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- AUSTRALIA'S EARLY RADIO PIONEERS
- FIFTY YEARS OF 'HOBBY' PROJECTS!
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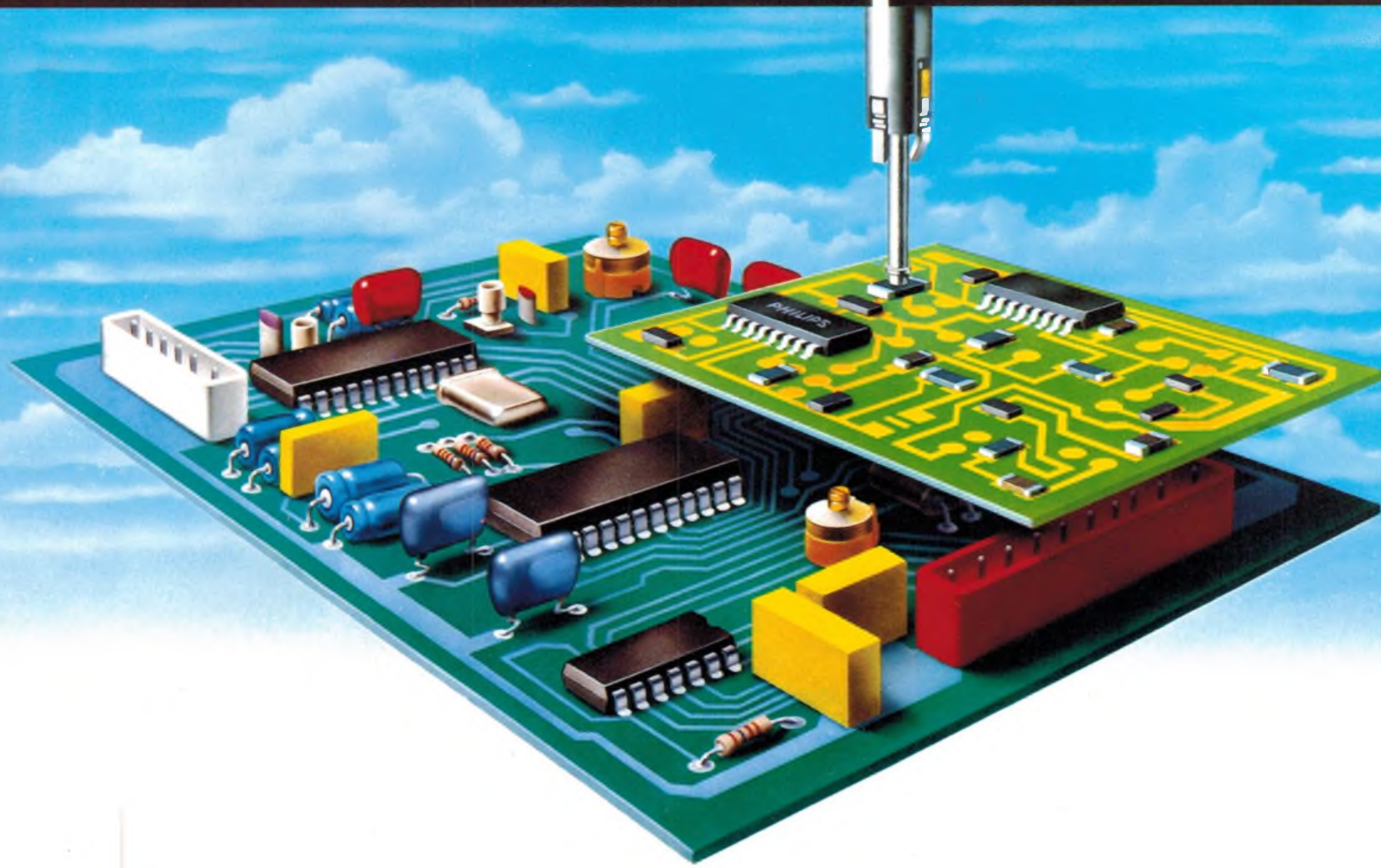

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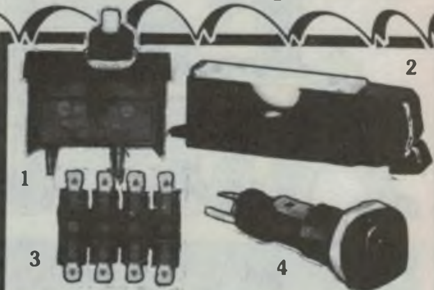

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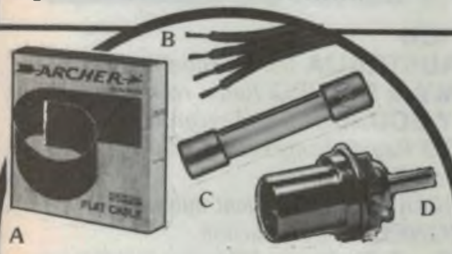

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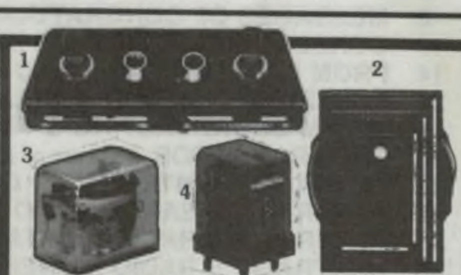

