to the nominal values. The 20V supply is not regulated and will be delivering upwards of 250mA at this stage, to heat the oven.

The 'seconds' LED should be flashing alternately red and green, at half-second intervals. This indicates that all decade dividers are working. At this stage, each of the eight decade outputs may be checked on the CRO.

The oven, having been checked earlier, will come up to the temperature previously set (about 48°C) in about ten minutes, but will not stabilise for about one hour.

Set the 'crystal' switch (S1) to 'AFC off'. Take a piece of hookup wire about 100mm long and fix an insulated crocodile clip to it. Clip it onto pin 1 of IC4, corresponding to the end of the coaxial lead. With a receiver tuned to WWVH on 10Hz, adjust trimmer TC1 (through hole in oven lid) for zero beat. The case may be stood on one end for this adjustment.

The length of the 100mm lead may need to be altered to give the right level of signal into the receiver. This will vary with the distance between the receiver and the unit being tested, along with other factors, such as the strength of the signal from WWVH.

Now for the TV signal circuits. I set my unit to channel 28 (1), channel 9 (2) and channel 2 (3), being suitable for the Sydney area. These settings should also suit the Melbourne area. Channel 28 is not particularly useful as a frequency reference, but other UHF channels could be useful in certain areas where they are used as translators for the ABC, TCN, etc.

As a guide, here are the voltages at the rotors of the trimpots on the prototype, and as indicated on the digital voltmeter:

1. Channel 28 +4.08V
2. Channel 9 +14.39V
3. Channel 2 +5.17V

These figures will help when looking for and selecting the channels of your choice.

For the next series of adjustments you will need to connect a TV antenna. An antenna which gives satisfactory reception of the TV channels of interest in your area will do nicely.

Connect the CRO probe to the junction of R41 and R42, with the CRO timebase set to 2 or 5ms/division. Select the relative positions on the signal switch (S4) as required. Adjust each trimpot VR4, 5, 6 for the wanted signal and adjust for a clear frame pattern display on the CRO screen.

Move the CRO probe to the collector of Q11, with the timebase set to 10 or 20us/division. This should give you a display of the horizontal synch pulses. All being well, move the CRO probe to pin 6 of IC15, or more conveniently to the junction of R51 and R52. With trimpot VR8 already at mid-position, it may only need a slight adjustment, along with VR7 to get an approximate sinewave slightly clipped at the top and bottom peaks.

Now move the probe to the '15625Hz TV' output, with the timebase set to 10us/division. The square wave display should be critically observed and checked for exactly equal halves. A slight touch may be required on VR8, but the final equalising will be achieved by careful adjustment of VR7. Move the probe to '15625Hz local' and the waveform observed should be virtually identical with the former one.

Connect a high resistance voltmeter to pin 3 of IC14, the junction of R36 and VR2. Adjust VR2 for exactly half supply voltage, which will be close to 5V. Now connect the voltmeter to the junction of R39 and the collector of Q9. With a suitable crocodile clip lead, connect pin 2 of IC14 to +10V. The meter should read greater than 9.5V. Also, with S3 set to 'phase', adjust VR3 so that the meter on the front panel reads the same value.

Now connect the crocodile clip lead from pin 2 of IC14 to earth. Both meters should read the same and less than 0.5V.

If the meter readings of the foregoing fail to reach the limits given, then the value of R38 will need to be varied accordingly. Remove the crocodile clip lead and the voltmeter.

At this stage, the crystal oscillator should be locked to the incoming sync pulses. The phase reading on the meter should be right at centre scale. If the meter reads low, the oscillator is tending slightly high, and vice versa. To adjust this, turn the frequency trimmer anticlockwise (lower reading) and vice versa. Now if you view the two 15625Hz waveforms on a 2-channel CRO, they should appear with a phase difference of 90°.

Your new TV Derived Frequency Standard is now running with a long term stability equal to that of the TV signal to which it is tuned. If you wish to set the seconds pulses against a time signal transmission, or other time reference, this could be the next step. Hopefully, by the time this appears in print, VNG should be operational from Llandilo, west of Sydney.

Feed the seconds pulses into the external trigger input of the CRO and feed the time signal from a receiver into one of the channels. Set the timebase to 10 or 20ms/division. Watch the trace and listen to the time signal. Press the push-button momentarily on the back of the unit. This stops the train of signals through the dividers and so shifts the phase of the seconds pulses.

This is tricky, but try to get the time signal appearing on the screen as close as possible to zero or the extreme left of the trace. It is practical to be satisfied with 10 to 20ms along the trace, which means that your seconds pulses are fast by that amount.

You may well be satisfied with this order of accuracy and it may be left there. If not, set the switch S1 to 'retard'. This unlocks the crystal oscillator and slows the frequency. As a result, the time signal will slowly move towards the start of the trace. This process will take several minutes, according to the amount of shift required.

When the time signal just reaches the beginning of the trace, switch back to 'AFC on'. And that is it.

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DAVID FLYNN

Wollongong's VHF TV gets reprieve

Television transmissions in the Wollongong area of NSW are to continue on VHF channels 4 and 5A, until a UHF translator station can be built for the Ulladulla area. This was announced by Minister for Transport and Communications Mr Ralph Willis two days before VHF transmissions were to cease on June 30.

Mr Willis said that while the closure of the channels had been planned for some time, they were currently the only source of television for some people in the southern Illawarra region.

"I am not prepared to allow that reception to be lost", he said.

Construction of the Ulladulla translator has been delayed, while environmental procedures are sorted out by the Federal and NSW governments.

Local satellite tracker a winner

Codan Pty Ltd, the Adelaide-based company known for its successful range of RFDS and marine HF transceivers, is producing an innovative satellite tracking controller which will help increase the life of communications satellites.

Partners in R&D of the 'Orbtrack' controller were OTC, the University of Newcastle, and the CSIRO's Division of Radiophysics (in association with the Australia Telescope).

Satellites have an accepted life of five to seven years. Although all their communications power requirements are provided by high-efficiency solar panels, each bird must use small rocket motors to check any drift in orbit and keep them fixed in the correct geostationary position. But only a limited amount of rocket fuel can be carried on-board, and when this expires the satellite slowly develops an inclined orbit, moves out of position and becomes relatively useless to all but large tracking dishes.

The Orbtrack allows smaller antenna to follow the satellite movement and can 'learn' the peculiar orbit of a drifting bird, maintaining tracking for up to seven days, even if the satellite beacon is lost.

Using Orbtrack not only extends the useful life of communications satellites, but minimises the effects of delays in launching new satellites – as the existing bird can be used for longer periods.

Codan has been granted the exclusive worldwide licence to manufacture and market Orbtrack, and believes it to be worth hundreds of thousands of dollars in export sales.

TV facsimile

Those clever oriental engineers are pushing ahead with sending fax transmissions via television broadcasts. TV fax uses the same method as teletext for embedding data in a TV signal, except that in this case it goes to a printer which is built into the set or connected as an accessory.

Designers claim it is an ideal way to get a fax machine into every home, although of course it doesn't allow the usual personal traffic between users. It would however be ideal for marketing, sending recipes from cooking series or dispatching any other information from a broadcaster to any number of viewers.

Of course it remains to be seen just how many viewers would be prepared to invest in a fax machine hooked permanently to their TV set, for the privilege of receiving hi-tech 'junk mail' – on expensive paper they would have to buy themselves!

Tunnel radio

With the growing reliance on mobile radio in all its forms, one of the problems for people driving in mountain or undersea tunnels is how to keep in touch. Even city underpasses cause total drop-out of AM/FM radio, let alone two-way systems such as cellular.

The answer is the well-named 'leaky cable' system, running through the tunnel and radiating signals from a longitudinal split in the sleeving.

In addition to handling broadcast radio, leaky cables can also be configured to transmit paging tones and emergency traffic anouncements which can interrupt all other broadcasts. The tunnel can also have its own 'cell', allowing cellular telephones to be used through an automatic hand-off as one enters and leaves the tunnel.

Systems such as these are being considered for most large-scale tunnel projects, including the England-France Channel Tunnel and Sydney's Harbour Tunnel.

New shortwave listening guide

A new listening guide for shortwave listeners in Australia, New Zealand and neighbouring countries has been launched by Australian Monitoring Services.

The second edition of the *Australian Shortwave Guide* includes a computerised listing of several hundred entries, in time order, for broadcasts to the Region, as well as 'Stationfile' – a comprehensive address list of international broadcasters, to assist those wishing to collect QSL cards.

Cost of the *Guide* is only A$5.00 within Australia and New Zealand, which includes packing and airmail postage. To all other countries the price for airmail delivery is A$6.00, US$5.00 or eight International Reply Coupons.

The *Australian Shortwave Guide* is available from Australian Monitoring Services, GPO Box 2143-T, Melbourne 3001.

Now you're really roaming!

Telecom is currently negotiating for 'roaming' arrangements with several countries, to allow Australian cellular phones to be used overseas.

The first links to be established are expected to be with Pacific neighbours including New Zealand, Singapore, Hong Kong and much of South-East Asia. These countries all use systems identical to ours, and Telecom is investigating billing procedures and minor technical arrangements.

Further afield, it is also hoped that both the UK, the USA and Europe may also be bought into our extended network at some stage. Although using the same frequencies and general specifications as Australia's CMTS, these regions support different computer protocols with which our own phones are presently incompatible.

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WESTERN DIGITAL 1006-MM2 2 x HDD, 2 x FDD MFM 1:1 INT. LEAVE 16-BIT (AT)	$276
WESTERN DIGITAL 1006-SR1 2 x HDD RLL 1:1 INT. LEAVE 16-BIT (AT)	$258
WESTERN DIGITAL 1006-SR2 2 x HDD, 2 x FDD RLL 1:1 INT. LEAVE 16-BIT (AT)	$288
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Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

VCF/oscillator has 1MHz bandwidth

Precision Monolithics has announced availability of the SSM-2044, a 4-pole voltage controlled filter oscillator. As an alternative to switched-capacitor filters, the SSM-2044 offers 1MHz bandwidth and a far wider range of applications including medical imaging/ultra-sound sytems, instrumentation and sonar systems.

The SSM-2044 is a –24dB/octave low-pass filter with a 10,000 to 1 variable cutoff frequency. The cutoff frequency is determined by a control voltage, making the device ideal for real-time analog filtering under microprocessor control.

A special feature of the SSM-2044 is its on-chip resonance control, which can produce a low distortion sine wave for use in Voltage Controlled Oscillator (VCO) applications.

With a dynamic range of 90dB and 1MHz bandwidth, the SSM-2044 is a low noise alternative to switched-capacitor filters in a wide variety of applications, including antialiasing and reconstruction filtering.

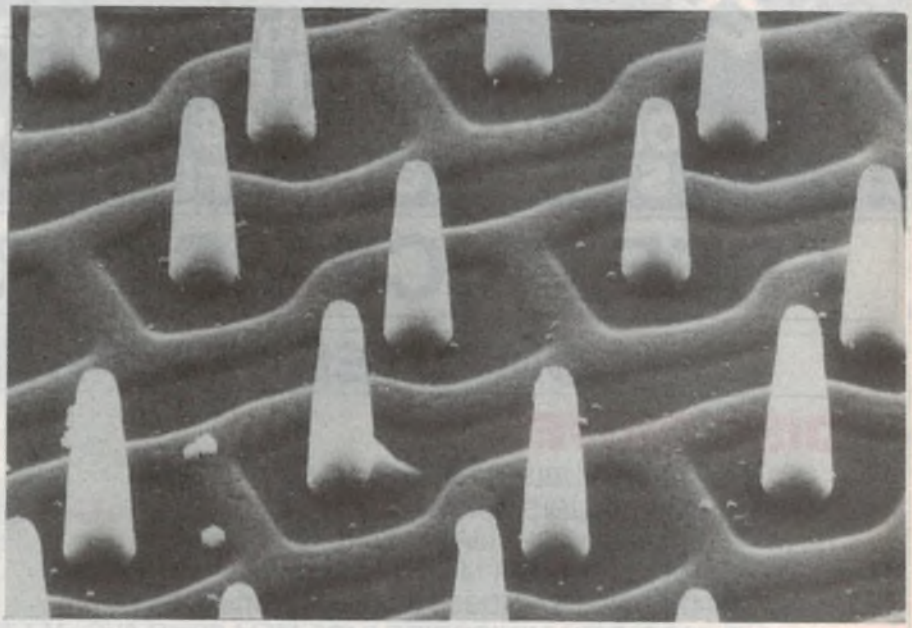
For further information, contact VSI Electronics (Australia), 16 Dickson Avenue, Artarmon 2064 or phone (02) 439-8622.

First EISA chip set

Intel has demonstrated the industry's first chip set designed to implement the 32-bit Extended Industry Standard Architecture (EISA).

Intel's 82350 EISA bus chip set consists of two system board devices that provide 100% compatibility with the EISA bus. In addition, the company is supplying a bus master device for add-in cards and a bus buffer device that integrates system board and glue logic.

Samples of the 82350 chip set, which have been available in the US since June, were delivered exactly to the silicon schedule that Intel mapped out last September when EISA was announced, according to Paul Otellini, Vice President and General Manager of Intel's Folsom Microcomputer Division.



No, it's not a bunch of candle flames, but an inverted scanning electron microscope shot of the trench capacitors in Siemens' new 4MB DRAM chip.

High-speed controller for ADC's

For very fast data processing at 100 mega-samples per second in measuring instruments or medical equipment, Siemens has integrated in one chip the important functions previously provided by a few dozen chips with considerable complexity and expense. The SDA 8800 controls the entire sequence for high-speed data acquisition (HSDA) and ensures that data volumes which are received in surges and cannot be processed immediately are first stored in buffers or caches via a shift register. The Siemens range already includes the SDA 8020 HSDA chip as shift register. The SDA 8800 HSDA controller (CMOS, 2.0um, PLCC 68) was designed for joint operation with the microprocessor families from Siemens/Intel and Motorola. The heart of the chip are two 16-bit counters which are intended for an acquisition rate of 25MHz.

The SDA 8020 data acquisition shift register allows high-speed buffering (via caches) to be increased to 100MSps. Devices which can serve as caches are

static CMOS RAMs from 1K byte to several megabytes. The SDA 8800 HSDA controller is already intended for operation with future SRAMS. Up to 32 caches of 4Mbytes each can be connected to one SDA 8020 HSDA shift register.

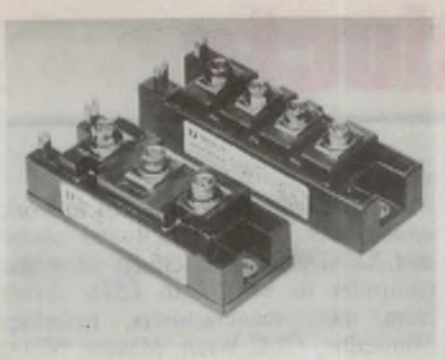
Applications for the 100 MSps data acquisition system using the SDA 8800/8020 chips will include digital oscilloscopes, logic analysers, transient recorders and generators as well as digital image processing with high resolution.

For further details contact Siemens Ltd, Electronic Components department, 544 Church St, Richmond, 3121 or phone (03)420 7314.

High power MOS modules

Just released by US supplier Siliconix are 500V, 50A MOSPOWER transistor modules that are said to offer the fastest reverse recovery time and the lowest on-resistance of any 500V modules available today. Designated the SPMB50A500 and SPMF50A500, they allow the construction of motor controls and power supplies without the tedious and complex parallelling of discrete transistors. The package developed for these new modules is designed to meet UL standards with 2500V isolation, enhancing system performance and making mounting procedures more simple.

The 500V, 50A rating allows direct operation of these modules from rectified power lines up to 240V, thus eliminating the need for an intermediate transformer and reducing the size and weight of power conversion equipment rated at 1kW and above. Further



reduction in parts results from their reverse recovery time of 270ns which lowers diode losses and eliminates the need for additional diode chips. Smaller heatsinks can be used since the low on-resistance (100mohm max.) reduces power losses.

Specified with a 12us short-circuit tolerance, the SPMB50A500 and SPMF50A500 can withstand momentary overloads without destructive effects.

Further details from Anitech, 1-5 Carter Street, Lidcombe, 2141 or phone(02)648 4088.

Single-chip C-Quam stereo receiver

In an industry first, Motorola has introduced a low-cost single-chip C-QUAM AM stereo receiver IC. The MC13024 device is expected to be especially widely used in the inexpensive 'headset' type of portable radio, with the capability of receiving high fidelity AM stereo from the more than 700 C-QUAM broadcasting stations now operating worldwide.

A number of key features give the MC13024 AM Stereo Receiver remarkable performance at low cost. The IC operates over the range of 1.8 to 8.0 volts, allowing typical operation from two AA batteries at approximately 3 volts with only 5mA of current required. The unique tuning indicator output level will keep a display LED dark with no signal or a weak signal; show half brilliance with a usable mono or stereo signal; and light the LED to full brilliance with a valid C-QUAM stereo signal.

In addition, the device incorporates a 'smart' signal quality detector which simultaneously examines the lock condition, the C-QUAM 25Hz pilot tone level, interference-caused phase modulation, and changes in the station tuning circuit. Any conditions that prevent good stereo are immediately identified, whereupon the receiver drops back gently into 'mono' mode without a transition 'pop' effect.

Other performance specs include less than 1% distortion, stereo channel separation of more than 25dB, 'blend on' stereo turn-on, and fast, high accuracy VCLO tuning lock-up. All of these features combine to give the listener the same 'feel' and audio quality that has previously been provided with a good quality FM portable radio.

Single chip power supply

The HV-1205 is a single chip power supply that can supply 5V to 24V at 50mA output current. Just a few inexpensive external components are needed to provide a compact, light weight, cost effective power supply.

The HV-1205 replaces a transformer, rectifier, and voltage regulator. This chip is made in the new Harris' High Voltage Dielectric Isolation process. This breakdown process (500V) allows a patented switching circuit to draw current from the AC line only as necessary to supply the load.

For more information contact Promark Electronics, 104 Reserve Road, Artarmon 2064 or phone (02)439 6477.

Matched power FETs

Fujitsu Microelectronics has introduced to the market its latest addition to the Linear Internally Matched Power FETs.

These devices are designed to be used in linear amplifiers in the 4.4 to 5.0GHz frequency bands, requiring output power of 4 to 20 watts or more. Applications include QAM Terrestrial Microwave Links, Digital Video Links for RPVs, etc.

The three parts being released are the FLM4450-4D (4W out, 8.5dB power gain), the FLM4450-8D (8W out, 7.5dB power gain), and the FLM4450-14D (17.8W out, 8.0dB power gain).

Further information from Electronic Development Sales, Unit 2A, 11-13 Orion Road, Lane Cove 2066 or phone (02)418 6999.

Phase locked oscillator

The Series 3000 Fixed Frequency Phase-Locked Oscillator operates over a frequency range of 8-20GHz or 20-40GHz with a doubler.

This compact, lightweight unit incorporates a varactor-tuned, low-noise DRO phase-locked to a stable reference to yield 5ppm stability over a temperature range of -55° to +85°C, using an internal reference; an optional external reference that yields higher stability and lower noise is available. At 15GHz, the typical SSB phase noise is 95dBc/Hz at 1kHz offset from the carrier; minimum output power is +24dBm.

MIC thin film construction is used throughout the unit, making it highly suitable for Hi-Rel and airborne applications. The Series 3000 Fixed Frequency PLO weighs approximately 100 grams and is only 2.3" x 2.0" x .650" in size.

Further information from Electronic Development Sales, Unit 2A, 11-13 Orion Road, Lane Cove 2066 or phone (02)418 6999.

10ns PIN diode switch

KDI/triangle has introduced a new SPDT switch (series XN) using high speed PIN diodes to achieve 10ns switching speeds. The unit maintains greater than 100dB isolation between the two signal paths. Insertion loss is 1.5dB typical and VSWR is less than 1.5 to 1.