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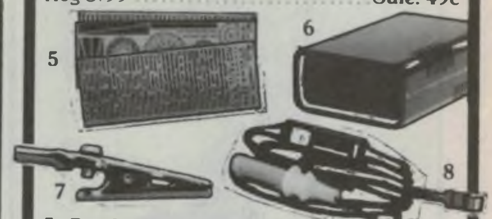

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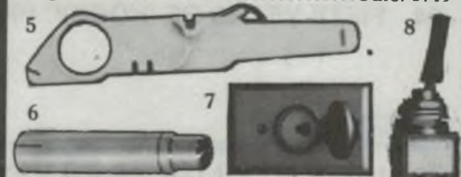

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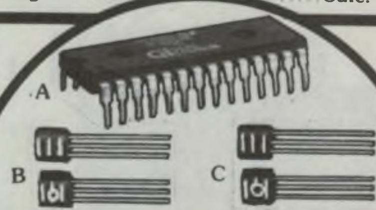

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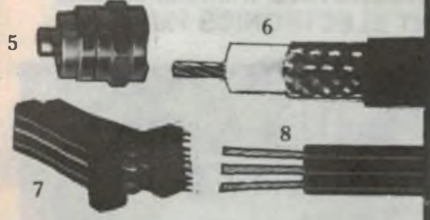

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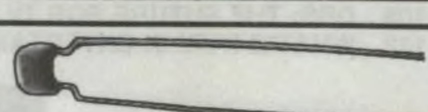
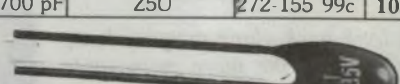


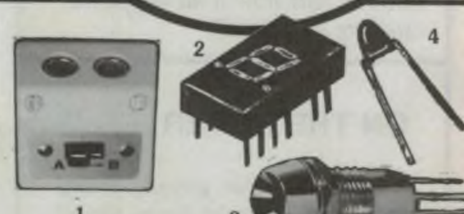
Monolithic Ceramics.

Value	Temp Coefficient	Cat No Reg	Sale
470 pF	NPO	272-153 99c	20c
4700 pF	Z5U	272-155 99c	10c



Tantalums.

UF	WVDC	Cat No	Reg	Sale
0.1	35	272-1432	99c	10c
2.2	35	272-1435	99c	20c
10	16	272-1436	1.49	10c
22	16	272-1437	1.99	10c



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Electronics Australia

AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

From Wartime radar to Radio Astronomy

After World War 2, using makeshift war surplus equipment plus loads of enthusiasm, CSIRO scientists made breakthroughs that gave Australia a key role in radio astronomy. Dr E.G. Bowen tells how it all happened, starting on page 67.

Special Anniversary Features

Features

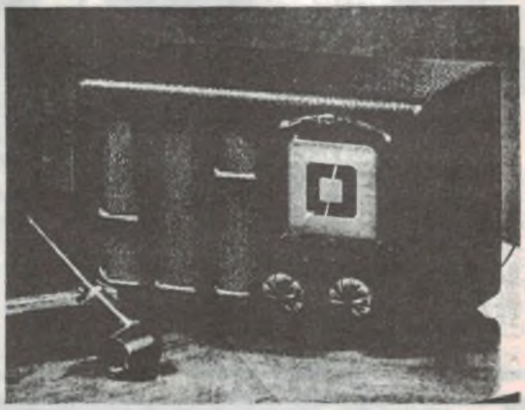
Entertainment Electronics

ON THE COVER

No doubt you've already found this month's special bonus lift-off 76-page Souvenir booklet, showing you exactly what the magazine was like when the first monthly issue appeared back in April 1939. Compare it with this month's issue to see how things have changed...

Fifty Years of 'Hobby' Projects

A look back along memory lane, at some of the more memorable construction projects that have been published in the magazine during the last 50 years – from the famous 'Little General' mantel radio, all the way to TV sets, Deltahets and computers!



Special 50th Anniversary Edition

Volume 51, No.4
April 1989

Projects and Technical

News and Comment

Departments

DBS: the future for TV broadcasting

In Europe, direct TV broadcasting from satellite is now really taking off; the USA has had it for years. How does it work? And when will it reach Australia? See our story on page 108.

PROJECTS TO BUILD:

Low cost 2-sector House Alarm

All the features that are normally needed in a house alarm, in a low cost and easy to assemble package. It's easy to install, too. See page 160.

Car brake lamp monitor

Easy to build, this project will warn you if your vehicle's brake lamps aren't working properly – before another motorist rams into your rear! See page 168.

Build an old time induction coil!

Recreate an authentic old-time Ruhmkorff induction coil, as used by the original radio pioneers to power their 'spark' transmitters. Peter Jensen tells you how, starting on page 176.

Low cost adaptor for tuning your car

Very easy to build and get going, this simple project turns your multimeter into a tacho or dwell meter for tuning up the engine of the family chariot. Rob Evans provides the details, starting on page 186.

Single channel UHF R/C Receiver

Here's the matching receiver for the transmitter described in January. It's very versatile, but also low in cost – see page 194.

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Letters to the editor

AM radio

As a broadcast engineering consultant I was interested to read the article by Bryan Maher – Basics of Radio Transmission & Reception (*EA* Oct '88). My attention was particularly drawn to a number of basic errors in his article.

On page 138 he says '– the whole broadcast frequency scale is divided into 20kHz channels'. This is wrong. We use 9kHz channel spacing in Australia with station carrier frequencies on 990, 999, 1008kHz etc., starting from 531kHz and extending to 1602kHz. He also says 'sidebands more than 9kHz from the carrier are filtered down in amplitude towards zero at 10kHz.

This is also wrong. there is no requirement to use a 9kHz filter and most stations have an audio response extending to at least 10kHz and therefore occupy 20kHz or more of spectrum due to their upper and lower sidebands. In fact with 9kHz channel spacing, AM stations would theoretically need to limit their audio response to 4.5kHz to avoid first adjacent channel interference.

In practice, however, stations serving the same or adjacent areas are not assigned adjacent carrier frequencies and so the overlap of sidebands by stations is not a serious problem when transmitting a wide audio bandwidth. In view of the foregoing, figures 7 & 8 in the article are both inaccurate.

One final point, plate modulated transmitters became obsolete some time ago. Modern transmitters use advanced switching techniques to avoid the use of high power modulators and therefore achieve much higher overall efficiency.

Neil McCrae
Audio Services
East Hawthorn, Vic

Life of magnetic and other media

I would like to make a comment regarding the life of media used to record events. From my own experience, it seems that video tape is not a particularly good method of storing information.

I have a couple of half inch Sony helical scan video recorder units that I use in my ham station as monitors whilst transmitting TV. I recently found out that the local Sony agent had a couple of dozen unused, brand new video tape reels in stock. Of the dozen or so tried, one worked, the others just refused to be pulled past the heads, prefering to jam up, stick, shed oxide and eventually trip the machine off as an end of tape alarm. The rest were subsequently 'sold' to the appropriate garbage bin.

These tapes were about 20 years old, in sealed plastic boxes, stored under a concrete building in reasonably constant temperatures, with the silica jelly moisture removal unit intact, and they still were useless. I also inherited about 200-odd tapes with the machines, and all of them have either refused to play or shed so much oxide that the heads needed cleaning every 5 mins or so!

Some of my experiences with audio tape also reveal problems, of a different type. Cassettes are now about 20 odd years old and some I have dated almost to the start of this era. The problem is not shedding to any great extent, but 'print through' This is where the tape is so close together that the two pieces on the reel each impart their magnetic field to the other, causing you to be able to hear what appears to be another sound track behind the one you are listening too. Also there seems to be a demagnetisation of the track, or a combination of both.

It's interesting to speculate as to the life of CD's. Sure, the disk may survive 50 or 60 years, but will the player? From sources within the industry, it seems that the half-life of the laser diode pickup in a CD player is around 20,000 hours, (about 3 years of continous service). This indicates that the laser head will need replacing at regular intervals. (A ordinary LED has a half-life of around 20 years continuous use). Half-life means the time for the output to have dropped to half what it was initially.

I also seem to remember people saying that the life of video heads was around 1000 hours. Yet my old Sanyo is around 10 years old now, has had two or three head cleans, and gets used a lot in a very dusty environment (a farm with a dirt road access). The heads are still OK, and in all probability may out-last the machine mechanicals and tapes!

I also wonder at the long term storage life of information recorded on computer magnetic media, and note that some companies like IBM state a maximum life span for their magnetic material. I wonder how future historians will fair when faced with no written records and only 'dead discs' for research. In contrast, my record player was made in 1918, and doesn't need power to run. It's portable, I can either buy or make any necessary spare parts (needles etc.), and it still can play records that are 70 or 80 years olds!

A final comment re nF and mF etc. I think that we should be using the SI system of units and these abbreviations are useful, but on a poorly reprinted circuit or a crowded diagram it makes more sense to use the multiplier in the middle of the value. That is 4M7 is either a capacitor of 4.7 microfarads, or a resistor of 4.7megohms. The circuit diagram almost always is clear enough to make out which it is, even though the value may be unclear. Decimal points seem to get lost, or don't come out, or get left off at typesetters etc. The same goes for inductors, and the multipliers for picofarad and nanofarad. That is 6p8, 180p, 4n7 or 6n8 or 10n – no decimal point to get 'lost'. Many popular overseas magazines, especially 'Elector' use this sytem, and so do I when designing circuits. After all, the circuit diagram is to convey information, and should do this unambiguously, or else it's not worth anything.

Peter Laughton, VK2XAN/7NGL
Albion Park, NSW.

Manual needed

I need a workshop manual, or the 'statted' pages thereof, for a multiband receiver, a MARC, Model NR52F1. I hope that one of your readers might be able to help. They may contact me at the address below in the first instance, whereby we can reach a mutual agreement on costs incurred, etc.

I thank you for your assistance in the matter.

Peter Held
24/25 Phillip Street,
Lakemba NSW 2195
Phone (02) 759 5174.

Free energy?

I have been reading a lot lately about 'Free Energy' machines. There is a plethora of inventors, and they all claim their inventions are being suppressed. They are very free with details on how to build their machines, so maybe they

Continued on page 255

Editorial Viewpoint

50 years as Australia's leading electronics monthly

Welcome to a very special issue – our 50th anniversary issue as a monthly, and by far the largest we have ever produced. The book itself has a whopping 256 pages plus covers, and as you've no doubt already discovered, it's also accompanied by a special souvenir reproduction of our complete first 76-page monthly issue, back in April 1939.

For the last 50 years – first as *Radio and Hobbies*, then as *Radio, Television and Hobbies*, and finally as *Electronics Australia* – we have been informing, helping and inspiring generations of electronics hobbyists, students and professionals. And in that time electronics has of course developed dramatically, from the early days of radio and valve technology to today's incredibly diversified industry and technologies.