The series XN switches may be used as radar duplexers and are available in all standard radar frequency bands.

Electronic Development Sales, Unit 2A, 11-13 Orion Road, Lane Cove 2066 or phone (02)418 6999.

New Products

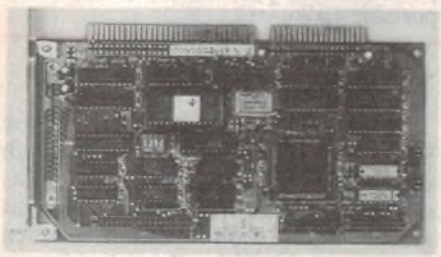
Electronics Vyce

Record Marples has released a special product designed for use in the electronics and instrument making industries. Unlike many vyces used for more intricate work, the Record product is of cast iron to provide stability and a feeling of solidity in use. It also allows an integral anvil to be included.

Features include a 360° swivel base with coin operated locking screws, and V-grooved polypropylene jaws, which are designed to hold circuit boards and other flat objects in a horizontal or vertical plane. Jaw width is 89mm (3½").

The vyce also has pipe jaws designed to hold up to 2mm round materials. But perhaps the most attractive feature is that the normal 89mm (3½") jaw capacity can be doubled to 178mm (7"), by screwing the slide out to its normal limit and replacing it into the rear of the base.

Design and manufacture is by Record Marples (Industrial Tools) Ltd. of Sheffield, UK. Australian distributor is Dureau Tools, 1 Tabbita Street, Moorabbin, which also has branches in other state capitals.



ESDI hard disk controller

Electronic Solutions has just released the model HA-200 ESDI hard disk controller, offering a very high speed, low cost interface to the latest crop of large, fast ESDI hard drives coming onto the market.

The HA-200 can be installed to work under both MD-DOS 3.0 and above and XENIX. Jumper settings allow the controller to work with ESDI drives from most manufacturers, including Miniscribe, CDC Wren, Maxtor, NED, Fujitsu, Toshiba, Siemens, Priam and Micropolis.

The controller comes with full documentation and carries a 3 month warranty and a 14 day guarantee.

For further information contact Electronic Solutions, Box 426 Gladesville 2111, or phone (02) 427 4422.

Stand-alone EPROM/ micro programmer

Logical Devices has released the Shooter, a low cost stand-alone EPROM programmer with a standard 512K of internal ram. The Shooter is capable of programming all popular single voltage EPROMs from 2716 through to 27512, including 'A' and CMOS versions. An optional adaptor allows the programming of 8751/87C51 micros.

In stand-alone mode, the user can directly copy and verify EPROMs via three control switches and LED status indicators. When connected to a MS-DOS compatible computer or dumb terminal, the user has full function control including RAM edit, blank check, checksum, upload, download, offset and file transfer format. Upload and download formats cover Intel hex, Motorola hex, ASCII hex or binary file formats.

The unit can program most NMOS, CMOS and HMOS EPROMs. The built in RS-232 port operates at 110,300,1200 or 2400 baud. Fast intelligent algorithms combined with its compact size, make the Shooter ideal for use in personal projects or field service applications.

For further information contact Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.

Rack mounting LCR bridge

Prism Electronics has announced the addition of a rack mounting LCR bridge to its existing range of bench top instruments. The new 6458 is orientated to OEM and systems applications, occupies a 2U high slot in a 19" rack, and is available with front or rear panel test connections.

The 6458 offers 0.1% measurement accuracy of L, C, R, D, and Q at three test frequencies of 100kHz, 1kHz and 10kHz. Primarily intended for remote operation, the instrument has full talk/-listen facilities via both IEEE-488 and RS232 interfaces. For local operation all functions are controllable from the front panel and a full 5-digit high brightness display is included.

Standard features include 4 terminal measurements, 2V DC bias for electrolytic capacitors and a 'Zero C' facility to offset stray capacitance in external test fixtures.

A wide range of accessories is available including component test leads with Kelvin clips or SMD tweezer style probes and menu driven software for logging and analysis of results on a PC.

For further information contact Parameters, 25-27 Paul St Nth, North Ryde 2113 or phone (02) 888 8777.

Synthesized function/ sweep generator

Hewlett-Packard Australia's new HP3324A synthesized function/sweep generator delivers synthesizer performance at a lower price than most comparable generators, according to HP.

With an Australian price of $5,946, the HP3324A is a practical alternative to standard-function generators that do not provide synthesizer performance. Whether it is used as a pure-frequency reference source, a function generator or a sweep generator, the new instru-

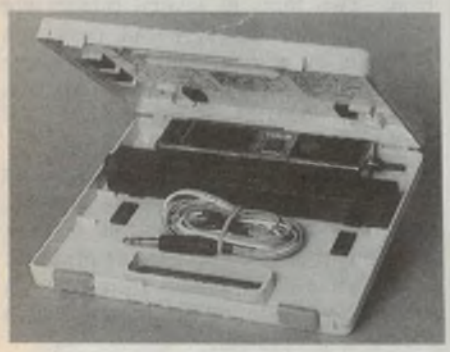
ment is fully synthesized.

It offers a frequency accuracy of 5ppm, which provides good stability and reliable stimulus for accurate test and measurement results. A high stability option is also available, enabling a frequency stability of 0.05ppm/week to be achieved.

Five waveforms are generated by the HP 3324A: sine, square, triangle, negative and positive ramps. Because the generator covers a 1mHz (sinewave) frequency range, it can be used in low-frequency applications such as material testing, and in high-frequency applications such as testing of phase-locked loops.

A 1mHz to 60MHz TTL (transistor-transistor logic) clock also is incorporated in the generator for use in operations such as clock generation of fast A/D or D/A converters. The 9 digit display allows frequencies to be set up with a resolution as low as 1mHz.

For further information contact Hewlett-Packard Australia, 31-41 Joseph Street, Blackburn 3130 or phone (03) 895-2644.



Telephone test instrument

Exceptional cost savings and rapid pay-back period are claimed for a new concept in telephone cable test equipment, recently perfected.

The device, 'Loop-a-Line', enables a linesman working on site to identify a pair, and then remotely switch the line at the MDF to open circuit and then to short circuit, for installation and fault-finding tests.

Using 'Loop-a-Line', double journeys to the MDF are eliminated. It operates over at least 16km and is equally effective for installers or faultmen when working in city blocks or in country locations.

Hitherto, linesmen using conventional equipment have been required to make additional expensive, time-consuming journeys along the line under test. 'Loop-a-Line' can dramatically reduce those costs, and is estimated to provide a pay-back period of less than one month.

For details, contact Teletech Pty. Ltd, 61 Betula Avenue, Vermont 3133 or phone (03) 873 2777.

Opto/relay isolator board

The Mondotronic MD100 is a general purpose isolator board for IBM PC/XT/AT or close compatibles – designed, built and supported in Australia. It features 16 opto coupled inputs, eight output relays and supports hardware interrupts 2-7.

For increased speed and ease of programming, all input outputs are I/O mapped with the I/O range of the PC.

The 16 inputs will directly accept any AC or DC voltage from 5V to 25V, making it easy to directly interface to TTL, C-MOS, any 12V or 24V date acquisition or industrial control system. With the addition of an external resistor this may be increased to 50V. Also eight of the inputs are provided with a switch selectable delay. This may be used to de-bounce contacts or filter AC signals, which significantly reduces software overheads. Being individually coupled, the inputs display a high degree of noise immunity even over a long length of cable.

The eight output relays provide single change-over contacts with a current rating of 3A, and are reset when power is turned on.

For further information contact Mondotronic, 560 Waverley Road, Glen Waverley 3150 or phone (03) 232 4110.

PCB CAD software, laser plotters

Printed-circuit board CAD software and laser photoplotters from the French firm Secmai are now available in Australia from Electri Board Designs.

The Secmai SPCB CAD/CAM software system is claimed to provide a complete solution for PCB design and manufacture, from schematic design and performance simulation right through to tools for manufacturing. All tools are integrated into a cohesive whole, providing power, flexibility and adaptability.

SPCB is available on all major standard workstations and computers, as either a software package or a complete turnkey system. Secmai has OEM agreements with Digital, Apollo, Tektronix, Cetia and Sun, while SPCB uses standard software interfaces for easy adaption to other platforms.

Secmai's photoplotters are all based on the use of a laser. Most models offer rasterisation of the image and a rotating drum. Flat vector photoplotters form part of the range, however, as they are still required for certain applications.

With the drum plotters, the film to be exposed is held by a vacuum on the rotating drum, which is made of composite aeronautical quality material. The mobile head, with one or up to five laser beams scans the drum generatrix. A press-stone ensures protection from vibration and a highly even surface to hold the drum ball-bearings and the lens-mount carriage mechanism.

The LUB 161GT plotter uses a single laser and provides 1200 lines per minute performance, with resolutions of either 1000 or 2000 lines per inch. Beam spot diameter is 30 microns, with an overall resolution of 43,000 by 48,000 pixels in 2000lpi mode. Plotting speed is typically 40 minutes in this mode, and 20 minutes for the 1000lpi mode. Film sheets from 300 x 240mm to 600 x 500mm can be accommodated.

The LMB 580 plotter employs five laser beams, and provides 2500 lines per minute performance, with an optional ability to provide 2000/4000lpi resolution. Beam spot diameter in 4000lpi mode is 12 microns, with an overall resolution of 128,000 x 96,000 pixels.

Further information on both the SPCB software and laser photoplotters from Secmai is available from Electri Board Designs, 15/31 Waterloo Road, North Ryde 2113 or phone (02) 888 3929.

Clip-on heatsinks

Redpoint has recently released its new range of clip-on heatsinks. Known as the PF750 range, these offer high performance and are small and light weight to suit TO220 packages.

The PF750 version has integral tags and solderable finish, allowing flow solder to printed circuit boards. The PF 751 is black anodised with integral tags which can be used for mechanical attachment. The PF752, without tags, is attached using the integral spring clip only.

Thermal resistance ratings for the PF75l and PF752 are 20°C/W and 23° respectively. For the PF750 solderable version thermal resistance is also 20°.

Further information is available from Clarke and Severn Electronics, PO Box 129, St. Leonards 2065, or phone (02) 437 4199.

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Since the introduction of VIFA speaker kits in Australia in 1985, thousands of speakers have been built with superb results. VIFA is now proud to release four new speaker kits ranging from a mere $399 to $1199 per pair including cabinets.

Never before have speaker kits been so popular in Australia than after the heavy devaluation of the dollar. Similar fully imported quality loudspeakers are today typically 2-2½ times more expensive. And these speakers may very well be using Danish VIFA drivers anyway, as VIFA supply more than 50 of the world's most respected loudspeaker manufacturers with drivers.

But why the big savings? Because fully imported speakers suffer from 25% import duty, 20-30% freight, 30% sales tax and 28% handling charges (typically). So if you would rather put your money into better quality than in other people's pockets, VIFA speaker kits are the only way to go.

Are they difficult to build? No, the kits are supplied with all parts needed including fully built crossovers and pre-cut flatpack cabinets ready to assemble. No soldering or carpentry skills are needed, just a Phillips head screwdriver, some simple hand tools and a few hours of your leisure time.

Are they as good as people say? Read the reviews, listen and compare with any other speakers twice the price or more. Need we say anymore?

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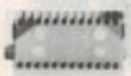

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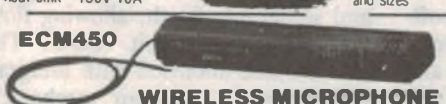

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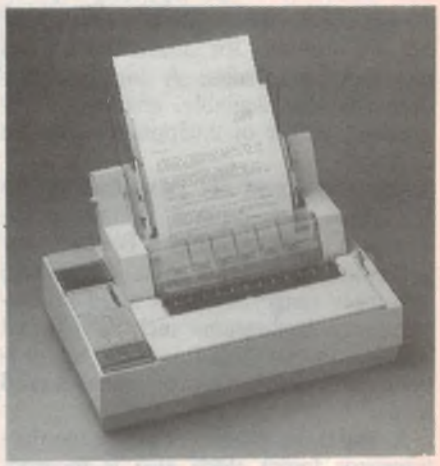

New 24-pin WP printers

The new 80-column B2400 and 136-column B2450 matrix printers from Facit are specially tailored for work-processing applications.

"Both models produce true letter-quality print by means of a 24-pin printhead. Two fonts in several pitches are standard, and the user can customise printouts by adding from a wide range of optional font cards", says a spokesman for Australian distributors, Elmeasco Instruments.

The printers' paper handling provides tractor and friction feed, paper tear-off, simplified loading as well as a park function to enable the user to print cut sheets while a continuous form remains loaded. A single – or double – bin sheetfeed is optional.

The printers are designed to be placed in the operator's immediate work area and feature a low noise level plus a special 'quiet' key for occasions when almost total silence is required.

Two emulations are provided as standard 2 – IBM Proprinter X24(4207) and Epson LQ-850.

For further information, please contact your local Elmeasco Instruments office for additional details: Sydney (02) 736 2888; Melbourne (03) 879 2322; Adelaide (08) 344 9000; Brisbane (07) 875 1444 and Perth (09) 470 1855.

I/O card for PC compatibles

The Procon PC-IO-DK/I board has been designed for industrial applications where reliable operation in the most arduous conditions is required. These boards are mounted externally and are capable of operating through any IBM-PC parallel printer adapter interface (It

is recommended that the PC-BD-IO interface card be used for guaranteed operation). Fifteen boards may be daisy-chained on a single 25 way cable providing up to 120 inputs and 120 outputs.

The board uses eight SPST relays, each rated at 10 amps (resistive) at 250-VAC or 30VDC. These relay outputs offer heavy-duty switching capability in a minature plug-in relay design. They may be used to control; lamps, solenoids, motors, motor contactors and other high current equipment. The eight opto-isolated industrial inputs allow either AC or DC switching voltages to be used. Contact debounce and filtering is provided on the board. Each input and output is isolated from the other and from the computer circuitry, providing maximum immunity to electrical noise and maximum flexibility in the system's design. The isolation barrier between each I/O and the low voltage circuitry is designed to withstand 4,000 volts rms. This conforms to the IEC Class III impulse voltage test (IEC pulication 255-4, Appendix E).

Further information is available from Procon Technology, Box 43, Essendon 3040 or phone (03) 336 4956.

Thermal video system

Tech-Rentals has added the recently released Hughes TVS 7300 Thermal Video System to its extensive inventory, and now has it available for rental.

The TVS 7300 detects infra red radiation from a device under test and presents it in a video format, which can be observed on a colour monitor. The outline of the unit being observed is visible, with the surface temperature variations being shown as different coloured areas on the display. A choice of three colour palettes, with a total of 128 colours, is available to the operator as well as black and white and reverse video.

Thermal imaging is expected to find applications in industries as diverse as bloodstock and brickmaking, or in any field where non contact temperature readings need to be taken. A typical use would be the periodic examination of switchboards for hot spots caused by poor connections.

Further information from Tech-Rentals, 12 Maroondah Highway, Ringwood 3134 or phone (03) 879 2266

Compliant contact headers

The 609 series of compliant contact headers from Thomas and Betts provides reliable, solderless, press-fit termination to PC boards and backplanes. The lock/ejector feature assures positive contact and easy ejection of compatible flat cable female socket connectors. The Flex-Fit compliant contact minimises PCB plated through-hole deformation and contacts can be removed and replaced without comprising electrical or mechanical performance.

The range extends from 10 to 64 contact positions, with a plating finish of either 30 or 50 microinches of gold. Tails can be either tin/lead or with 15 microinches of gold and are available in 4 different lengths. The range is also available with no ejection or retaining features, with the contacts being supported by a high temperature plastic header.

The complete range requires only one press platen to install connectors to PCB boards.

For further information from Thomas and Betts, PO Box 11, Wyong 2259 or phone (043) 53 2300.

Euro/SCART connectors

A range of Euro-AV plus and sockets to DIN-EN-50049 (SCART) is now available from Crusader Electronics.

The Euro-AV connector system allows all connections between television set and peripheral units (i.e., video recorder, hifi equipment, TV games or teletext) to be made with one single plug and socket connection.

Advantages of the system include parallel and simultaneous transmission of all signals, since entry and exit are separate from each other when necessary; obviation of demodulation within the television set and modulation in the peripheral units; and the need for only one plug for all connections.

For further information contact Crusader Electronic Components, 73-81 Princes Highway St. Peters 2044 or phone (02) 516 3855.

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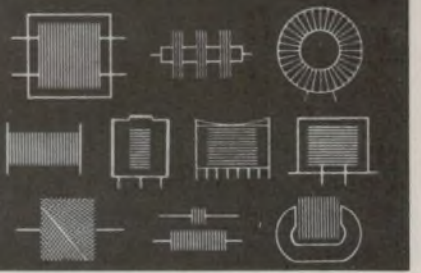

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Soldering product review:

Royel's 'Thermatic' soldering station

Developed and manufactured in Australia, this new high-tech soldering station meets the stringent US military specifications for temperature stability and component safety.

The general look and complexity of soldering irons has certainly changed over the years. In the past, a simple hand-held unit where the tip heating element is powered directly from the 240V mains supply *seemed* to do the job – after all, what's essentially required of an iron is to hold enough heat in the tip to melt the solder, which ultimately forms the desired electrical and mechanical bond.

Yet these days, a typical high quality soldering tool is quite an elaborate arrangement by comparison, and supports the rather grand title of 'soldering station'. Such units tend to have a small temperature controlled tool (the actual soldering iron if you like), which is powered by a bench mounted control unit incorporating a low voltage isolating transformer. So the complexity, and certainly the cost of the humble soldering iron have escalated in recent years, to a point where some readers may wonder if we are simply victims of marketing strategies, or there is a real need for this increased sophistication.

Not surprisingly, the answer lies in the need for servicing tools to keep pace with today's stampeding technology. The increasing miniaturisation of components means that the iron has to cope with a small tip for accessing densely populated circuit boards, yet maintain a narrow temperature range to prevent any thermal damage of the minute semiconductor junctions and bonding wires.

In less elaborate soldering irons these requirements are somewhat contradictory, since a smaller tip mass will store far less heat, which would be rapidly drawn away by the soldering job at hand. The only way to compensate for this effect is to run the iron at a much higher operating temperature, and hope the tip has enough thermal inertia to complete a successful joint. The danger here is that when initially applied, the tip may be at a high enough temperature (say above 400°C) to quickly damage any thermally delicate components.

Further problems with the more traditional irons were highlighted with the widespread use of CMOS and other voltage sensitive semiconductors. With a 240V AC heating element present within the irons' barrel, a poor earthing system will allow leakage currents or induced voltages to develop destructive potentials at the tip.

In extreme cases of inadequate earthing, more than the semiconductors are at risk – a human operator is certainly more difficult to replace than a couple of chips!

A thorough earthing system is also essential to prevent high voltage static potentials finding their way to the irons' tip, since when applied to the leg of an IC, this electrostatic voltage can effortlessly punch through an internal high impedance semiconductor junction. These potentials can arise from a number of sources, ranging from the familiar static build-up developed when walking on carpet, to levels generated from the actual manipulation of a soldering iron's plastic handle.

So to address all of the above problems in the increasingly critical area of hand soldering, a whole new breed of soldering irons (or stations) has developed. In short, they employ a physically small soldering tool with close control over the tip temperature, a low-voltage heating element and comprehensive earthing techniques.

Royel's solution

An elegant example of this advanced type of soldering station is Royel's new 'Thermatic' unit, which incorporates a sophisticated temperature sensing and control technique, and a number of novel earthing/antistatic features. In fact the effort taken by Royel's designers has been rewarded by a number one rating amongst nine other popular soldering stations, in an independent American performance test.

As with other soldering stations, the Royel is comprised of two main sections – the power unit and an actual soldering iron or 'pencil'. The neat little power unit measures only 100mm x

140mm x 80mm and is available in four formats to suit different applications.