To celebrate this unique occasion in Australian electronics publishing, we have prepared many special features. You'll find these inside, in addition to the articles, projects and departments you'd expect in a normal issue. There are many articles looking back at what has taken place during the last 50 years – in the industry, in electronics technology and science, and in the magazine itself. Historic articles on the development of consumer electronics; Australia's role in the development of radio astronomy; how our radio broadcasting industry developed; the invention of the computer, the transistor and the IC; the hobby projects that we've described over the years, and so on.

But we aren't just looking backwards. There are also articles looking at the present and short-term future of television broadcasting via satellites, and an attempt to predict what might happen to electronics in the longer-term.

Frankly, it has been a mammoth effort for us to put it all together for you. But it's also been a labour of love, because *Electronics Australia* is an electronics publishing tradition and we couldn't let its 50th birthday pass without a celebration and quick look back over past achievements.

We're especially grateful for the help and encouragement we've received from our many friends, in preparing the special features in the issue. In particular I would like to thank our former Editor-in-Chief, Neville Williams; IREE Australia's Executive Director, Heather Harriman; former Chief of the CSIRO Division of Radiophysics, Dr E.G. Bowen; Mrs Leona Geeves, widow of historian Philip Geeves; Mr Barry Jones, Minister for Science, Customs and Small Business; and all of the executives, scientists, academics, engineers and fellow electronics editors who sent us messages of congratulation.

I hope you'll find as much enjoyment and satisfaction in reading this historic issue, as we have in producing it. And that you'll stay with us, as *Electronics Australia* moves on to discover what lies ahead, in the next 50 years!

Messages of Congratulation

On hearing that *Electronics Australia* would be celebrating 50 years of monthly publication, many of our friends in the industry, both within Australia and overseas very kindly sent us the following messages of congratulation:

Mr Barry O. Jones

MR BARRY JONES

Minister for Science, Customs & Small Business

I was a devoted, not to say fanatical, reader of *Radio and Hobbies* through the 1940's. It was a major influence on my thinking, constantly exposing me to information about new capacities in electronics, and its impact on society. It belonged to the great tradition of scientific popularisation which began with Humphry Davy, Michael Faraday, Joseph Henry and T.H. Huxley in the 19th Century and continued through much of the 20th Century with such names (some now forgotten) as William Bragg, Arthur Eddington, James Jeans, J.A. Thomson, A.M. Low, and Hugo Gernsback in electronics/physics/astronomy and, in the biological sciences, J.B.S. Haldane and Julian Huxley.

Carl Sagan, Stephen Hawking, and Stephen Jay Gould maintain that honourable tradition, but in the age of superspecialisation science appears increasingly complex and esoteric, and the universe conceals infinite mysteries.

Einstein, Edison and Madame Curie had a public recognition in the 1920's comparable to Princess Di and Madonna in the 1980's. Which major scientist, however eminent, now has an international recognition factor?

There has never been a greater need for scientific journalism, popularisation with quality, to bridge the gap between experts and the community.

For 50 years now, *Electronics Australia* and its predecessor have not only been informing the practitioners and the lay people of advances in the general electronics field, but have also stimulated a thirst for knowledge. I congratulate it on past achievements and wish it every success for the next 50 years.

Professor Graham Rigby

PROFESSOR GRAHAM RIGBY

Professor of Electrical Engineering, UNSW
Director, Joint Microelectronics Research Centre

There is a special feeling of satisfaction and excitement when you see your own electronic circuit work for the first time. This was true in 1939 and it is still true with the very different technologies of 1989. People who have experienced that feeling are all linked by a common thread, and many of them have made up the core readership of *Electronics Australia*.

It is a pleasure to congratulate your magazine on its 50th Anniversary. There is no question that, by stimulating an interest in electronics, it has led many people to make a career in electronics and our country is better off as a result.

We now face a future in which more and more people will depend on electronic systems, but fewer people will understand how they work. *Electronics Australia* has, I believe, a very important mission in reducing that imbalance by continuing to stimulate interest, curiosity and hands-on experimentation in electronics.

Good luck and good wishes.

MR PHILIP DARRINGTON

Editor of *Electronics & Wireless World*, London

May I offer my heartiest congratulations on the 50th anniversary of *Electronics Australia*?

When you take on the job of bringing an anniversary issue together, you become especially aware of the acceleration in the development of electronics in the last few years; it is literally exponential in that the rate of expansion seems to be in line with the stage of development reached. There was a time when as electronics engineer could take in the whole subject and be competent in it, but those days are long past.

As journalists, we have a responsibility to inform, instruct and entertain, the latter function being as important as the others. I am sure that your journal will continue to observe that philosophy, as it has for so long. As the editor of an (almost) octogenarian publication, I can say to a demi-centenarian "Keep up the good work – life is just beginning!"

Electronics & Wireless World

DR R.H. FRATER

Director, Institute of Information & Communications Technologies, CSIRO

I congratulate *Electronics Australia* on attaining its 50th Anniversary. I was fascinated to see the comments made in 1939 by Sir Ernest Fisk and others on the relevance of such a magazine and to contemplate how true the statements are, even today.

I have been a long time reader – from my teens when I built *Radio and Hobbies* kits – and my children have followed with similar interests. These activities have added to that crucial background experience component that complements our formal learning in the engineering field. There is a danger, in this world of rapidly increasing complexity, that we will cease to understand the basis of our technology. We may well depend, in the future, on magazines like *Electronics Australia* taking a key role in keeping alive and developing interest in an understanding of basic science and technology.

Your role in education over the past half century has been a vital one – as many thousands of our engineers, scientists and technicians will attest. The role will be no less important for the future. I wish you well.

Dr R.H. Frater

DR BOB HORTON

President, Institution of Radio & Electronics Engineers Australia

I would like to congratulate *Electronics Australia*, now one of the oldest technical electronics magazines in the world, in reaching this milestone of 50 years of continuous publication as a monthly magazine. This is an achievement for which you should naturally be proud, and an occasion to celebrate the significant role the magazine has played in the history and development of the Australian electronics industry – particularly in promoting a popular understanding of the broad field of electronics in various depths to suit the range of readership.

The inaugural edition of the magazine, in April 1939, conveyed messages of encouragement and goodwill from my predecessors, Mr N.S. Gilmour (then President of the IRE Aust.) and that giant of an intellectual, Sir Ernest Fisk, the founding President of IREE Aust. In these messages, they expressed the views that the present young generation was entering a very interesting period in a world which was becoming more and more intensely technical and scientific, and that your efforts would play no small part in the home training of many thousands of youths and adults who had a leaning toward engineering.

I believe those comments are equally valid today. Even more so, given the exponential pace of technological progress, and the now ubiquitous nature of electronics in our everyday lives. The fact that *Electronics Australia* has been able to keep pace with significant change and match this with the needs of its readers has made the magazine the most popular of its kind in Australia. This is a well deserved position.

I wish you well for the future, and look forward to the continuing valuable contribution you are making to this industry.

Dr Bob Horton

Messages of Congratulation

MR GARY JOHNSTON

Managing Director, Jaycar Electronics

On behalf of the staff of Jaycar Electronics may I wish you and all the *EA* staff a hearty 'Congratulations!'

I have been reading *EA* since 1961, when it was *Radio, Television and Hobbies*. I clearly remember the high point in my calendar, at the time, was buying an issue on the first Monday of the month and reading it cover-to-cover almost immediately. The inspiration and motivation that the magazine gave me certainly contributed to steering my career into electronics – thank you!

In the 60's of course most hobby projects were based on valve designs. Quite frankly I got an enormous amount of pleasure constructing valve projects – something that young enthusiasts today will not experience. (Am I being romantic? Building a chassis could be a mongrel!)

When integrated circuits began to appear in the late 60's I feared, like many, that they would spell the end for the enthusiast constructor. Many thought that if all the electronics was 'wired up' already in a tiny piece of plastic, what would be left for the constructor to do?

We were utterly wrong, of course, and the advent of the IC opened up project possibilities in the 70's and 80's that no-one could have dreamed of in the 60's.

But all the time *EA* was there. Making great project articles, giving us thorough technical background on the latest electronic technology and generally being a forum for all aspects of electronics and its impact on society.

Today as more and more information on Surface Mount technology passes across my desk I think back to those days of the late '60's. Rather than bemoan the technology, I am sure that SMT will create project opportunities that we could not dream of 10 years ago. And I am sure that *EA* will lead the way with projects!

Once again congratulations to Electronics Australia from an unashamed admirer. I hope that the next 50 years will be as stimulating as the first.

Mr Gary Johnston

DR BOB McCLUSKEY

General Manager, AWA Microelectronics

In April 1939 when Sir Ernest Fisk, the Chairman of AWA, congratulated you (*Radio & Hobbies*, as you were then) on your inaugural issue, advanced electronics were represented by radio systems containing no more than 5 or 6 thermionic valves. The first all-electronic computer – ENIAC – was developed in 1945, containing 1800 vacuum tubes and consuming the power of a small locomotive. In 1948, the transistor was invented in Bell Laboratories, and in 1959 integrated circuits as we know them now were developed by Fairchild Semiconductor. Initially semiconductor technology was the exclusive domain of the US industry, but is now disseminated throughout the whole of the developed world, leading the way to the astonishing worldwide growth of the electronics and semiconductor industries.

Through all of this, you have observed and reported on our complex, developing and increasingly multidisciplinary industry which now touches and shapes all aspects of everyday life. Your format and content has changed to reflect the increasingly sophisticated demands of your readers. The editorial now comments on world industry as well as the local industry, its politics and development, and in this way, as foreshadowed by Sir Ernest, you have contributed to its education and evolution.

Moore's Law suggests that the complexity of ICs doubles every year. That law also appears to apply to life in general: change is in the nature of things, and one of the few predictions we can make with confidence is that the pace of change will continue to accelerate. However I am also confident that in 50 years time, Australia's oldest technical journal will still be here to comment upon and illuminate this most demanding and satisfying industry.

Congratulations and thank you, *Electronics Australia*, and I wish you the best of good fortune for the next 50 years.

Dr Bob McCluskey

MR JOHN HAYSTEAD

Managing Editor, *EDN* Magazine, Newton, Massachusetts, USA.

We at *EDN Magazine* are pleased to offer our congratulations to *Electronics Australia* on the grand occasion of its 50th anniversary covering developments in electronics technology. As I compose this letter on a desktop computer, to be sent to the other end of the world nearly instantaneously by facsimile machine, the impact of fifty years of electronic advancement is immediate – how much electronics has changed our world.

In its own 34th year of publication, *EDN* has watched and shared with you much of the exciting roller-coaster ride of electronic achievement. Could anyone have accurately foreseen in 1939 how far the embryonic science of electronics would progress in 50 years? Can anyone see now with clarity what wonders lay ahead in the next century? As we both know, much of the fun is in the watching. Again, our warm congratulations on a job well done.