The basic 'analog' T1000 offers Royel's full temperature control and grounding features, and a simple rotary control mounted on the front panel which is able to adjust the tip heat between 200°C and 425°C. However the 'digital' T1050 sports a 3-digit liquid crystal display which shares the front panel space with the temperature control knob, and provides a readout of the actual tip temperature of the iron.

Further to this, both the analog and digital versions are available with the connections and mounting springs for dual soldering tools, which may be selected by a front panel changeover switch. This enables two tools of different thermal capacity (for example) to be used with the one power unit, which can then energise either iron as required by the soldering conditions. The dual power units are designated T1300 for the analog version, and T1350 for the model equipped with a digital readout.

The soldering tools are simply available as two distinct options – the T300 'pencil' with a 40 watt heating element, and the larger T500 of 60 watts capacity. Both irons feature a refined thermocouple sensing system developed by Royel, which is intimately coupled to the tip area for rapid temperature feedback to the power unit's control circuitry. This technique, coupled with an efficient thermal path between the tip and heating element, has allowed Royel engineers to maintain a very tight control over the tip's temperature in all soldering conditions.

Other features of the T300 and T500 include a (patent pending) tip-to-ground connection based on a solid tapered spike within the barrel, which actually penetrates the tip's copper core – according to Royel, this provides a reliable connection which resists corrosion for the life of the tip. The US tests have indicated a tip-to-ground resistance of 0.58 ohms, and a tip-to-ground leakage of 0.4 millivolts RMS, which easily complies with the Defence Standard 2000-1B limits of 2 ohms and 2mV respectively. By the way, this standard also requires the iron's tip idling temperature to be maintained within 10°F of the nominal setting – the Royel returned a tolerance figure of 3°F.

The tool's handles are constructed of a 'specially formulated static dissipative material', which is formed and mounted in a manner which minimizes thermal transfer by radiation or conduction – that is, it feels cool and doesn't promote static build up. In fact a little prodding about with the multimeter showed the handle's resistance to be less than 1k ohms, between the tip and the end of the handle at the cable entry point. Needless to say, the cable is constructed of a heat resistant silicone material, and is terminated in a metal plug (DIN style) which fits firmly into the control unit's socket.

So with all of this technology within the iron itself, what does the power unit get up to? As you would expect, it supplies power to the iron's heating element in response to information from the tip's sensing thermocouple. According to Royel's sales information, the unit employs 'proportional pulse width switching' to control power in the tip's 24 volt heating element.

A little investigation with the CRO at this point revealed that the unit delivers bursts of rounded 100Hz pulses, with a peak level of around 30 volts. In fact, this waveform simply appears to be a full-wave rectified version of the transformer's 24 volt secondary winding, which is passed to the tip element under control of the main switching transistor. The CRO waveforms also indicated that the control circuitry employs zero voltage switching techniques, and restricted switching speeds when each burst is applied.

During the initial heating of the tip or under heavy thermal loads, power is applied to the element in a continuous manner. However in an idling condition, the power is switched in and out at quite a rapid rate so as to accurately maintain the nominal tip temperature – in this situation the review model delivered 120ms packets of pulses at 650ms intervals.

Of course during all soldering conditions, the control circuitry will attempt to maintain the selected tip temperature by altering the duration of these power bursts. Incidentally, when the tip element is energized, a red LED mounted in the unit's front panel shows a small increase in brilliance, which is a handy indicator for the models without the digital temperature readout.

Soldering on

When the time came to attack a circuit board and a few components with the Royel, the results were very rewarding. With the temperature control adjusted within the recommended range of 260 to 360°C, a high quality joint can be completed in a very short time with the tip losing very little heat. Similarly, completing a series of joints in rapid succession is no problem at all, whilst the tip recovers its heat in just a few seconds.

An interesting test of an iron's thermal capabilities is attempting to tin a large section of the copper on a blank PCB, which is a surprisingly efficient (short term) heatsink. The Royel took this demand in its stride and covered a large area within a short time.

We compared this performance to that of a popular soldering station with a similar price tag, which features Curie point magnetic switching within the tip. Unfortunately this unit took some time to actually melt the solder onto the PCB, and then could only move around the copper at an extremely slow rate. If you consider the fact that both irons are rated at 60 watts, the performance difference is quite remarkable – in fact it's a clear indication of Royel's superior thermal efficiency. This is also demonstrated when the unit is first turned on, by the very short time in which the tip reaches its operating temperature.

As well as the power and efficiency benefits, the Royel scores well in the ergonomics department. The tools weigh in at 50 grams for the T500 and only 14 grams for the T300. The light weight, overall balance, handle shape and thermal isolation means that the iron may be comfortably used for extended periods of time.

Also, as a nice touch the tool stand, which mounts on the control unit may be changed over between left-hand drive and right-hand drive to suit the requirements of the bench space and/or operator. Of similar consideration to the user is the operating manual, which also includes full specifications, maintenance tips, troubleshooting guides, a parts list with exploded diagrams and the internal wiring diagrams for the tool and power unit – great!

So Royel have followed through nicely on a excellent design, and deserve the first class rating from the American test reports. Although designed with the rather demanding industrial environment in mind, the unit is quite appropriate for a hobbyist's work bench and is certainly not in excess of a serviceperson's needs.

Thanks to Royel International, *EA* readers may take advantage of a special introductory offer as presented in this issue, which offers the T3000 (a combination of the T1000 power unit and T300 soldering pencil) for $160.00 or the T3050 (T1050 plus T300) for $185.00 – the larger T500 iron is available for an additional $50. Not bad at all for what might be called the 'Royels Royce' of soldering stations! (R.E.)

Soldering & Desoldering Feature:

Continuous vacuum desoldering systems

With so many different types of desoldering system now available, it is easy to lose sight of the basic requirements for optimum operation. Here's an analysis of the processes involved, and a discussion of the benefits of using a continuous vacuum system with closed-loop temperature control.

by LOUIS ABBAGNARO
Engineering Manager, Pace Inc.

Although soldering systems both involve heating the work and melting the solder, the similarity ends there. In soldering, the primary objective is to heat the work and the solder that is applied to the work in a rapid but controlled fashion, to about 60-80°C above the solder melting temperature, just long enough to achieve a good solder connection or joint.

In contrast, the desoldering process when using a vacuum desolderer is more involved and consists of the following three objectives:

1. bringing an already formed solder joint to a temperature at least above the complete solder melt temperature;
2. providing a quick-rise vacuum of sufficient magnitude to draw all of the molten solder out of the joint area and leave it clean; and
3. drawing through the joint area a sufficient quality of air in order to cool contacted parts well below the solder melting temperature, thereby preventing their reattachment, i.e., a re-sweat joint.

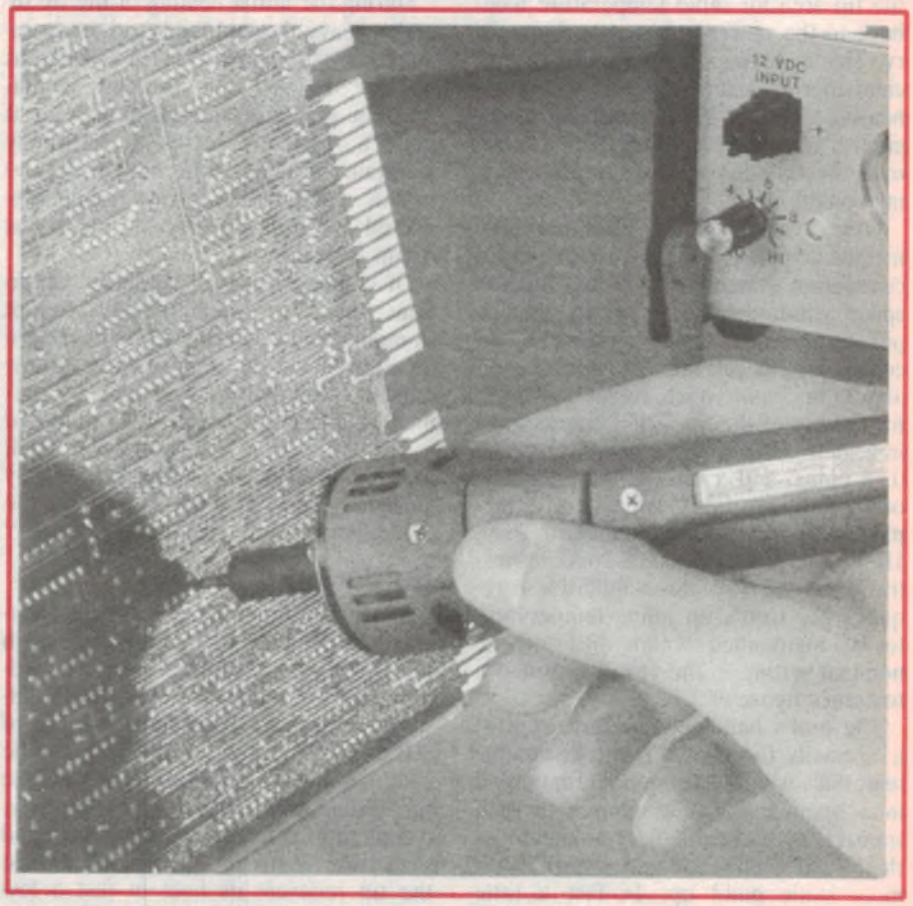
A high quality vacuum type desoldering system achieves all three of these important objectives and quantitative guidelines for such a system can be established based on field experience and analytical and experimental data.

The heat cycle

The first step in the desoldering process is to effectively transfer an adequate amount of heat from the tip of the desoldering tool to the solder joint so that complete solder melting occurs in a little over a second. This rapid yet controlled rate of heating of the solder joint is desirable since it minimises the chances of causing damage, either by heating too fast and burning the work or by heating too slowly and permitting excessive heat to dissipate to areas where it is not wanted.

Unlike soldering, in which virgin solder is more quickly and easily melted against a heated tip and lead, desoldering requires the rapid heating of an already formed joint which contains a large thermal mass of cold solder. For this reason, rapid yet controlled heating is often more diffficult to attain in desoldering than in soldering, and therefore requires greater control of the heat transfer process.

One factor that affects this heat



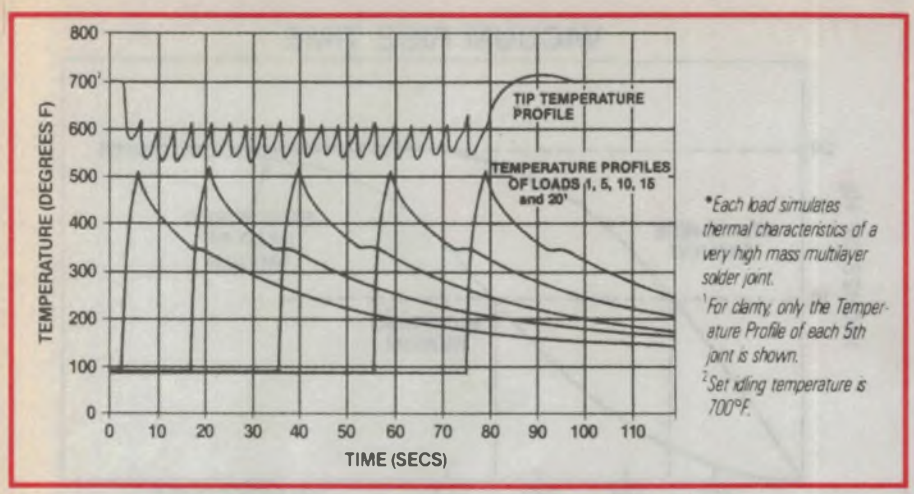


Fig.1: Temperature profile of a high quality, closed-loop vacuum desoldering system

transfer is soldering iron tip temperature. One commonly used benchmark is 'idling tip temperature,' which is typically defined as the unloaded tip temperature of the iron or extractor at equilibrium. Although this provides an upper limit safety ceiling for tip temperature, it really is not a good measure of performance since heat drain from the tip during operation causes the temperature to vary dramatically.

What is more important is 'sustainable operating tip temperature', which is defined as the temperature to which the iron or extractor tip can consistently and rapidly recover between repeated soldering or desoldering operation for an indefinite period of time. The process can be better understood by discussing what happens with the heat during the soldering/desoldering cycle.

Usually, the tip is heated to a predetermined idling point and then brought into contact with the solder joint. As heat is transferred from the tip to the joint, the heat in the tip becomes depleted and must be replenished by heat from the heater. This is observed as a sharp decrease in tip temperature and a corresponding sharp increase in solder joint temperature. As the joint temperature reaches and exceeds the solder melting point, heat transfer from the tip to the joint slows down and the temperature of the tip now begins to gradually increase in unison with the joint temperature as heat is resupplied by the heater through the tip (Fig.1).

In vacuum desoldering, once complete solder melting is achieved, the vacuum is applied and the molten solder is rapidly drawn out of the joint up into the desoldering unit's holding chamber, after which the airflow continues for 1 to 3 seconds depending on flow rate and the thermal mass of the work. During this phase, the temperature of the tip and the now clean joint drops off, due to the cooling effect of the air flow. This cooling effect is extremely important since the joint must be brought to a temperature below the solder melt temperature in order to prevent the formation of a resweat joint.

Although a simple mechanical solder puller can generate a pulse of vacuum and remove the solder, it does not supply this continual air flow necessary to properly complete the desoldering process.

Because heat in the tip is lost twice during desoldering – once when contacting the joint and again when air flows through the joint and the tip – the need for an efficient heat source to replenish the lost heat is often more critical in a desoldering system than in a soldering system.

Heating systems for desoldering and soldering units are generally divided into two types, namely open loop and closed loop. The phrase 'temperature controlled', which is usually applied to closed loop systems, can be applied to either since both types generally will provide a stable idle tip temperature, albeit for different reasons.

In many applications, either type of system can be used with acceptable results. When desoldering heavy thermal loads however, an advantage often can be gained from a closed loop heater since it has the ability to adjust to the work load and provide heat to the tip at the required rate, thereby resulting in a more stable sustainable operating tip temperature. This provides a more consistent rate of heating and in turn, more uniform operation.

In a closed loop controller, a sensor is placed into the system to provide an indication of the tip temperature. Various sensor schemes are possible, ranging from monitoring the change in resistance of the heater wire in the simplest systems to a separate precision thermocouple or resistance temperature detector (RTD) placed near the soldering or desoldering tip in more sophisticated units.

All of these systems use the sensor feedback to control the power into the heater, which in turn helps maintain a uniform tip temperature. During operation, the power into the heater is adjusted depending upon load conditions, seen by the sensor in the form of a ange in tip temperature.

This ability to maintain a desired operating tip temperature for an indefinite period of time provides consistency and repeatability in the soldering/desoldering process. In addition, a closed loop system will compensate for fluctuations in line voltage, since such a fluctuation will result in an increase or decrease in power and in turn, tip temperature.

Even if closed loop controllers are used, it should not be assumed that the tip temperature during the actual soldering or desoldering remains constant. The thermal transfer of heat from the tip to the load will cause an initial, rapid drop in tip temperature, as discussed earlier.

Where closed and open loop controlled systems differ is in their ability to quickly recover tip temperature after removal from load between operations. Closed loop systems usually restore the initial tip temperature in a few seconds after removal, while open loop systems may take more than a minute to return to this temperature. In addition, the open loop system has difficulty in maintaining a consistent operating tip temperature, especially after heavy loads are contacted in rapid succession.

Closed loop controllers differ in many aspects, with some more flexible than others in providing smoother temperature control and greater ease of use. Moreover, the design of the closed loop system has implications for the interchangeability of system components and their ability to operate in industrial environments. A few of the more important features are discussed in the following.

Temperature Set/Read Display: Some temperature controllers are fixed at a factory determined setting and are not changeable by the user. While this may help in achieving uniform performance, it reduces the flexibility of the system to work with many different loads, i.e., the temperature and rate of heat flow

may be too low or high for different work pieces.

Other systems allow calibration without a true readout of temperature. These systems require an initial calibration with a reference system, usually a thermocouple embedded into the tip. Even after calibration, any inadvertent change in the control dial will be unobservable by the operator and usually will require recalibration.

In my opinion, the best and most sophisticated controllers provide a display of actual temperature with one degree of resolution and a 'Set' control to allow the operator to select the ideal idling/operating temperature to match a specific work load.

Handpiece Interchangeability: It is desirable that closed loop temperature controllers continue to work properly, independent of the actual handpiece that is used. This is important in the event of a component failure, since it permits the user to merely replace the defective handpiece without the need to perform a major system recalibration.

Many controllers do not permit this flexibility and will require a full recalibration against an external reference (such as a thermocouple embedded in the tip) whenever any handpiece component is replaced.

Sensitivity To Loads: A good closed loop controller will respond very quickly to work loads, and this response may generally be observed by viewing the temperature display. If a controller does not show some reaction to an applied loan in 1 or 2 seconds, it indicates that the temperature control sensor is not placed directly in the heat flow path to the work load.

It also is useful to monitor the display during repeated soldering or desoldering operations to ensure that the iron has reached a stabilized condition and is restoring heat as fast as the operator is removing it. This monitoring is not only useful in evaluating the action of the handpiecc, but also informs the user whether the initial idle tip temperature setting is a good match to the work load.

As stated earlier, idle tip temperature in and of itself is not a good measure of performance. In a high quality closed loop system the idle or set tip temperature does, however, provide an upper limit safety ceiling of tip temperature and in many cases provides a higher sustainable operating tip temperature that results in faster heating of the joint.

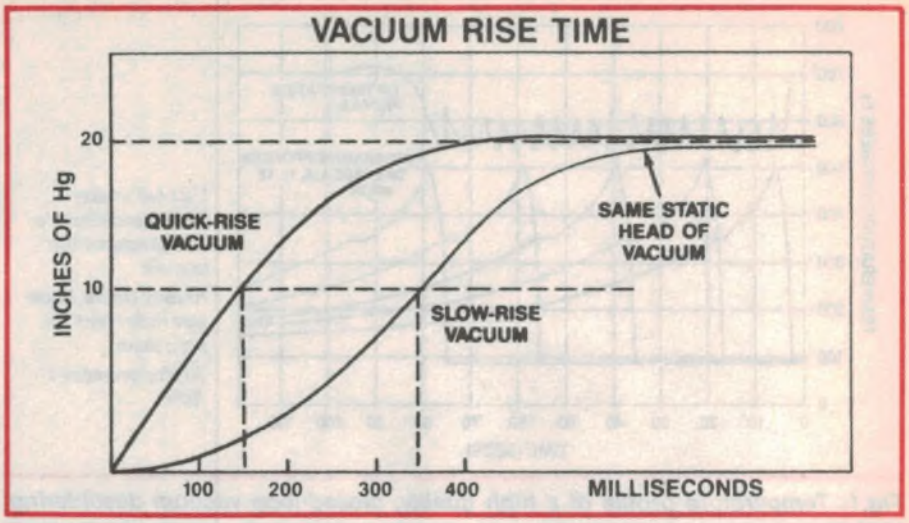


Fig.2: Although two desoldering systems can achieve the same static head of vacuum, only a quick-rise vacuum system will be able to desolder effectively heavy multilayer boards.

Set/Recovery Time: The initial temperature rise gives indication of the quality of a closed loop controller. On initial power up, a good unit will rapidly rise to the desired temperature and settle in after a modest amount of cycling about the desired set point. Usually, one or two over- and under-temperature conditions will occur before the final set temperature is reached.

The entire process should take less than 3 or 4 minutes. A poorly designed controller will take considerably longer to achieve a stabilised initial temperature, and sometimes continually hunts above and below the desired temperature set point. Recovery time after work is completed should occur within a few seconds and with less cycling than during initial power up.

Effect of Line Voltage: Open loop controlled units fluctuate in both idling and operating tip temperatures if there is a change in the line voltage within the facility. Many closed loop controlled systems also exhibit this undesirable characteristic. The best units will achieve a temperature calibration which is maintained indepedently of line voltage over a reasonable voltage swing.

Rapid vacuum

Vacuum desoldering units remove solder by applying a vacuum to the molten solder joint. However, the manner in which the vacuum is formed may be a key determinant in achieving a clean solder joint that is ready to receive a replacement component lead.

When the joint is heated to the solder melting temperature, the molten solder conforms to the extractor tip, forming a liquid seal which permits vacuum to build up in the tip, vacuum line, etc. after the pump is switched on. Ideally, this vacuum builds up at a very fast rate to a level high enough to withdraw the molten solder as a single slug, leaving the joint virtually solder-free.

If the vacuum builds up at too slow a rate, the solder may be only partially removed by the time the liquid seal formed by the molten solder is broken. Once this happens, vacuum buildup is diminished and residual solder left in the hole which has solidified can no longer be removed. The partially cleaned joint is very difficult to further clean, and it usually is necessary to resolder the joint and then attempt to desolder it again.

The absolute value of the static head of vacuum drawn by a desoldering station is not particularly important to the desoldering action. Rather, it is the rate at which an adequate level of vacuum is developed that will determine the quality of the desoldering action.

With the advent of multilayer PCB's of increasing density and thermal mass depth, this capability is even more important, since the high thermal absorption causes resolidification of the solder at points furthest removed from the extractor tip much more readily than with simple single-and double-sided boards.

Rapid-rise vacuum desoldering removes all of the solder in one cohesive, molten slug before it has a chance to break apart, cool down, and solidify in the hole.

The earliest vacuum desoldering systems relied on pressurised shop air to develop a vacuum by venturi action, and did not contain internal vacuum pumps. However, the need for portability and freedom from line air, and the

relatively high cost of compressors, regulators, line installations, and maintenance, have made the vacuum pump a desirable feature in many applications.

While good venturi vacuum systems often provide the desirable quick vacuum rise, this feature may be missing from some self-contained vacuum pump units. In fact, some systems may not even be designed to attain rapid vacuum.

The action can be quantified if one measures the time for vacuum to develop from the switching on of the pump at ambient pressure, to a benchmark level of vacuum of 10″ of mercury (Hg). If this is measured at the end of an extractor tip to include all the volume to be evacuated (tip, vacuum line, etc.), one finds that a quick-rise venturi system will achieve the benchmark vacuum level in about 120 to 130ms.

A typical slow-rise, synchronous, motor-driven pump takes much longer and requires 300 to 400ms to reach this level (Fig 2). Until recently, the better pump systems would reach 10″ of Hg in about 200ms, but now, a self contained, portable pump system is available that permits the system to duplicate the quick rise time of a venturi system.

Adequate air flow

Most users tend to overlook the last part of the desoldering process, where air is drawn through the hole to promote rapid cooling. This action has several benefits, the most important of which is the cooling of the solder joint after removal of the solder.

Even though a solder joint is properly heated and all of the molten solder is completely removed, there always remains some tinning on the lead, pads, and in the hole which could cause the parts to re-attach to each other, thereby forming a resweat joint. Cooling the joint down below the solder melting temperature immediately after removal of the molten solder prevents this.

Another important benefit of proper air flow is that it rapidly carries the solder up through the extractor into the glass holding chamber. This prevents solder build-up in front of the glass holding chamber and behind the heater which leads to eventual clogging. It also tends to cool and solidify the aspirated solder into pellets, which are drawn to the rear of the glass holding chamber, thereby enabling the chamber to accommodate more solder before cleaning is necessary.

The net result is greater productive use of the desoldering system with less downtime during actual use. In fact, good desoldering systems will usually work at near optimum levels until the glass chamber is filled with solder at which point the air flow is impeded and they quickly stop removing solder. From an operator's standpoint, this action is an obvious reminder to clean the glass holding chamber.

Systems with poor air flow tend to hold less solder, clog more readily and degrade in performance continually from start of use until the glass chamber is cleaned again.

In quantifying adequate air flow it has been observed that air flow rates above 1cfm and closer to 1.5cfm are desirable in high quality desoldering systems since a higher flow rate will provide faster cooling, thereby reducing the time required to complete the desoldering process. This flow rate is closely related to and must be considered in conjunction with the rate of vacuum rise, in establishing guidelines for desoldering systems which give the best assurance of achieving top performance.

EOS/ESD control

DOD-STD-2000, WS-6536, and other related military specifications have established standards for soldering equipment to be used on electronic assemblies to which such specifications are applicable. Although desoldering systems and other types of equipment are not specifically mentioned in the specifications, their compliance is equally as important since they come into contact with the electronic assemblies (as does soldering equipment) and can just as easily cause damage from uncontrolled heat, electrical overstress (EOS), or electrostatic discharge (ESD).

To minimise or eliminate these dangers, the specifications set forth the following criteria:

- idle tip temperature: ±10°F of set point
- leakage: no greater than 2mV RMS at tip
- tip to ground impedance: no greater than 2 ohms
- transients: all zero power switch (ZPS) circuitry must be used
- static control: all handles must be static dissipative

Handpiece characteristics

It is felt that pencil grip desoldering handpieces (Fig.3) generally provide the best targeting and tip orientation ability, since they may be finely manipulated by the fingers in much the same way a pencil is while writing. In addition, the shorter the tip-to-grip distance, the greater this manipulative control.

In contrast, pistol grip resoldering handpieces may provide less manipulative control since they generally are actuated by the wrist, elbow, and shoulder.

Conclusion

With the multitude of devices on the market today it is easy to lose sight of what features are necessary and desirable for high-quality desoldering. However, an understanding of the soldering process should make the desoldering system purchase decision much easier.

Reprinted by courtesy of Pace, Incorporated. Further information on Pace desoldering systems is available from Coltronics Pty. Ltd., 6 Stanley Street, Auburn 2144 or phone (02) 647 1566.

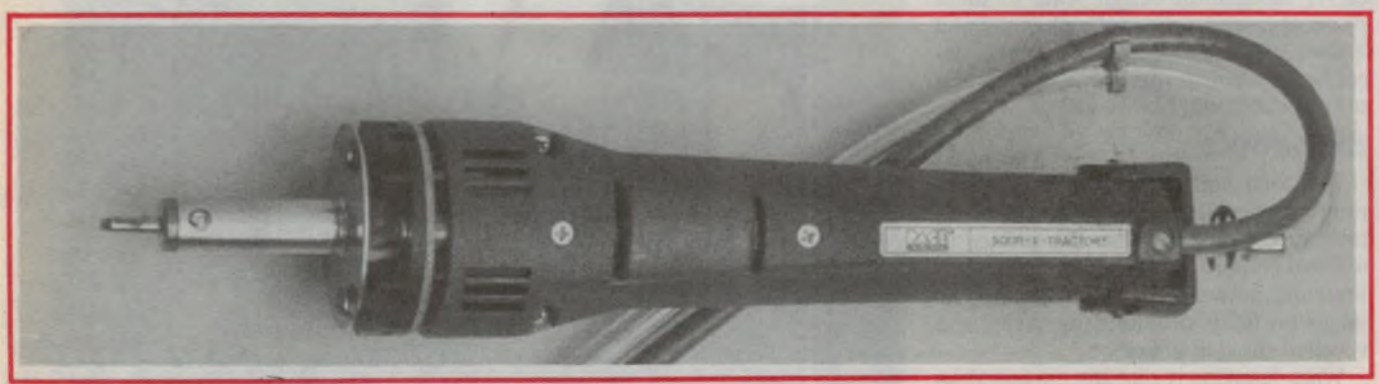


Fig.3: The PACE pencil grip desoldering handpiece is made of static dissipative material.

Soldering & Desoldering Feature:

Metcal systems use RF skin effect

Most of the latest generation of soldering and desoldering systems use a separate sensor to sense and control the operating tip temperature. However with the innovative technology developed by Metcal Inc, the heating element itself senses and regulates its own temperature automatically.

Founded in 1982 and headquartered in Menlo Park, California, Metcal Inc is the inventor and developer of an innovative technology in the area of resistance heating. The technology has been named *Self-Regulating Skin Effect*, to distinguish it from other kinds of electrical resistance heating.

By virtue of their metallurgical composition, soldering iron heaters using this technology have the ability to inherently self-sense and self-control heat generation, in order to provide constant temperature. They are designed to maintain and vary their power input (and hence thermal output) to accommodate each thermal demand.

Using this technology products can be developed to operate at uniform, stable design temperatures without reliance on external monitoring and control circuitry. Reliability is increased and the problems associated with inadequate heating or runaway temperatures are eliminated.

Metcal's heating technology results from the combination of two unrelated laws of physics, together with some clever mechanical design. One of these physical laws describes the phenomenon known as *skin effect*; the other describes a characteristic of magnetic materials, called the *Curie effect*.

Skin effect

It is well known that alternating currents, particularly at higher frequencies, tend to concentrate near the surface of a metal conductor. This is due to the interaction between the currents and the magnetic fields produced by them, and is called the *skin effect*.

What happens is that the current density in the conductor decreases exponentially, moving inwards from the conductor surface. The 'skin depth' is defined as that depth which carries 63% of the total current, and is given by:

$$s = 0.503 \times 10^{-2} \sqrt{\rho/(f.\mu)}$$

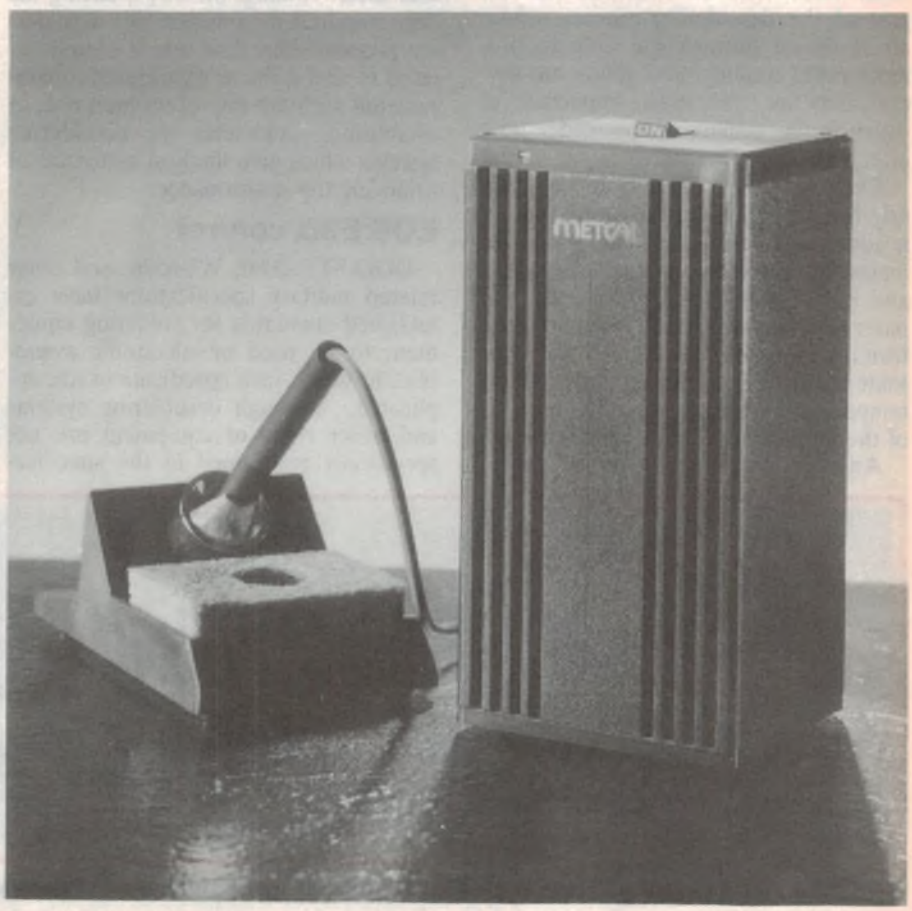
where ρ = the conductor's resistivity, in micro-ohm centimetres;
f = the frequency in MHz;
and μ = the conductor's relative magnetic permeability

You can see from this that the skin depth *increases* with *decreasing* permeability.

Curie effect

Basically, the Curie effect is a phenomenon whereby the magnetic permeability of a material that is 'magnetic' at normal temperatures falls with increasing temperature, reaching unity at a particular temperature – known as that material's *Curie point*. In other words, the material loses its magnetic properties.

Metcal makes use of both skin effect and Curie effect in a way which causes the resistance of the iron's 'heater', formed from a laminate of two metallic



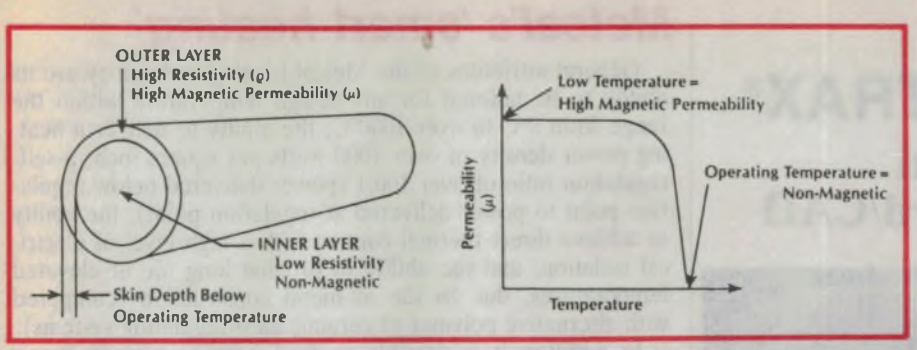


Fig.1: The two layer heater.

Fig.2: Permeability/temp. curve.

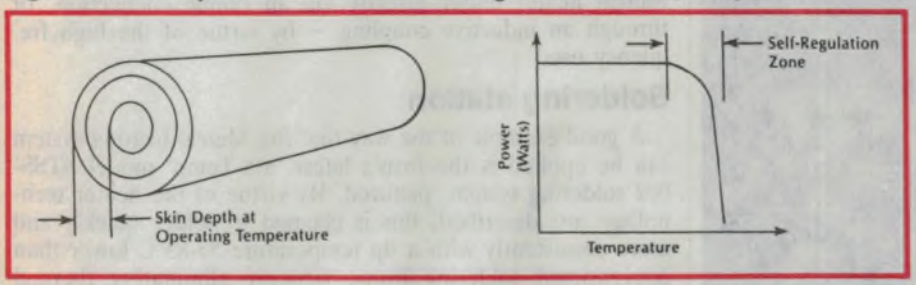


Fig.3: Skin depth in operation.

Fig.4: Power varies with temperature.

layers (Fig.1), to decrease dramatically as its temperature gets close to the Curie point of the magnetic outer layer. This outer layer is a ferromagnetic material with relatively high electrical resistance, while the inner core is a non-magnetic material with low thermal and electrical resistance.

Instead of 50Hz or 100Hz power the Metcal power source provides a high frequency AC, from what is effectively a constant-current source. The high frequency current flows near the surface of the laminate, due to the skin effect.

When the heater is operating below its operating temperature, the skin effect causes most of the current to flow in the outer, high permeability layer. Since this layer also has a high electrical resistance, this causes a high power dissipation and the generation of considerable heat. However as the temperature rises (Fig.2), the magnetic permeability of the outer layer falls due to the Curie effect, which deepens the 'skin' and allows more and more of the current to flow through the low resistance inner layer. This in turn lowers the power dissipation, and with it the heat generated (Fig.3).

At the design temperature, the heat generated and the heat required to maintain tip temperature are in balance, and the temperature is maintained within 1.1°C. When the temperature of the tip assembly is lowered by a thermal load, the heat generation instantly increases to maintain the temperature (Fig.4).

This process is inherently reversible, and provides what is claimed to be the industry's first high power, precision, self-regulating temperature source – what Metcal calls its 'smart heat' technology, with envisaged uses in many fields apart from soldering and desoldering. ▷

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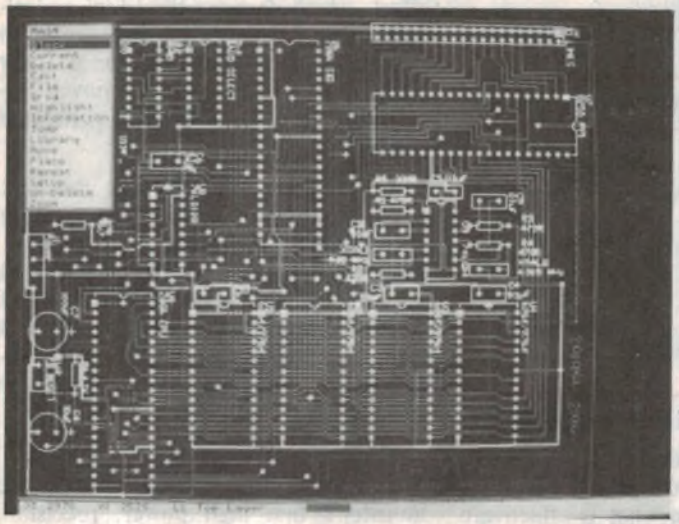

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Metcal's 'smart heating'

General attributes of the Metcal heating technology are its ability to be tailored for any design temperature within the range from 0°C to over 1000°C; the ability to deliver a heating power density of over 1000 watts per square inch; a self-regulation ratio of over 100:1 (power delivered below regulation point to power delivered at regulation point); the ability to achieve direct thermal contact with a high level of electrical isolation; and the ability to provide long life at elevated temperatures, due to the all-metal construction (compared with alternative polymer or ceramic auto-regulating systems).

In addition it is possible to feed heating current into a Metcal heater either directly via an ohmic connection, or through an inductive coupling – by virtue of the high frequency used.

Soldering station

A good example of the way that the Metcal heating system can be applied is the firm's latest 'Sta-Temp' model STSS-002 soldering system, pictured. By virtue of the heater technology just described, this is claimed to solder quickly and more consistently with a tip temperature 55-83°C lower than conventional soldering irons, virtually eliminating thermal damage while at the same time producing high quality soldered connections. As a result, Metcal recommends the use of tips which operate at 100°F (55°C) lower than you would normally choose for a conventional iron.

The system can use a wide range of interchangeable tip cartridges, which can be exchanged in about 2 seconds. The cartridges provide a wide variety of tip shapes, operating temperature ranges and sizes for specific applications, and include utility models, heavy-duty models, long-reach high-powered models, precision models and rework tips for surface mount applications. All tips meet DOD-STD 2000-1B specifications for tip-to-ground millivolts, tip temperature stability and tip-to-ground resistance.

The tip cartridges are designed for efficient and rapid delivery of thermal power, rather than for its storage. This allows the heater to react to the thermal requirements of making the solder connection quickly, bringing the joint to the chosen temperature in the shortest possible time. And the heater within each tip is self-regulating, so the temperature and rate of power delivery are determined by the tip cartridge itself, not by the operator.

The cartridges provide 'start-up' power dissipation figures of 18-35W for precision models, 25-35W for the 600°F 'Turbo' models and 32-38W for the 700°F 'Turbo' models. Heat-up time is specified as 20 seconds, with average tip temperature drop when performing 10 solder connections during a timed test given as 95°F and average tip temperature recovery during the same test 92°F. Time to return to idling temperature after 10 connections is 4 seconds.

The STSS-002 soldering system consists of two main parts – a conventional-looking soldering station and a high frequency constant current power supply, housed in a finned rectangular case. Maximum power output of the supply unit is 40W at nominal line voltage, and 25W into a 50-ohm load.

Other Metcal soldering systems have been developed in the USA, including a model STSS-002 'Solder Signature' system with enhanced features and a model STSS-DS1 desoldering system. These are expected to be available here either later this year, or early in 1990.