Mr John Haystead

MR BILL PAGE-HANIFY

Chairman and Managing Director, Alcatel-STC Australia

No industry epitomises the 20th Century as does the electronics industry, and nothing changed the information flow of the world like radio. So a magazine about radio, which later extended into the wider fields of electronics, had to be significant. I say this now with the wisdom of hindsight, but I'm sure it wasn't so readily apparent 50 years ago when *Radio and Hobbies* first became a monthly.

As a catalyst in the development of electronics over the last 50 years, magazines have played an important role. Breakthrough discoveries in electronics systems, new understandings of electromagnetic principles, and the development of new electronic components have been steadily flowing from companies, research laboratories and universities on a weekly, if not daily basis since World War II. In a rapidly changing environment like this, books are constantly out of date, so magazines become essential to carry the exchange of ideas and explain the discoveries.

For engineers, with and without formal qualifications, the need for systematic 'further education' is apparent. *Radio & Hobbies* as it was, and *Electronics Australia* as it is now, has been filling this need with substantial articles and 'teach-yourself' series. It is amazing that a popular magazine has also been the 'de facto' technical institution, university and school of continuing education for two generations of engineers and technicians.

I am pleased to see that the magazine that helped me, as a boy, to build my first two-valve radio set has had a successful existence.

Congratulations to the magazine on its achievements – we look forward to the next 50 years with interest.

Mr Bill Page-Hanify

MR NEVILLE THIELE, BE, FIREE Aust, FIE (Aust), FAES

Formerly Director of Engineering Development, ABC. Past President, IREE Aust.

Many happy returns, *Electronics Australia*, on your 50th birthday. Those of us who have been around for more than 50 years realise what an achievement it is just to have survived so long. To be still fresh and vital at the end of it, that is really something.

I have a special affection for *Electronics Australia*, as a regular adolescent reader from the very beginning, under your earliest alias *Radio & Hobbies in Australia* and even, dare I say it, of your elder brother, *Wireless Weekly*. You led me through the painful process of learning to read circuit diagrams, interested me in negative feedback – 'series inverse feedback' in those days – made me enquire into the relative merits of triodes vs. pentodes, and wonder just why should direct-coupled audio amplifiers be so special?

Also, though I didn't realise it at the time, you carried my first publication. Neville Williams, in his 'Forum' pages (then 'Let's Buy an Argument'), had been asking for six months "What waveform is recorded on a disc by an electrical square wave?" I finally wrote him a letter of some asperity, exposing him to my youthful undergraduate ideas. He published selections from it, with great humour, asperities and all, 'from A.N.T. of Randwick', in April 1951.

Long may *Electronics Australia* continue to flourish and maintain that most precious quality in a popular journal, 'simplification without falsification'.

Mr Neville Thiele

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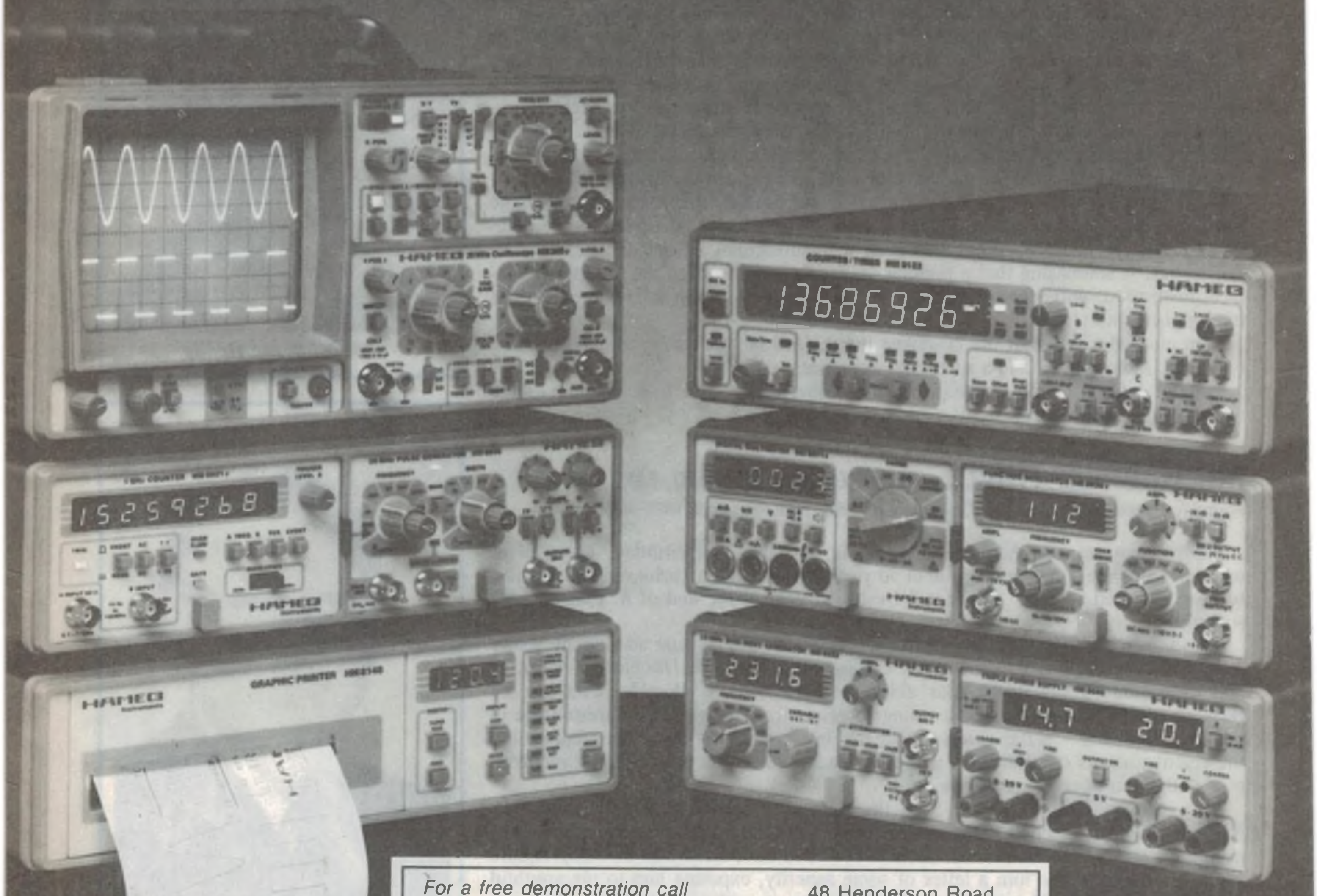