Further details of the Metcal 'smart heating' system and 'Sta-Temp' STSS-002 soldering system are available from Australian distributor CLC Agencies, of 51 Armitree Street, Kingsgrove 2208 or phone (02) 750 4005.

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New Soldering Products

Tri-temperature soldering station

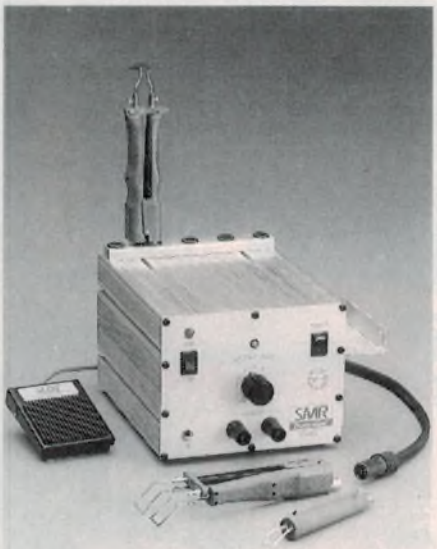
The SA-10 Tri-Temperature Soldering Station from OK Industries now meets military specification DOD-STD-2000-1B and WS6536E. The unit is ideal for manufacturers requiring exacting performance standards.

The temperature setting is achieved via a recessed switch and is indicated by either a green, amber or red display light. This feature provides superior ability to monitor solder station temperature settings on a production line where strict temperature control may be mandated by contract.

The closed loop, thermocouple control circuitry provides temperature repeatability to ±6.6°C as well as quick heat recovery resonse. Direct tip grounding yields low tip to ground resistance values. Additionally the SA-10 is designed with zero voltage switching for spike-free operation. Tip to ground potential is less than 2 mV.

The SA-10 stations are designed for durability and feature extra long-long life soldering tips, a burn resistant silicone rubber iron cord, a threaded metal solder iron cord connector and socketed PCB connections. The station includes a 115V or 230V controller, 24V/48W iron, iron holder, sponge with tray and manual.

For further information contact Electronic Development Sales 2A, 11-13 Orion Road, Lane Cove 2066 or phone (02) 418 6999.



SMD reflow system

Pace, Inc. has announced the introduction of its new SMR-25 'Pulse-Heat' SMD Reflow System. Representing a major departure from high-temperature, continuously heated SMD soldering irons, the SMR-25 provides controlled temperature ramp-up from room temperature, thereby eliminating virtually all chance of thermal shock or other thermal degradation to sensitive components and substrates.

Often, the high-temperature, bulky tips of SMD soldering irons transfer heat to the work too suddenly, thereby greatly increasing the risk of thermal damage. In contrast, the small, low-mass tips of the SMR grasp the component or contact the leads cold, and heat up rapidly providing a gentle temperature ramp-up to reflow. The non-soldering tips can also grasp the component or hold down the leads before and during reflow and cool down, thereby providing a 'one-handed' SMD soldering/removal operation. If solder paste is used, this temperature-ramping feature also minimises the chances of spattering and solder ball formation, which is often a problem when using continuously heated soldering irons.

The versatile SMR-25 comes complete with three rapid connect/disconnect handpieces (in less than 3 seconds!), an assortment of compact tips that reach into tight spaces, the Readi-Rack handpiece holder, hot cubby, universal power cord and foot pedal switch. The SMR power source features a high current, low voltage output which is controllable in high and low ranges and meets all applicable DOD-STD-2000 requirements. An extensive range of optional tips are available to handle a wide variety of SMD packages.

Further information from Coltronics, 6 Stanley Street, Auburn 2144 or (02) 647 1566.

SMD removal system

The SMT-W2 from OK Industries is a hand-operated SMD removal system. Featuring a variable temperature controller, tweezer-action handpiece, handpiece stand, and wide variety of optional tips, the system affords an effective low-cost solution for SMD removal.

The tips are designed with high thermal capacity to support removal of the most demanding components. Dual 80 watt ceramic heating elements provide rapid heat recovery and exceptional temperature stability. Additionally, the adjustable controller enables the user to vary temperature output for heat sensitive applications.

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Hand soldering: 'Achilles heel' of reliability

A great deal of money is spent ensuring that automatic soldering machines operate within tight parameter tolerances, to prevent damage to delicate components and PCB tracks. When the same precautions are not taken with hand soldering tools, they can cause considerable damage.

by ALAN ROYSTON
Managing Director, Royston Electronics

There was time when we thought we could do away with manual soldering irons, but, alas, it did not happen. We still rely on hand soldering for interconnections, rework and component replacements.

Many manufacturers spend tens of thousands of dollars selecting and testing soldering machines, component preparation and pick and place machines – and then overlook, or fail to appreciate the necessity to upgrade their soldering irons – to handle the necessary process control for modern circuitry.

A study by IBM (Roger Wild) in 1982 (Fig. 1) found that the best way to degrade a PC board connection was to touch it with a soldering iron!

Since this study the problem has become more critical again, due to the increasing miniaturisation of electric circuits. If we cannot do away with hand soldering irons, then, surely we must find some way to control the process.

Few production or service engineers realise that the same laws of thermal dynamics and metallurgy applying to machine soldering must also be applied in the use of the manual soldering iron.

Let us consider the soldering process.

Any self respecting soldering machine has a crucible containing a large mass of solder – 400-800 pounds of it. Why so large? There are basically two reasons:

1. It provides sufficient mass to absorb contaminants from the work-pieces; but more importantly,
2. To achieve the vital thermal stability – that very important 480 to 520°F (depending on indiviual needs or preferences), at which the strongest and most durable solder joints are made. If the temperature varies by more that 5 degrees up or down, usually the line is shutdown and much investigation and head shaking takes place.

How many engineers have related soldering iron tip temperatures to these same parameters?

Thermal damage

Many operators are happy to poke a 700 or 800°F tip at those tiny, critical, soldering termination. Flux boils off, leaving non-wetting halide actuators on the pad; track and pad adhesion is destroyed; bonds within the chip packages are degraded; silver is reflowed within capacitors; glass to ceramic seals are over-stressed thermally – while the operator sweeps on across the board, leaving a trail of degradation and brittle 'intermetallics' which will surely lead to

Royel's test unit, which can be used to monitor whether an iron continues to meet temperature control and leakage specs.

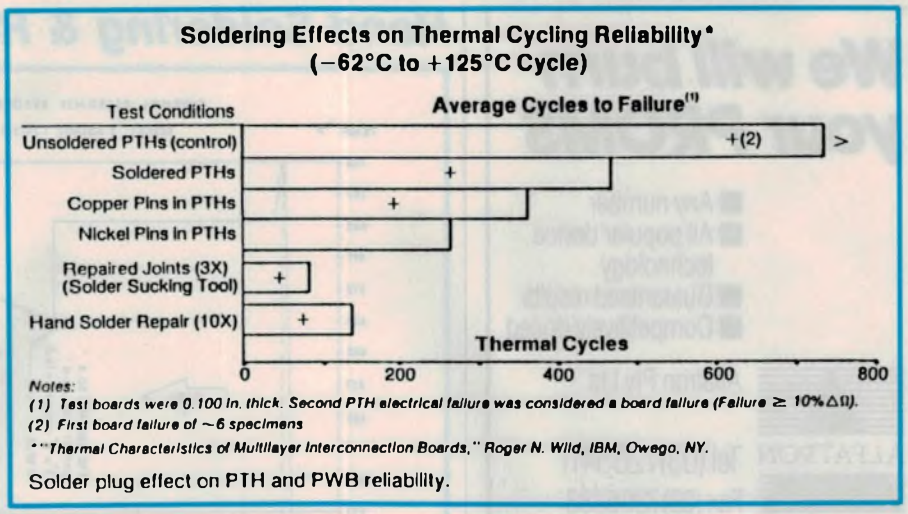


Fig.1: Summary of a study by Roger Wild of IBM in 1982, which found that hand soldering and desoldering were major contributors to unreliability.

system failure somewhere out in the field!

Why can't hand soldering be performed within the same temperature band as the very carefully calibrated and maintained soldering machine?

True, the slender soldering iron tips needed for the tiny soldered terminations of modern circuit boards cannot store a sufficient volume of energy to maintain a constant temperature. But as the tip is applied and the temperature drops, if we can switch on a heating element of sufficient power, quick enough – and the thermal path from element to tip is efficient enough, we can limit the temperature drop to say 40°F.

If we can measure the temperature drop on a given circuit board or series of terminations, then we can run the soldering iron idling temperature at the requisite premium temperature above the favoured 480 -520°F – and provide the necessary process control in hand soldering.

Simply to limit the maximum temperature is not enough. 'Heat flow' or the thermal efficiency of the soldering pencil/iron is important – the ability to recover the set temperature at the soldering face between successive soldering applications. Thermal efficiency is a result of refined design in the soldering iron.

The speed of the heat flow in a given soldering pencil is instantly recognised by experienced soldering operators. It can be measured by the time-lapse between switch-on to (600°F) working temperature. Thirty seconds is seen as ideal.

Small but powerful and thermally efficient soldering stations are available – which can deliver the necessary repeatable performance. Fig. 2 is a thermal test chart of a well-designed soldering pencil, showing its ability to recover quickly.

Long experience has shown that the most rapid heat flow is achieved with plug-type tips inserted in close tolerance, swaged barrels. Annular or split tips, tips with the copper core removed to accommodate sensors or loose fitting tips have a limiting effect on heat flow and reduce the thermal efficiency of soldering tools.

Electrical damage

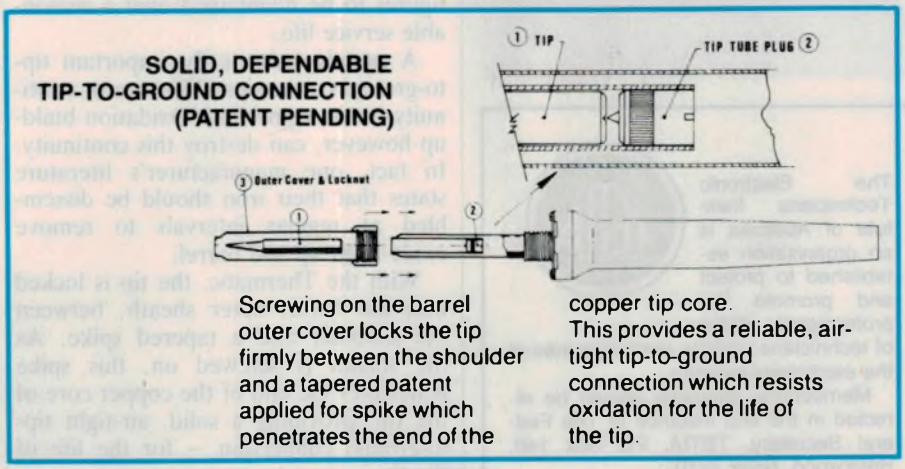
The potential for electrical degradation or catastrophic damage is also recognised in current DOD specifications. For example, Defense Standard 2000-1B requirements with regard to soldering equipment include the following:

1. Soldering tip to ground resistance: max 2ohms
2. Tip to ground voltage potential: max 2mV RMS
3. Idling temperature range: + or – 10°F maximum

Other requirements include non-static generating soldering iron handles.

All of the foregoing considerations have been taken into account in designing the new Royel Thermatic soldering stations, which were recently rated 'No1' by an independent US testing laboratory, against eight well-known competitors. The Thermatic gained top rating by the test lab because it was at, or near the top in all of the parameters tested – including those specified in DOD 2000-1B.

Additional test parameters included:



To ensure reliable long-term grounding of the tip, Royel's Thermatic iron uses a tapered spike, which penetrates the back of the tip.

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Hand Soldering & Reliability

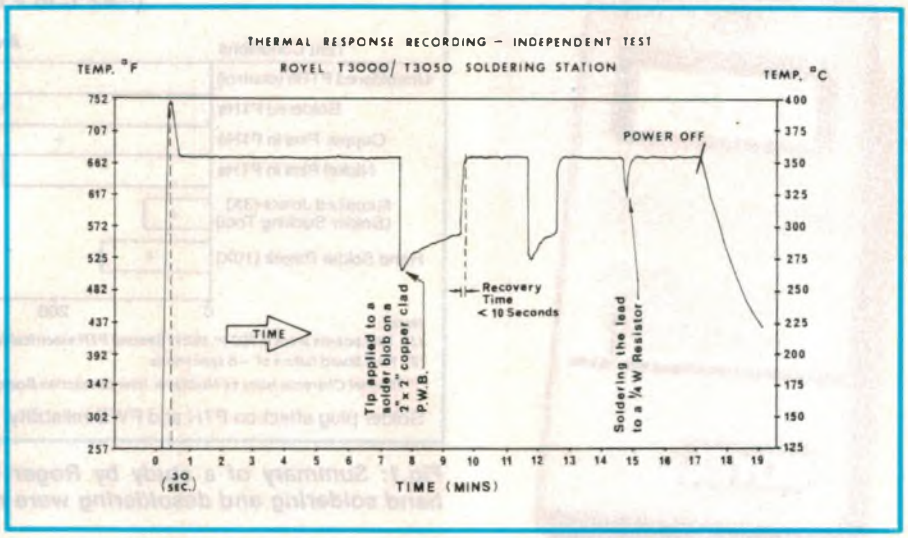

Fig.2: Thermal response chart for the Royel T3000/T3050 soldering station, showing its warm-up, idling, joint making and recovery characteristics.

- Time to reach soldering temperature after initial turn-on.
- Recovery time after typical soldered joints.
- Accuracy of temperature control.
- Ergonomics of soldering iron.
- Soldering tip life.

No specified figures or tolerances were laid down, of course. The tests were simply 'the better, the better' on a straight comparative basis.

Static dissipation

Royel acknowledged the importance of ESD protection by making the iron handles from static-dissipative material – without sacrificing thermal resistance.

It is one thing for a soldering iron to produce certain test figures when new, of course. It is quite another for those figures to be maintained over a reasonable service life.

A case in point is the important tip-to-ground connection. When new, continuity is not a problem. Oxidation build-up however, can destroy this continuity. In fact, one manufacturer's literature states that their iron should be dissembled at regular intervals to remove oxide from tip and barrel.

With the Thermatic, the tip is locked into the barrel outer sheath, between the shoulder and a tapered spike. As the sheath is screwed on, this spike penetrates the end of the copper core of the tip, providing a solid, air-tight tip-to-ground connection – for the life of the tip.

A patent for this development is pending.

Monitoring

Manufacturers whose soldering equipment must comply with DOD 2000-1B must also provide evidence of regular monitoring of this compliance.

To this end, Royel has also provided a convenient test unit which can be used 'on line' by the production supervisor.

The unit is illustrated in use in the photograph which shows the digital dual-tool Thermatic.

Conclusions

Without adequate process control, hand soldering operations degrade circuit reliability to an unacceptable level.

Accurate process control can be achieved in hand soldering with protection of components and substrates against thermal and electrical damage, with the introduction and regular monitoring of high efficiency soldering equipment.

Even the most skilled and conscientious soldering operator needs all the help their guardian engineer can provide.

The new Royel Thermatic soldering stations are available in either analog or digital versions. Two soldering irons match the power units – a 40 watt iron with 3mm tip and a 60 watt iron with 5mm tip. Power units are available which accept either or both irons.

A brochure with further details is available from Royston Electronics, 27 Normanby Road, Notting Hill, 3168, phone (03) 543 4122 or 2/28 Vore Street, Silverwater, 2141, phone (02) 647 1533.

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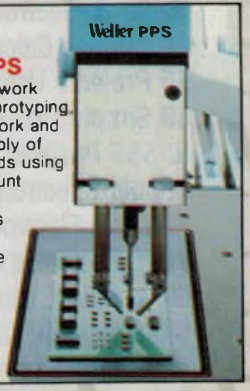

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Frequency Modulation

Frequency modulation or 'FM' is a system of radio transmission/reception wherein the RF carrier frequency varies proportionally with the audio amplitude. The purpose is to achieve noise-free reception.

by BRYAN MAHER

Previously in this series we looked at amplitude modulation (AM), a system in which the audio signal changes the amplitude of the carrier transmitted by the station. In AM the carrier frequency remains constant and all variations in carrier amplitude are reproduced in the receiver as audio sounds, music and speech.

That's all very nice, but there is a catch. Should any unwanted variations in carrier amplitude occur, the receiver reproduces these as sounds too. The sad part of that story is that most radio interference adds to the received signal amplitude, so is reproduced as noise by the receiver.

City and suburban radio reception using AM usually contains no noticeable interference noise, because the local stations are strong and close. You receive a powerful carrier signal, and electrical interference is as a rule insignificant.

But when trying to receive signal from far distant or small weak transmitters (e.g., a walkie-talkie) life can be much more difficult. The desired carrier wave at your location may be very low in amplitude.

In such an environment interference can be even stronger than the received station signal. The result is hopelessly noisy reception. Also all receiver circuits add some noise signals, noticeable when the desired signal is weak.

Early advances

By 1930 the fledgling radio art was in trouble with interference noise. Transmitters were not very powerful in the early days and reception over distances was being attempted. Many sources of radio noise had been identified. As well as lightning, there were electric motors with commutators and brushes, high voltage power lines, and a few motor cars all with spark plugs. All these generate electrical interference, as do valves (and transistors), resistors and even the distant stars.

Researchers looked for a noise-free system, in which changes in carrier amplitude would produce no sound in the receiver. Something better than AM was sought.

The idea of modulating the carrier's *frequency*, rather than its *amplitude*, was proposed in 1931. By 1933 Major Edwin H. Armstrong worked out a practical method and had a frequency-modulated transmitter and receiver working by 1936. In July 1939 he began the first regular FM transmissions from his station in Alpine, New Jersey.

In Major Armstrong's system the variations in audio amplitude from a microphone caused a proportional shift in *phase* of the station's carrier wave. Change in phase of a sinewave means a change in timing, as in Fig.1. Advancing the phase simply means the waveform reaches its peak earlier, as in Fig.1(b). Retarding the phase (or timing) of the wave causes the peak to be reached later, as in Fig.1(c).

It can be shown that every time the phase of a sinewave is altered, some shift in frequency also occurs. And the reverse is also true. But the changes in phase and frequency are not in proportion.

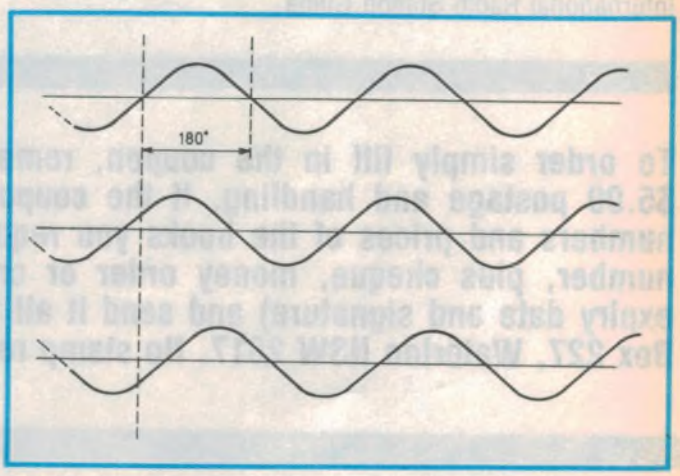


Fig.1: Graphs showing the effects of phase shifts on a sinewave. The centre waveform (b) is advanced in phase, and the bottom waveform (c) retarded with respect to the top waveform (a).

When changes in amplitude of an audio signal produce proportional changes in the phase of a high frequency sinewave carrier signal, we call that Phase Modulation or 'PM'.

But if in a different circuit, changes in amplitude of an audio signal cause proportional change in the frequency of a carrier we have a Frequency Modulation or FM system.

Simple circuit

One very simple method wherein audio sound waves can change the frequency and phase of an RF carrier is shown in Fig.2. Here some type of RF sinewave oscillator uses a tuned LC tank circuit, shown as L1 and C2. Capacitor microphone C1 is in parallel with C2 and L1, with C1 much smaller in capacitance than C2.

With no sound at the microphone, C2 is adjusted to set the unmodulated RF frequency to the desired centre frequency, which we will call *fc*. The condenser microphone C1 consists of two capacitor plates, one fixed, the other light and flexible enough to be moved by the air pressure of impinging sound waves. Thus sound waves from your speech can vary the capacitance of C1.

But C1 and C2 are both part of the RF oscillator tuned circuit. Therefore the changes in capacitance of C1 caused by the audio frequency sound waves will vary the frequency generated by the oscillator.

Increased capacitance of C1 reduces the RF oscillator frequency; while re-

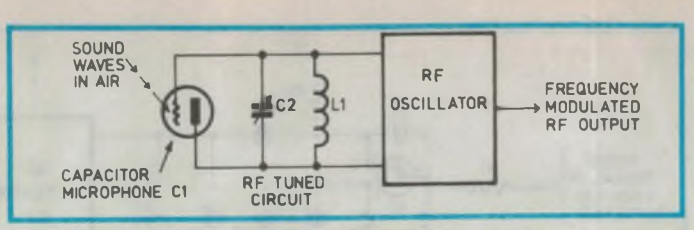


Fig.2: A simple way of achieving FM, using a capacitor mike across the RF oscillator's tuned circuit.

duced capacitance of C1 increases the RF frequency.

Though simple, this circuit does not necessarily achieve linearity, because of the $1/\sqrt{(LC)}$ factor in the equation of a tuned circuit as given in Part 3 of this series:

Frequency $f = 1/(2\pi\sqrt{(LC)})$.

But Fig.2 does illustrate the essential points, namely that:

1. A large volume of sound produces big changes in RF carrier frequency.
2. A small volume of sound causes small changes in RF carrier frequency.
3. How fast these changes in RF frequency occur depends on the frequency of the audio signal.
4. The greatest shift in carrier frequency coincides with the amplitude peaks of the audio signal.

Fig.3 illustrates these facts. Fig. 3(a) shows the unmodulated RF carrier sinewave *fc* in the absence of any audio signal.

When the circuit of Fig.2 has audio sound waves applied to the microphone, the positive peaks of the sound wave (points 2, 6 and 10 in Fig.3) push the plates of C1 further apart. This decreases the capacitance of C1, so raises the oscillator frequency.

The negative peaks of the sound wave, (points 4 and 8 in Fig.3) cause the plates of C1 to come closer, increasing the capacitance of C1, so reducing the RF oscillator frequency.

At null points of the sound wave (points 1, 3, 5, 7, 9 and 11) the RF frequency returns to its undisturbed or unmodulated value *fc*. With a sinewave audio signal, the changes in radio frequency are smooth and sinusoidal, the frequency changing (relatively) slowly at the audio rate.

The audio sound wave thus continuously alters the frequency of the RF carrier oscillator. But notice that the amplitude of the RF wave is at all times constant. That's the vital point.

Then we need to equip our receiver with some kind of demodulator which can detect changes in carrier frequency. Of course such a demodulator would not be interested in carrier amplitude.

Noise rejection.

Now if lightning or other forms of radio interference (RFI) occurs, these will certainly add to the amplitude of the carrier received by the listener. But such RFI cannot change the carrier frequency.

The FM demodulator, looking only for frequency changes, will just not respond to amplitude changes in the carrier. Therefore the FM demodulator produces no noise output in the presence of RFI.

FM receivers can (ideally) reproduce the desired music or speech signal quite noise-free, even in the presence of strong electrical interference. Lightning storms, fluorescent lights, car ignition, commutator motors or other sources of RFI will not adulterate your FM reception.

Practical circuits

How well the above ideals are met in practice depends on circuit design. The very simple FM modulated RF oscillator in Fig.2 does work, though not very well. Apart from its nonlinearity there is an obvious disadvantage in having the microphone built into the RF carrier oscillator.

This method is used in some very basic FM transmitters, wireless microphones, cheap walkie-talkies and the like. But most FM stations use remote microphones, record and CD players, tape decks and a host of audio sources. Naturally volume controls, mixers and tone controls are also needed.

The end result sent to the transmitter is an electrical audio frequency signal, not a sound wave in air. And the transmitter may be many kilometres from the studio.

Therefore methods have been invented whereby voltage signals at audio frequency can change the frequency of a remote RF oscillator.

Reactance modulator

Fig.4 shows the basic idea of the *reactance modulator*. Invented years ago when valves were the in thing, the circuit was known as a 'reactance tube'. However any active device, such as a FET or junction transistor may be used.

The example in Fig.4 uses an N-channel JFET as Q1. The resistance of R2 must be much less than the reactance of C1. Under this condition capacitive feedback from drain D to gate G makes the JFET look like a reactance. We can change the value and phase of this pseudo-reactance by changing the drain current.

Applying an audio voltage signal to the gate via R1 changes the drain current and the value of this artificial reactance.

But the JFET, Q1, is in parallel with the tuned circuit L1 C2 of RF oscillator Q2. Therefore when Q1 acts like a varying reactance it alters the total values of the tuned circuit, so changes the radio frequency generated by the oscillator Q2.

We have achieved frequency modulation of the oscillator Q2, by applying an audio frequency voltage to Q1. The changes in radio frequency will occur at an audio frequency rate; and how far the frequency is raised or lowered depends on the amplitude of the audio signal.

Modulating a crystal

Crystal controlled master oscillators are often chosen for transmitters as they provide a very stable centre frequency *fc*.

The frequency of a crystal oscillator

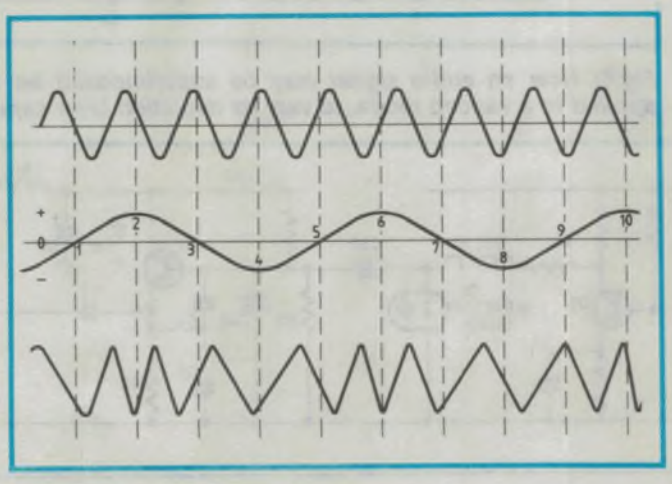


Fig.3: Relationships between the RF carrier (a), at top, the audio waveform (b), centre, and the resulting FM signal (c), bottom.

can be changed slightly by adding capacitance in series or in parallel with the crystal.

In Fig.5, to frequency modulate the crystal oscillator Q1 we place the variable capacitance diode D1, a varicap or *varactor*, in parallel with the crystal. A varactor is simply a heavily doped reverse-biased semiconductor diode, in which we exploit the property of junction capacitance.

All semiconductor diodes exhibit the effect of capacitance across the depletion region between anode and cathode regions as in Fig.6(a). When reverse biased, the cathode region is held positive by a DC potential; only a tiny leakage current flows and the diode is in a high impedance state. The positive battery terminal attracts electrons from the N region, while holes in the P region are attracted towards the battery negative end.

Due to recombination of electrons and holes in between the N and P regions, a depletion layer always exists in the middle. This depletion layer, being devoid of free charges, is in effect an insulating *dielectric* in between the conductive anode and cathode regions.

But any two conductors separated by a dielectric form a capacitor, so the back biased diode does exhibit capacitance between anode and cathode. We call this the 'junction capacitance'. The more heavily doped diodes have the greatest junction capacitance, due to their narrow depletion layers.

While other different uses of diodes find this capacitance a nuisance, we can exploit the effect in the application in Fig.5.

Increasing the reverse bias potential in Fig.6(a) attracts free electrons of the cathode region upwards, and also attracts holes of the anode region downwards. This widens the depletion layer (the dielectric), reducing the junction capacitance between anode and cathode.

Decreasing the reverse bias has the opposite effect. The cathode's free electrons and anode's holes move closer together. This narrows the depletion layer, increasing the junction capacitance.

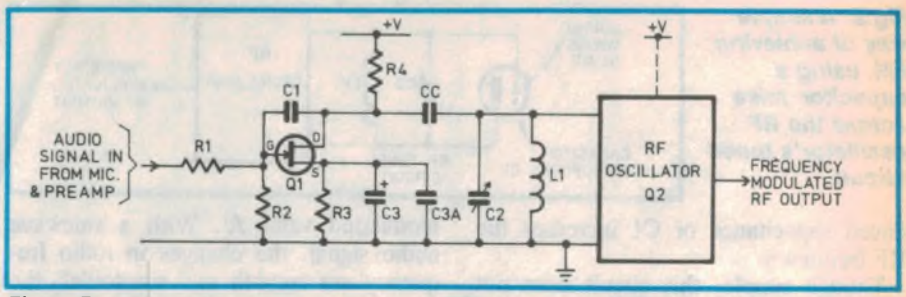


Fig.4: Reactance modulation using a JFET transistor (Q1).

A varactor diode is specifically designed so that changes in reverse bias potential produce large changes in junction capacitance. Linearity here would be an added advantage.

Actually a varactor is not very different from a low voltage zener diode; both are heavily doped.

Superimposing an audio frequency voltage upon the diode back bias potential as in Fig.6(b) simply changes the diode bias voltage at audio rate.

This in turn changes the diode junction capacitance in sympathy with the audio voltage.

Now we appreciate that in Fig.5, to the right of the points x and y we simply have the Colpitts crystal oscillator explained in chapter 9 of this series.

To the left of x and y we see a varactor diode D1 held in the reverse bias state by the positive collector potential of transistor Q2.

Audio signals applied to Q2's base at A cause changes in Q2's collector current and potential. This changes the reverse bias voltage across D1, and hence alters the junction capacitance of D1 in sympathy with the audio signal.

Coupling capacitor C21 couples the junction capacitance of D1 in parallel with the crystal. So the audio frequency variations in junction capacitance D1 alter the frequency of the crystal oscillator.

These changes in oscillator frequency are very small, therefore good design can achieve approximate linearity between audio signal voltage and RF oscil-

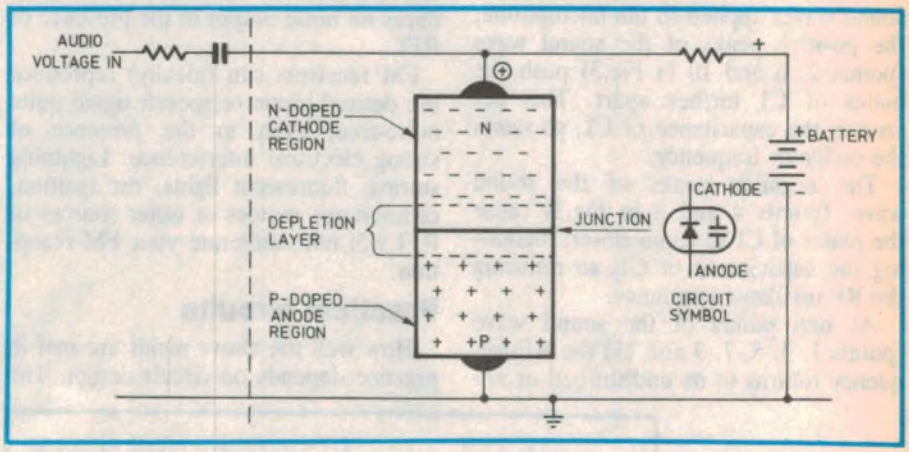
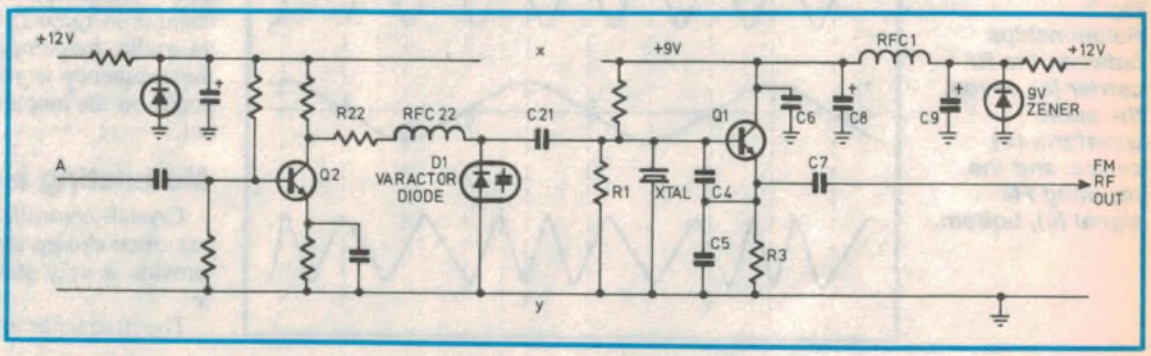


Fig.6: How an audio signal may be superimposed on the DC reverse bias applied to a varicap diode, to vary its depletion layer capacitance.



How a varicap diode is used to achieve frequency modulation of a crystal oscillator.

lator frequency. We have frequency-modulated the crystal oscillator by an audio voltage.

Radio frequency choke RFC22 and resistor R22 isolate the RF signals from the audio section.

Direct FM

Any method (such as the above), which causes frequency modulation of the frequency-determining elements of the RF oscillator, is called *Direct FM*.

For stability all transmitter master oscillators, either tuneable or crystal controlled, operate at very low power. This minimises self-heating, which would cause undesirable frequency drift.

Some moderate RF frequency between about 1MHz and 18MHz is usually chosen for the oscillator. This frequency range allows convenient economical choice of oscillator components and easy construction.

Except in special cases most FM transmissions are at VHF and UHF frequencies, (later we shall see why). It follows that, between the frequency modulated oscillator and transmitting antenna, stages must be interposed to raise both the power level and frequency of the signal.

Our FM transmitter will then incorporate RF power amplifiers to raise the voltage, current and power levels. These amplifier stages may, if we wish, also *multiply* the frequency until the final stage output is the desired VHF or UHF.

More to come

And there's still more to it! In addition to the Direct FM methods we have looked at, there are other *indirect* methods of producing frequency modulation of an RF signal.

You may resort to complex integrated circuits, or back to simple circuitry using discrete diodes and transistors.

The RF bandwidth requirements for FM are also rather more complex than for AM – in fact strictly speaking the sidebands stretch to infinity, although things aren't quite this drastic in practice providing you're careful.

Of course we still have to consider such aspects as audio frequency response and linearity, hifi, stereo transmission and all that jazz. Later we may even sneak a look at DC frequency modulation, as used in instrumentation telemetry.

The deep thinking minds of readers see immediately that this FM is a vast topic, and you are quite right! But we must wait until the next instalment for more of this story to unfold.

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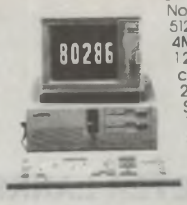

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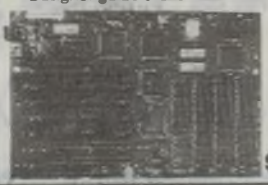

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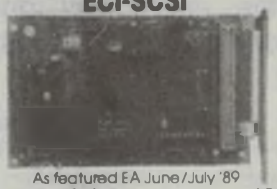

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Vintage Radio

by PETER LANKSHEAR

The 'Hikers' – my first radio

About 50 years ago, as a pre teenager, I built my first radio, thereby infecting myself terminally with the radio bug. This humble little effort was one of the literally thousands of 'Hikers' series of sets, constructed by young enthusiasts of the period.

Kitset and homebuilt radio construction was very popular during the 1930's. One reason was economic necessity – a decent sized receiver was priced at a level equivalent to a colour TV set today, and incomes were relatively much lower. A small boy had little chance of owning a 'real' radio.

As a personal example, the weekly wage for delivering newspapers, involving a 10-mile bike ride starting at 4.30 each morning, was 11 shillings ($1.10). At the time this was about the price of one valve.

Fifty years ago, radio held for technically minded hobbyists a fascination much like computers have today. Little wonder then, that magazines such as the *Wireless Weekly* carried a steady flow of constructional articles – including for the young fry, crystal sets and small battery powered regenerative receivers. Today a complete superheterodyne receiver can be purchased for the equivalent of the 1939 price for a single valve, and there is little incentive for youthful enthusiasts to make their own.

No equivalent today

Semiconductor technology has no real equivalent to the regenerative grid leak detector. Using fewer than a dozen components, a well designed one-valve regenerative receiver could, when connected to a decent sized aerial and in the absence of strong local transmissions, provide night time headphone reception from much of Australasia and even beyond.

Hobby magazines featured every conceivable circuit for these radios, each one claimed to have some particular virtue such as ease of tuning, extra selectivity or sensitivity. However even these simple receivers presented a problem for a lad with limited pocket money. The high tension supply generally required a 45 volt battery, costing around 20/– or $2, a sizeable amount for a youngster to accumulate.

The solution

The American *Popular Mechanics* magazine featured hobbyist radio circuits each month. Around 1936, it described a one valve radio called the 'Hikers One' which needed only 6 volts high tension, achieved by operating the valve in the *space charge* mode.

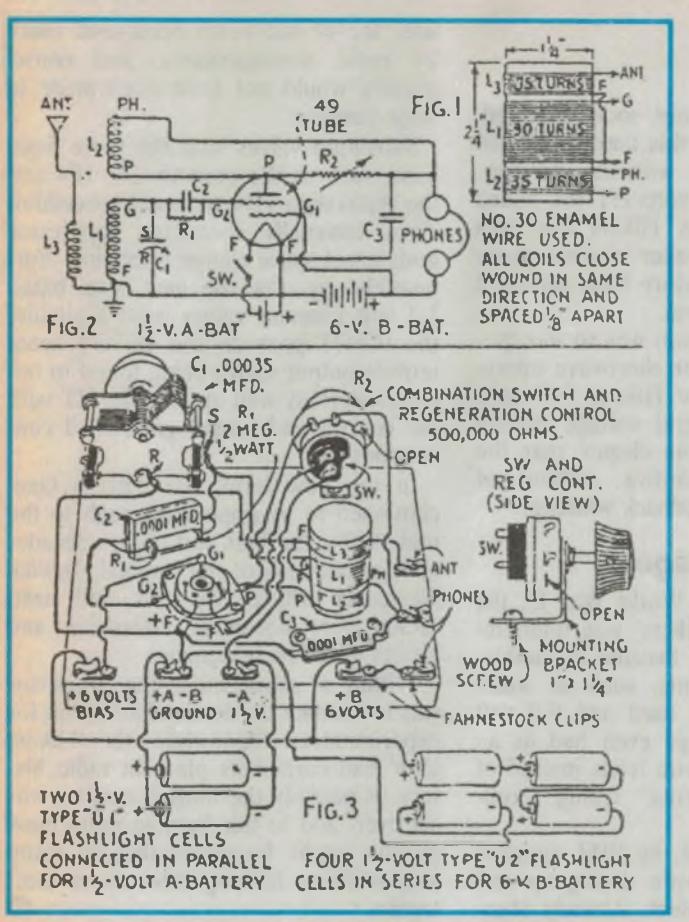
Space charge operation had been investigated a decade earlier and found to have some interesting characteristics. A valve with two grids was connected so that the inner grid was operated at a few volts positive, whilst the outer grid was used as the control grid. The positively charged inner grid attracted copious quantities of electrons, many of them returning to the battery as a grid current flow. However, some 'overshot' and formed a cloud or *space charge* around the inner grid.

These electrons acted as a source of anode current, to be controlled in the conventional manner by the outer grid. The space charge in effect, formed a large diameter cathode, creating a valve with high performance at quite low plate voltages.