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Special 50th Anniversary Feature:

How Consumer Electronics developed in Australia

As in most other developed countries, Australian consumer electronics in all its present diversity grew from radio (or 'wireless' as it was first called) communications, and more particularly from the public 'entertainment' broadcasting which emerged in the early 1920s. Rapid listener acceptance caused it to gain considerable momentum within the following decades, fostering an indigenous radio manufacturing industry which prospered up to, and throughout World War II. It reached new heights with the coming of monochrome television in 1956. But since the mid 1970s, the nature of the electronics industry has not only expanded but changed dramatically, with most consumer equipment now being imported.

As part of our celebration with this issue of 50 years' publication as the country's leading electronics monthly, Electronics Australia *is proud to present the following comprehensive and first-hand account of the changing electronics scene in Australia during the past 60-odd years. It has been written by the man who presided over the magazine's editorial content for longer than any other person: our retired Editor-in-Chief, W.Neville Williams – himself one of the most widely-known and respected electronics engineers and technical writers in Australia.*

Neville Williams is in an excellent position to review the development of Australia's consumer electronics industry, having been involved in it professionally almost since the beginning. Interested in 'wireless' even during his school days, he joined Reliance Radio in 1933 and gained early experience in receiver production, testing and servicing. Then in 1936 he joined the Amalgamated Wireless Valve Company, working initially in the Applications Laboratory at Ashfield and later transferring to Head Office where he worked with the famous Fritz Langford-Smith on the production of valve data, 'Radiotronics' bulletins and the 'Radiotron Designer's Handbook'. He also lectured to industry groups, to Marconi School of Wireless students and to signals trainees in the armed forces.

Neville Williams, FIREE Aust.

In 1941 he became Technical Editor of this magazine, then called 'Radio and Hobbies', beginning a record 42 years of continuous service. During this period he guided the magazine, its staff and its readers through many phases in the development of electronics, including the growth of 'hi-fi', disc and tape recording, the commencement of broadcast television, the transition from valves to semiconductors, the 'digital' revolution and much more. During his distinguished career he served on the Publications Board of the Institution of Radio and Electronics Engineers Australia (IREE Aust.) as deputy chairman for some years, and in 1982 was honoured by the Institution by being elevated to its highest rank as a Fellow. He retired as Editor-in-Chief in 1983, but remains very active as a freelance technical writer.

The material presented in the following articles has been specially adapted from a Bicentennial Paper which Mr Williams was invited to write for the 'Journal of Electrical and Electronics Engineering, Australia', and published in Volume 8, No.2 (June 1988) issue of that journal, by kind permission of the IREE Aust.

From Battery Valves to FM and AM Stereo

It is perhaps only fitting that we begin this look at the development of Australia's consumer electronics industry with radio receivers, because it was from the fledgling 'wireless' industry that the rest of today's industry developed. And the wireless industry itself began in the early 1920's, when public broadcasting began...

by NEVILLE WILLIAMS

Readers born into the era of radio, television and electronic sound reproduction may not readily appreciate the degree of isolation from entertainment and information that was commonplace in Australia before the introduction of public broadcasting. The author, for example, spent his boyhood in small a country town less than 100km from Sydney where, initially, there were, at most, a few spring-driven phonographs, scarcely any private telephones and not a single wireless set.

However, in country and city alike, mounting interest in the as-yet unfulfilled dream of official public broadcasting was sufficient to prompt the launch of a Sydney-based threepenny (3c) magazine called *Wireless Weekly* on August 4, 1922 – the weekly forerunner of the magazine later to become *Radio & Hobbies* monthly in 1939 and then renamed *Electronics Australia* in 1965. An item in that first issue of 1923 entitled 'Out Back – As it should be' captured the aspirations of would-be listeners, as expressed in the following brief snippets:

Dad Wayback entered the living room of the little homestead. Hanging up his hat he went to where a neat 3-valve wireless sat on a table in the corner, adjusted the earphone and switched on.