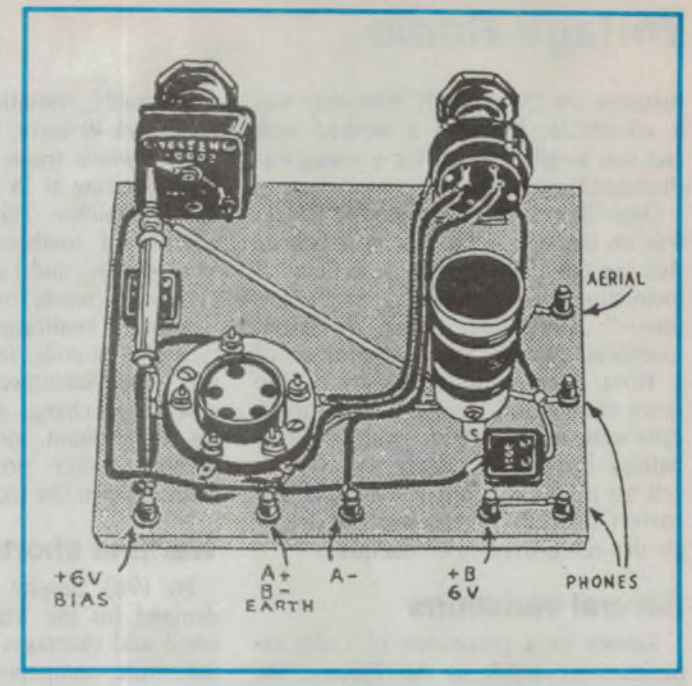
Original investigations concentrated on power amplifiers, but it was found that although respectable anode currents could be achieved, the total power handled by the valve was still quite small and the idea languished.

In 1933, two unique dual grid valves

The 'official' construction of the Improved Hikers One. The two control knobs and headphone terminals were on the front panel, with a row of Fahnstock spring terminals at the rear for all other connections.



The original instructions for building the Hikers One, from a 1936 edition of the US magazine 'Popular Mechanics'.



Constructional details of the first kit version produced by Lamphouse, the NZ kit supplier.

intended for the newly-popular class B audio amplifier service appeared on the American scene. These were the mains operated 46 and the battery version, type 49. Although with two grids, they were intended to be operated as triodes. With the outer grid connected to the plate, these valves became low impedance, low-mu drivers. Connecting the grids together produced a high mu-triode suitable for zero bias class B output stages.

Although the 46 and 49 were used to a limited extent in large receivers, they were never very popular, one reason being the requirement for a total of three valves for an output stage and driver. Radio hams used the 46 for modulator service, but the 49 was largely ignored.

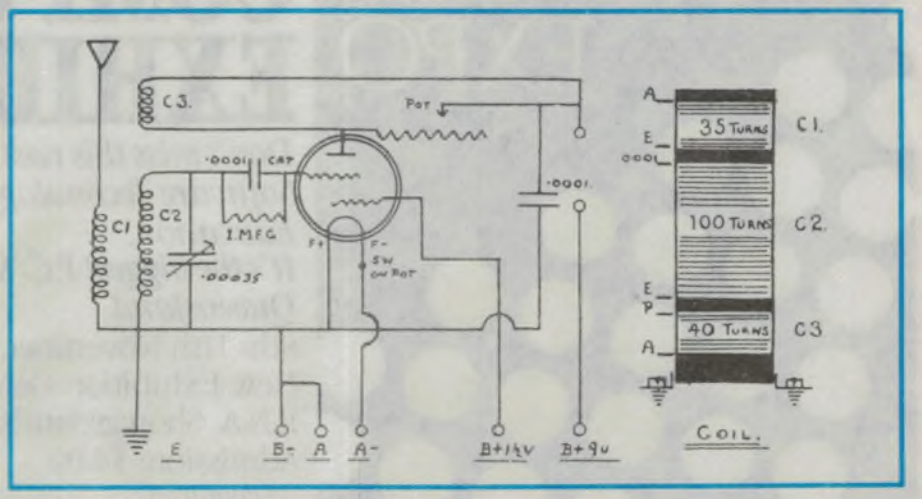
Someone in the *Popular Mechanics* team apparently realised that the structure of the 49 made it suitable for use as a space charge valve, and used it in a compact little breadboard constructed 'Hikers One'. This was a simple one-valve regenerative receiver using only four AA cells for a high tension supply, and two torch cells to light the filament. Useful as a radio for back-packers it might have been, but the real attraction for many was the inexpensive high tension supply.

Electric Lamphouse

Fifty years ago, 11 Manners Street, Wellington, could be likened to a mediaeval Dick Smith Electronics. In a long narrow shop in the heart of the city, the front of the 'Lamphouse' store lived up to its name by featuring an impressive display of lamps. At the rear a wide range of electrical and radio components was sold, with a very successful mail order service centred round their annual catalog.

More than a price list, the *Lamphouse Annual* included a mine of information about many aspects of radio and gave instructions for building their many kit-set radios, a large proportion being *Wireless Weekly* designs.

The *Lamphouse Annual* for 1937 included, without acknowledgement, the *Popular Mechanics* article on the 'Hikers One', and offered the parts less



The circuit of the Improved Hikers. The 'pot' was an inexpensive regeneration control and on/off switch. The use of regeneration gave sensitivity and selectivity out of all proportion to the small number of parts used.

batteries for 25/– ($2.50). Not only was it affordable, but also it worked well and was simple enough for a young enthusiast to assemble.

Outselling all other kitsets, the Hikers was an immediate success, so much so that for the 1938 *Annual*, very detailed instructions were written about an 'Improved' Hikers One. Most significant modifications were the incorporation of a front panel, and reduction of the space charge grid voltage. Untidy torch cells were replaced by a 9-volt grid bias battery for the 'B' supply and a No.6 cell for a filament supply. Although the correct filament voltage was 2.0, a single dry cell proved to be adequate.

Several variations

Known to a generation of radio experimenters simply as the 'Hikers', the new version was an unqualified success. Kitsets were sold in their thousands throughout New Zealand and in Australia. Unusually for a one-valve radio, independent firms sold Hikers fully assembled, often in plywood cabinets. Many more, including mine, were built up from scrounged and salvaged parts.

Inevitably, variations soon emerged. A second 49 valve, this time connected as a low-mu triode without grid bias, and operating at 18 volts HT was added as an amplifier. This 'Hikers Two' was capable of loudspeaker operation on local signals, and before long appeared in a metal chassis form.

Another modification was to incorporate plug-in coils, for shortwave operation. The 'Shortwave Hikers' had variable space charge grid voltage control for regeneration, more elegant than the original rather primitive method of loading down the feedback winding.

Wartime shortages

By 1940, despite World War II, the demand for the 'Hikers' was undiminished and shortages became inevitable. Substitute components, such as wafer valve sockets, were used and 9.0 volt batteries at one stage even had as an austerity measure, wire leads instead of the original 'Fahnstock' spring terminals.

Most serious of all, by 1943, supplies of type 49 valves were drying up and there was no equivalent. Already obsolete, the 49 had never been used much by radio manufacturers, and consequently would not have been made in large numbers.

Substitute valves with the same 5-pin base, such as the pentode 33, 1F4 and the Australian 1D4 were not successful. Their internally connected suppressor grids upset space charge operation. Fortunately, by now the new octal based 1.4 volt filament valves were available, the 1C5GT pentode and 1Q5GT beam tetrode output valves being found to operate tolerably well at 9.0 volts HT with the control and screen grids used conventionally.

In this new form, the 'Hikers One' continued to be popular through to the mid 1950's, the best part of two decades after publication of the original *Popular Mechanics* article. By now, full sized radios were becoming affordable and kitsets were less in demand.

Within a short while the transistor was to become the focus of attention for experimenters. Meanwhile, the 'Hikers One' had earned its place in radio history as possibly the longest running kitset ever, and to this humble radio must go the credit for generating in many youngsters a lifelong interest in electronics.

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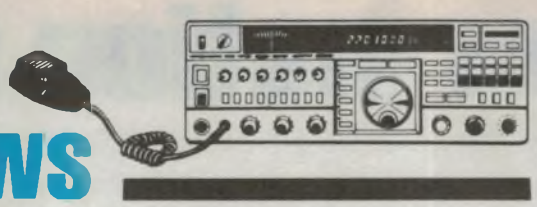
Amateur Radio News



Aussat helping again with JOTA

This year's Jamboree-on-the-air promises to be even bigger and better than in the past few years, with Aussat providing two additional satellite services to help provide additional interest for Scouts and Guides participating in the event.

In addition to the half-duplex 2m links between Sydney, Melbourne, Perth and Brisbane provided for the past 2 years, Aussat is also providing a full duplex link between Sydney and Perth, with 2m Tx and 70cm Rx. Both cities will also be able to communicate with the New Zealand National Repeater Link System via a half-duplex satellite link.

The services have all been made possible with the co-operation of Icom (Australia), which is generously loaning the amateur band equipment necessary.

JOTA is being held on 21-22 October, with the frequencies and times for all links to be announced on WIA Sunday news broadcasts.

Regular net for chess enthusiasts

Amateurs with an interest in chess may be interested to know that there is a regular net for chess enthusiasts. Called 'CARI', for *Chess Amateur Radio International*, the weekly Australian net is conducted at 0930 UTC Wednesday nights on 3.567MHz. International nets are conducted at 0330 UTC on Saturday and Sunday afternoons, and also at 0530 UTC on Saturday for US stations – all on 14-.270MHz.

This information comes from Anthony Wesley, VK2BGQ, via the USENET network and the VK2WI broadcasts.

Australia-Denmark reciprocal licensing

After negotiations which began back in 1971, a reciprocal licensing agreement has finally become effective between Australia and Denmark.

This now makes 16 countries which have reciprocal licensing agreements with the Australian DoTC.

DoTC agrees to WIA 6m submission

For some time Australian amateurs have been prohibited from using the 50-52MHz segment of the 6-metre band, due to the perceived risk of interference with reception of TV stations using channel 0. However after a concerted approach by the WIA, the DoTC has finally agreed to allow shared use of the 50-52MHz – subject to certain rules.

Basically amateurs in South Australia, Western Australia and the Northern Territory may operate unrestricted, with up to the maximum legal limit of 400W transmit power, provided that no interference is caused to the reception of channel 0 transmissions. Those in the remaining states which are located outside certain radial distances from channel 0 television stations or translators transmitting or receiving on channel 0, may operate in the 50.05 – 50.20MHz sub-band, with a maximum power of 100W and on CW or SSB only.

The radial distances involved are 120km from a main channel 0 TV station, and 60km from a translator station either transmitting or receiving on channel 0. However these radial distances do not apply for amateurs in VK1.

These new rules applied from July 1, 1989. In announcing the good news, WIA General Manager and Secretary Bill Roper VK3ARZ paid tribute to the efforts of Peter Stackpole, VK1RX, who played a major role in negotiations.

New callbook marks WIA's 80th birthday

By the time you read this, the new WIA callbook should be available. Called the *1990 80th Anniversary Australian Radio Amateur Call Book*, it will include not only up-to-date callsign listings but also reference material including repeater listings, location maps, beacon listings, DXCC and Australian band plans.

The recommended retail price of the 1990 Call Book is hoped to be the same as the 1988 edition, namely $9.90 to non-members and $8.50 to members of the WIA. It will be available from WIA state bookstores.

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Information centre

Conducted by Peter Phillips

There's always another way...

The word *Clayton's* seems have become part of the vernacular these days, suggesting clever advertising somewhere along the line. For those who don't know, a Clayton's doodad is a doodad you have instead of the real thing. This month we have a range of Clayton's doodads, some ideas, suggestions and generally useful information.

I recently received a letter from a correspondent who, as well as providing some thoughts on the venerable microphone pre-amplifier (*EA* Nov, Jan and July) also included his solution to the question I posed in the July edition of this column. This question required the calculation of the output voltage of an op amp circuit. I was pleased that not only did the supplied answer agree with mine (meaning we are either both right or wrong) but to get feedback suggesting that this may be a popular item.

I suspect many *EA* readers enjoy pitting their wits against a technical question, providing the final solution is relatively simple, if a mite difficult to find. The solution offered by the correspondent, while correct, was derived using a more complex method than mine, and hopefully he, and others who may have tried this question will enjoy my method of solving the problem. Which leads me to my point.

I would like readers who could, to send me problems that fall into the category of a 'technical teaser'. Please include the solution of course. If suitable, I will present it for others to have a go at, with a full acknowledgment of the source of the question. The question I've posed this month is typical of what I'm looking for – that is, it must be of an electrical nature and not require heavy maths to solve it. And so to this month's correspondence...

Automatic lights and blue LEDS

The following letter asks two questions, which are related only in that they are both about some form of lighting device.

I believe Kambrook markets an overhead porch light which detects someone moving nearby, causing the light to turn on for a pre-determined interval. I think an LDR is also used to prevent the light turning on during daylight hours. I am wondering if a similar circuit has ever been published in Electronics Australia.

Also, some time ago reference was made in the New Products section about a blue light emitting diode. I would like to obtain such a device, and am hopeful you can supply me with an address I could contact concerning supply. (J.B., Warana Beach Qld)

In regard to the first query about an automatic light, *EA* has not produced a specific project for such a task. However, the Passive Infrared detector project described in May 1988 would be the ideal second choice. As it stands, this project features an onboard timer and an output stage, complete with a relay.

As the article mentions, this relay should not be used to operate a 240V appliance, as it is only rated at 12V. However, it can be used to either operate the input of a solid state 240V relay, or another relay with a 12V coil but with a contact rating of 240V. The onboard timer is set for either 10 seconds or 100 seconds, depending how you set things up initially, but this could be increased by changing the value of C13. Incidentally, please note the errata concerning this project, as C13 is not identified on the circuit diagram.

To prevent the device operating in the daylight, I suggest placing an LDR across C11. The LDR will have a low resistance when light falls on it, sufficient to hold the output stage in the off state. It may be necessary to remove R17 to maintain the integrating action of the input stage. The project is available as a kit for around $40 from Oatley Electronics at PO Box 89, Oatley, NSW, 2223, phone (02) 579 4985.

Regarding the blue LEDS, I was unable to locate the item referred to. My enquiries led me to Hitachi, but at this stage even they could not help me, and advised me that this device is not in their current catalog. I do know they exist somewhere, although I'm advised their linearity (colour purity versus brightness) is not as good as their red counterpart.

If any readers know something more about these devices, I would be pleased to hear from them.

Interior light delay

The next letter refers to the June 1989 project 'Interior light delay for your car'. This project was one developed by a winner of our recent competition, and features delayed extinguishing of a car's cabin light after entry. The correspondent has a suggested modification that improves this already very useful project.

I note that you have published details of an interior car light delay. Some time ago I constructed a similar project from a Projects for Cars publication, and duly installed it in my car.

It worked well except that it also operated the Door Open warning light, causing it to come on with the dome light during the delay time. This was somewhat disconcerting, as it defeated the object of the warning light – which should only come on if a door is not properly closed. It therefore needed to be independent of the dome light.

This condition also applies to the new circuit, but it is easily overcome by inserting a diode (type 1N914) between the door pin switch and the junction of R1 and R2. The cathode of the diode connects to the switch and the warning light remains connected between the switch and the 12V supply. In other words, the pin switch is the only path to earth for the warning light.

Hopefully this small modification will be useful for other readers. (J.S., Kingscliff NSW)

Thanks J.S., I fully agree with your suggested modification. However, as a lot of cars don't have a Door Open warning light, it is easy to see why the designers forgot this point.

On the subject of cars, here's another suggestion from a reader concerning a Clayton's car alarm. As well, this letter describes how to make a non-polarised capacitor from two electrolytic capacitors.

Replacing a real one

I am writing regarding the Clayton's car alarm circuit described in the Circuit and Design Ideas in the May 1989 edition. The idea seems hellbent on using a UJT as a relaxation oscillator, and requires a separate external switch to turn it on and off – easy to forget to use.

I have included an alternative circuit which I discovered somewhere, and have since fitted to my car. It uses a 555 timer, which is probably cheaper than a UJT and the circuit doesn't require an external switch to operate it. I constructed the whole thing using point to point wiring, wrapped it all in masking tape and shoved it into the wiring under the dash.

When the ignition is turned on, the transistor will conduct, disabling the circuit. Turn the ignition off and the circuit will commence flashing the LED.

On a separate matter, I refer also to page 126 of this same issue, regarding bipolar electrolytic capacitors. I have used an alternative arrangement involving two back to back electrolytic capacitors, with a diode across each one, as the run capacitor of a shaded-pole motor in a TV antenna rotator. The original Dubilier capacitor gave up the ghost some years ago and a direct replacement was not readily available. (B.F., Hillarys WA)

The circuits referred to by B.F. are shown respectively as Fig.1 for the Clayton's car alarm and Fig.2 for the capacitor arrangement. Resistor R1 of Fig.1 could be connected to any 12V supply point that is switched by the ignition switch, such as that supplying the car radio.

While I agree with B.F. that his suggested circuit has the feature of automatic turn on and off with the ignition, I have to add that it is still nothing more than a circuit to flash a LED. The UJT circuit shown in the May issue (page 81) was originally presented more to show how the alarm can be made to *look* real, rather than for its technical merit. Perhaps the ideal combination would be the packaging used by the UJT alarm with B.F.'s circuit.

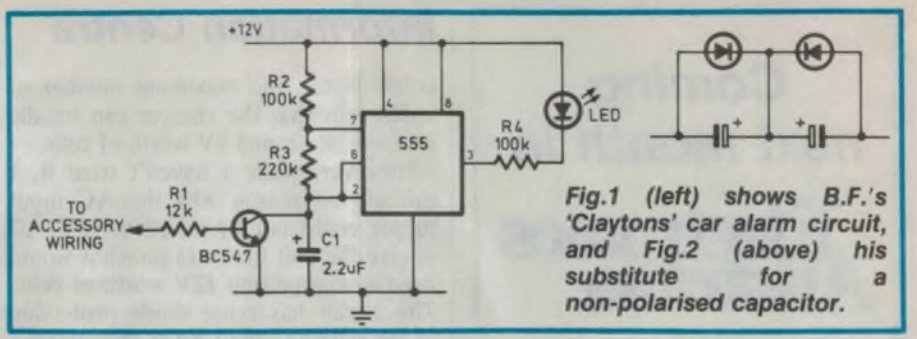

Fig.1 (left) shows B.F.'s 'Claytons' car alarm circuit, and Fig.2 (above) his substitute for a non-polarised capacitor.

The idea of using diodes across two back to back electrolytic capacitors to form a non-polarised whole (Clayton's capacitor!) seems a good one, and is one that I seem to recall having seen in use elsewhere. Anyway, thanks B.F. for taking the time to share these ideas with us.

Velocity factor

The next letter starts by asking a question, but really provides not only an answer but food for thought on the topic of transmission lines.

Is the velocity factor of 'air dielectric' coaxial cable affected by air humidity? This question arose when I trimmed a section of low loss 75 ohm cable to resonance as indicated by minimum reflected power. The frequency of operation was in the 70cm band, and I performed the task in the shack where the temperature was around 5° higher than outside, meaning the humidity was therefore probably lower.

But when I tested the cable in free air outside, on a high humidity, drizzly day, the resonance of the cable was about 3MHz lower than that previously obtained.

Returning to the shack, I took measurements from the tip of the plug to the other end of the coax (actually the braid had been removed) and found the velocity factor to be around 0.63. When the cable was installed in its final location (outside, in the higher humidity) and retrimmed to resonance the velocity factor, using the same measuring techniques, came out to be 0.66.

Probably other factors were contributing, but it will be interesting to see if a seasonal drift of resonance occurs! (I.C., VK5KIC)

Velocity factor is a term radio transmission devotees would know, but I have to admit to resorting to a reference book to refresh my memory. The term refers to the reduction in the speed of transmission of electromagnetic waves, caused by the dielectric in a transmission line.

In free air, or more correctly, a vacuum, the velocity of a radio wave (and light) is equal to 3 x 10^8m/sec. The dielectric constant of a vacuum is unity, and other materials have a higher dielectric constant depending on their nature. It is the dielectric constant of the materials used in a transmission line that causes the velocity of the wave to reduce, giving velocity factors of 0.9 down to 0.6.

The important point is that as velocity is equal to frequency times wavelength, any change in velocity, assuming frequency remains constant, will result in a change in the wavelength. This becomes important where a piece of transmission line is being used as a *stub* to tune out the reactive component of the terminating impedance. It is this situation I suspect I.C. is referring to.

Interesting stuff, and very complex if you need to get into the maths of the whole topic. Whether I.C. is right about the effects of humidity on an 'air dielectric' cable I don't know, although it sounds feasible. Anyone with more knowledge of this?

NiCad Charger

The next letter asks a question about our July 1989 Nicad battery charger:

I am interested in building the Automatic NiCad Battery Charger published in July, as its simplicity and features are just what I want. My question is: can this unit charge a series pack of ten NiCad cells?

I have a transceiver that runs from 12V, supplied by ten size AA rechargables, and it would be great if I could recharge them without having to do this in stages. (F.G., Newtown NSW)

After receiving this letter, I dug out ten NiCads, connected them in series and hooked them to the prototype. As I thought, when powered with the suggested 12V AC plug pack, the unit could not raise more than a few milliamps of charge current. In fact, as the

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NOTE: Although these articles have been, or are being prepared for publication, circumstances may change the final content of the issue.

Information Centre

article states, the maximum number of series cells that the charger can handle is seven, or around 9V worth of cells.

However, while I haven't tried it, I can see no reason why the AC input supply could not be raised to 15V AC to give the unit the extra punch it would need to charge into 12V worth of cells. The circuit has zener diode protection of the supply to the CMOS ICs, and the remainder of the circuit should be able to handle the increased supply voltage.

If you do this, the power dissipation of the LM317 regulators will increase, particularly when charging only one or two series connected cells. Increasing the size of the heatsink will probably be necessary in this case.

The companion discharger will not be damaged by the extra voltage, although, as for the charger, the LEDs might glow more brightly. But I must admit that I didn't consider, when I designed this project, that anyone would have a 12V pack of NiCads! I've since learned that quite a few people use these for powering amateur radio and CB transceivers.

Cop that!

A young man of European origin recently attended a test to establish his educational status in the electrical field. He was going well, and language did not seem to be a problem until he was asked to identify the segmented copper device used in a DC motor that has two carbon brushes in contact with it.

"Ah", he confidently stated, "Das is der copulator." Well, I suppose it *is* made out of copper...

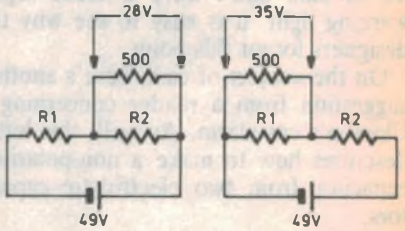
TV CRO adaptor

Mention has been made of our TV CRO adapter (May 1980) in previous months within this section, and yet another enquiry has now turned up. The correspondent cannot get anywhere with the project, although he purchased it as a kit. Readers having problems with this apparently quite popular project are referred to the September EA Information Centre for the only information we have.

However, it would seem that the time is now ripe for us to develop another version of a TV CRO adapter, and I intend to follow this through as time permits. After all, TV sets are now virtually disposals items, particularly monochrome sets – and putting one to use as a CRO is obviously an attractive proposition.

What??

I found this intriguing question in a pile of old family correspondence. The letter, dated 1951, gave the problem and an unsuccessful attempt to find the answer.



The question is, given the data shown on the two circuits in Fig.3, deduce the values of R1 and R2. Have fun – it's easy enough when you know how, but can lead you into some dead ends on the way.

Answer to last month's What??

The answer to last month's question concerning the simplest instruction to clear the accumulator of a Z80 microprocessor is XOR,A.

This instruction works on the basis that the contents of the accumulator are exclusive-ORed with themselves. It therefore doesn't matter what the previous contents were, the result will always be zero after execution, as exclusive-ORing 'like' logic levels gives the result of logic 0. At least this instruction is useful, unlike the equivalent AND and OR instructions, which leave the accumulator exactly as it was. Useful for filling in time perhaps, but otherwise rather crazy.

NOTES & ERRATA

LOW COST IR MOVEMENT DETECTOR (May 1989): The circuit diagram of the interface section (page 71) has not identified C13 due to a drafting error. This capacitor is the one between the output of IC5b (pin 3) and the input of IC5d (pin 5).

TTL-ANALOG VIDEO CONVERTER (Feb.1989): The parts list for this project (page 93) show the 10 turn variable resistors as being 10k. These should be 1k, as shown on the circuit diagram.

NICAD CHARGER (July 1989): The PCB layout (page 84) has the DC OUT socket labelled as DC IN. This socket, which is also not shown on the circuit diagram, (page 83) is to power the companion discharger and is connected across C1. Note that it is not possible to power the charger via this socket, as the timer needs the 50Hz AC signal to operate.

Letters

(Continued from page 5)

layer metallised paper construction, resulting in capacitors with dV/dt ratings of up to 2kV/us and surge ratings of around 8kV in some types.

These characteristics at present can only be achieved with multilayer metallised paper construction and good quality control during manufacture. It is not possible with film type capacitors e.g., polyester, to achieve this level of performance.

The failure mode of a film capacitor (which I assume is what you found) can be catastrophic. Due to the high carbon content in the dielectric material, a transient can lead to a conducting bridge between adjacent windings. This can lead to a snowball effect resulting in, at the best low insulation resistance and at the worst, catastrophic failure and fire.

The self-healing effect is an insurance policy only. Certain international testing authorities do not allow self-healing when conducting approval tests. In other words, self-healing should not be relied on by itself to indicate a safe capacitor. Nothing beats a quality design in the first place. The number and types of approvals are a good indication of quality, but still don't tell the whole story.

At the very least, choose a mains capacitor with plenty of approvals and from a reputable manufacturer, and if impregnated metallised paper construction you won't need to change capacitors every 10 years!

Alan Brodie, Product Manager
Ericsson Components
Preston, Victoria

Metric woe

Oh – how I wish that the item 'Watering Down Metrics' had not appeared in your April edition! So many of the apparently 'tongue-in-cheek' statements in the article are so very true for many older Australians.

For instance, I have given up looking for escaped prisoners because the police description of the escapee being '158 centimetres tall' means nothing to me. If they said he was 5 feet 10 inches I would know what they were talking about.

I'm too old to easily adopt the metric system. I acknowledge its advantages and benefits, but after more than half a century of feet and inches, gallons and acres, I'm just too far gone to change. Sorry about that! (Also, I'm too old to be caught by April Fool jokes.)

Jim Lawler,
Geilston Bay, Tas.

Comment: Sorry you didn't think much of our joke, Jim. It may comfort you to know that Peter was only half-joking anyway – he too has a few reservations about metrication.

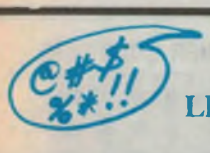
CD Reviews

(Continued from page 30)

During the planning of this work Tchaikovsky told his nephew – "The programme is permeated with subjective feeling, and quite often on my journey, composing it in my mind, I wept copiously. Formally, there will be much that is new in this Symphony, and incidentally the finale won't be a loud allegro, but, on the contary, a very slow moving adagio."

Ten days after its first performance, where it was coolly received, Tchaikovsky was dead.

This recording is simply the best I have heard to date. The tempos are 'just right' but there is a strong sense of depth and feeling, which comes across from this masterly orchestra. Technically, it is simply superb.



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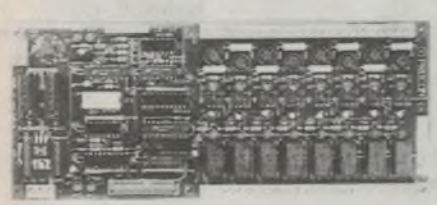

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RADIO AND HOBBIES IN AUSTRALIA

October 1939

Frequency Modulation Next Year, says US specialist: The new type 'frequency modulated' radio broadcasts will be filling the air in the major markets in this country within the next year, Dr W.R.G. Baker, head of General Electric's radio and television division, predicted in speaking before a delegation of college and university professors.

Dr Baker explained that frequency modulation is one of the latest and most promising developments in the field of radio, and makes possible for the first time practically static-free reception, with a high fidelity that has hitherto been unattainable with the conventional 'amplitude modulated' radio system.

"Two frequency modulated transmitters are already operating," Baker said. "One is in Boston and the other is in New York city. A third will be placed in operation here in Schenectady by early Fall."

The FM system employs the use of ultra-short radio waves, and the signals broadcast travel only slightly beyond the distance of the horizon, according to Dr Baker.

RADIO, TELEVISION and HOBBIES

October 1964

Wired TV Systems Gaining in Popularity: Recent reports from both Great Britain and the USA reveal that there is growing interest in the distribution of TV programs directly to viewers' homes by coaxial cable.

Offering a choice of three simultaneous colour TV channels and an FM music and program information channel, Subscription Television Inc of Santa Monica, California is planning to start pay-TV cable transmission in both Los Angeles and San Francisco, according to a recent article in *Electronics World*.

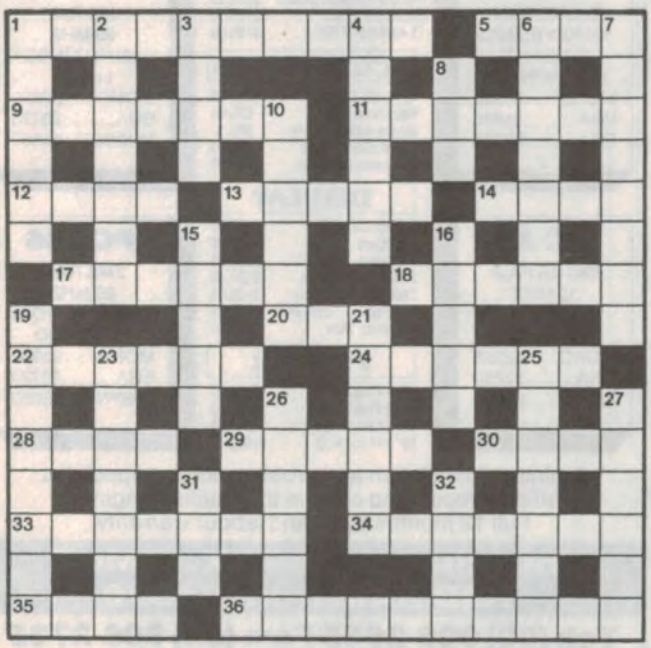
Illegal Snooping a Headache for US Authorities: The inconspicuous electronic eavesdropping devices known to the trade as 'bugs' are becoming an increasing headache for the Federal Communications Commission.

The tiny devices constitute a powerful investigative tool for law enforcement agents, but one recent report estimated that at any given moment, some 10,000 bugs are at work in the USA.

EA CROSSWORD

ACROSS

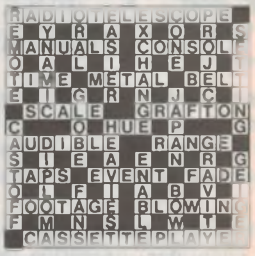
1. Basic solid-state device. (10)
5. Source of ghosting. (4)
9. Record a secondary signal. (7)
11. Determine the value of a variable. (7)
12. Glimmer of light. (4)
13. Long-term part of EA. (5)
14. A set of printing characters. (4)
17. Invent. (6)
18. Recursive computation, or ---crunching. (6)
20. Term giving effective value of cyclic variable. (1,1,1)
22. Producing sparks. (6)
24. Punched paper, the --- tape. (6)
28. Technician's aid. (4)
29. Prints contents of computer memory. (5)
30. Terminal of 1 across. (4)
33. Nature of a state of matter. (7)
34. Such a shape allows shedding of charge. (7)
35. Designation of a single-pole double-throw switch. (1,1,1,1)
36. Device that converts energy to required form. (10)



DOWN

1. Part of a transverse wave. (6)
2. Common solvent. (7)
3. SSB, or single --- band. (4)
4. Dense metal. (6)
6. SI electrical unit. (7)
7. Introduction to an opera. (8)
8. Acronym for designing system. (3)
10. Colloquial term for telephone or intercom. (6)
15. Instrument with a keyboard. (5)
16. The Leyden jar was named after a --- town. (5)
19. Power ratings of appliances. (8)
21. Type of transformer. (4-2)
23. The sort of line that angers callers. (7)
25. Having ability to recover shape. (7)
26. Source of radio signals from space. (6)
27. Initial part of tape or film. (6)
31. Term referring to voice. (3)
32. Coil wire. (4)

NOVEMBER SOLUTION



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Tandy Electronics	All		●		●	●	●	●
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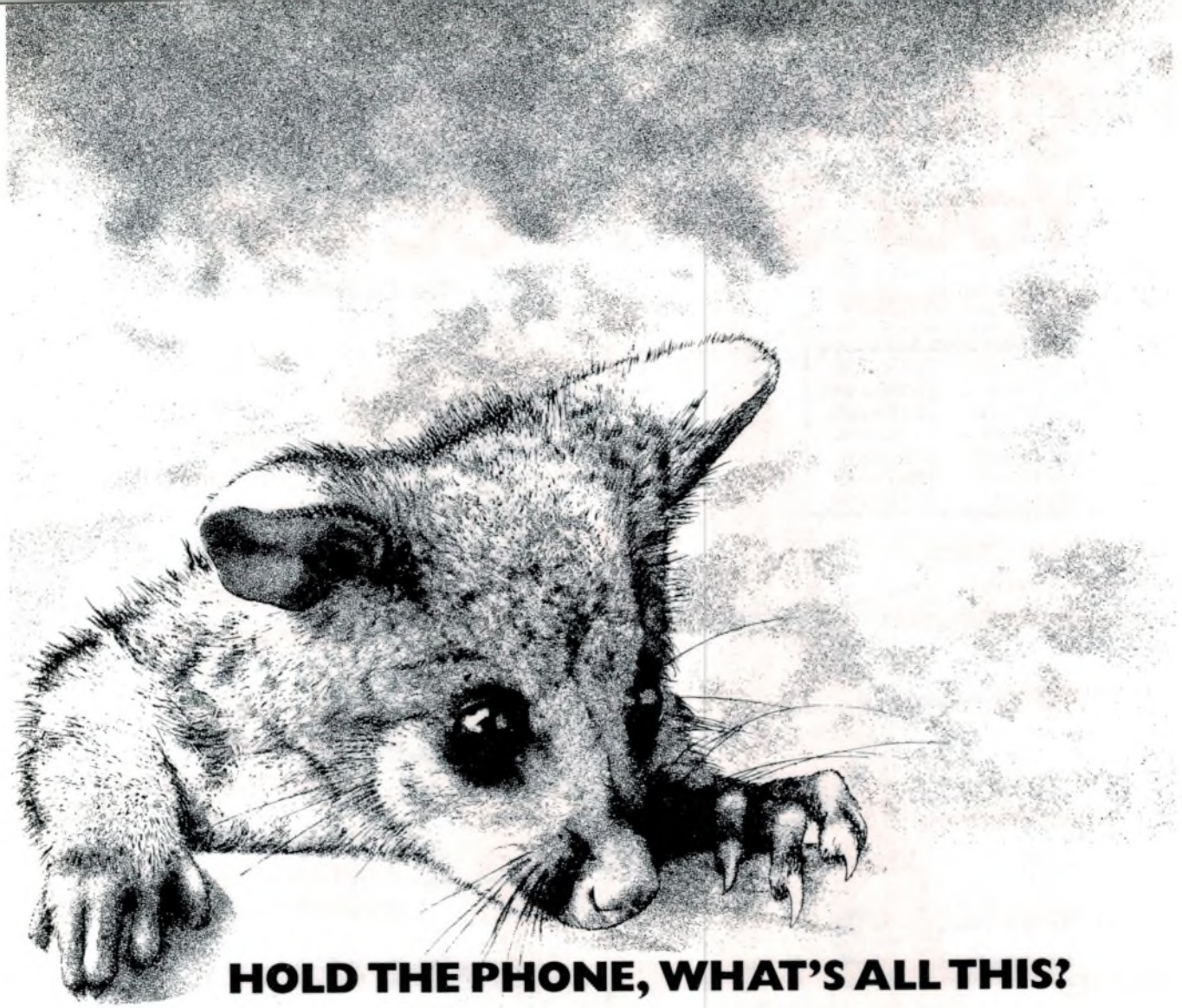

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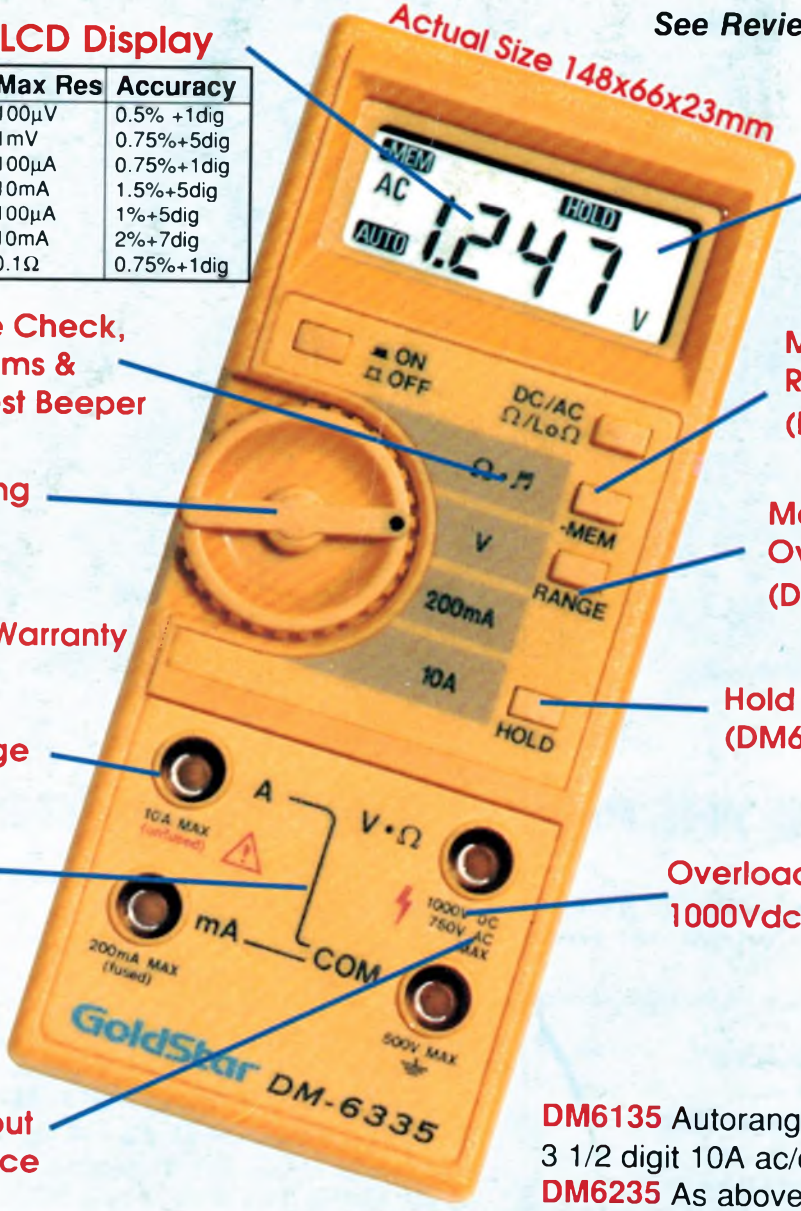

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