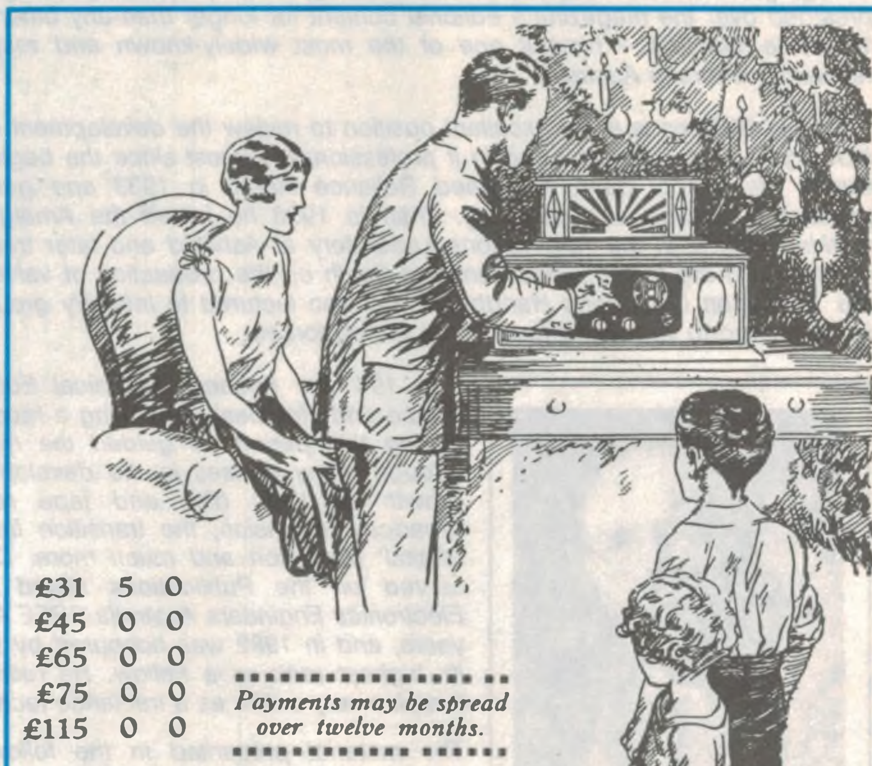
"Hello, hello. Sydney radio speaking. The forecast for the next 24 hours is ..."

Weather and market reports finished, Dad looked at the clock. "In a quarter of an hour", he said, "Amalgamated Wireless will be sending out their concert." At the appointed time, he tuned in to the concert wavelength and connected the loudspeaker...

With the end of the program, the lonely settlers were comforted in the knowledge that they were not altogether out of touch with the world.

Within a few months (e.g., March 9, 1923) *Wireless Weekly* was carrying a dozen or more regular advertisements for wireless (or radio) sets, components, books and magazines, and a radio college for enthusiasts, headed up by F.B.Cooke, principal. The editor's column drew attention to the many new receiving aerials being erected in the suburbs and the music to be heard every evening from amateur stations; to formal broadcasting which would hopefully commence 'within a month', and to expectations of a wireless 'boom' that could not now be far off.

Meanwhile, a new monthly magazine *The Australian Wireless Review* had appeared in January of that same year,



An AWA advertisement from Christmas 1927, which captures the atmosphere surrounding radio at the time. At 31 pounds 5 shillings, the cheapest model cost about 6 weeks' wages – far more expensive pro rata than a modern colour TV set.

featuring what was claimed to have been Australia's first-ever major radio exhibition and calling for the immediate authorisation of public broadcasting. In fact, 1923 did prove to be the year when it all started to happen! (Ref.2)

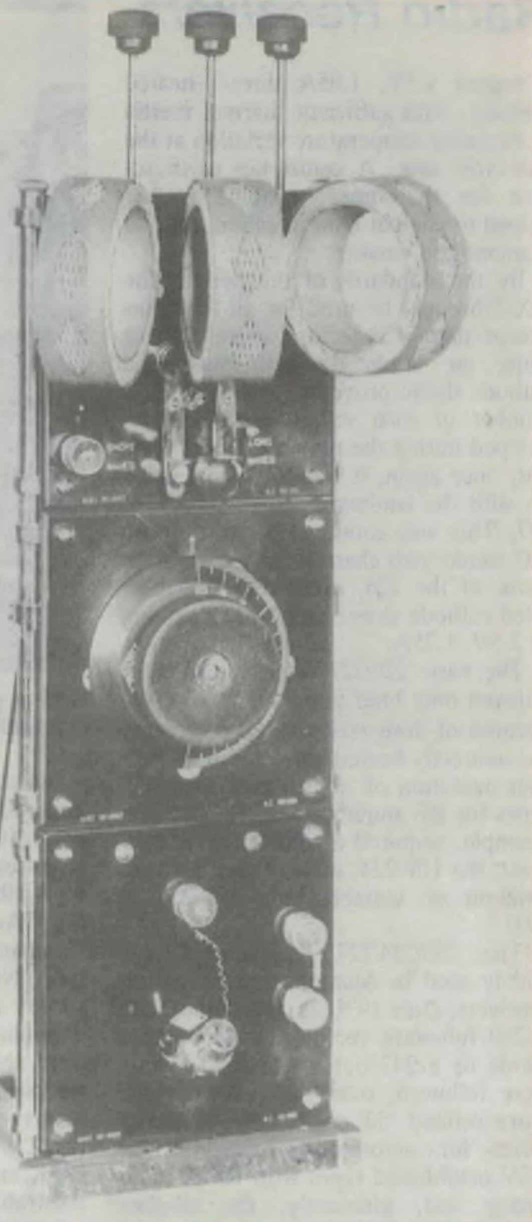
Early receivers

Most domestic broadcast receivers produced in the early and mid 1920s were housed in polished wooden boxes, with engraved black bakelite panels and knobs. They used directly heated, filament type valves and were normally battery powered, requiring typically:

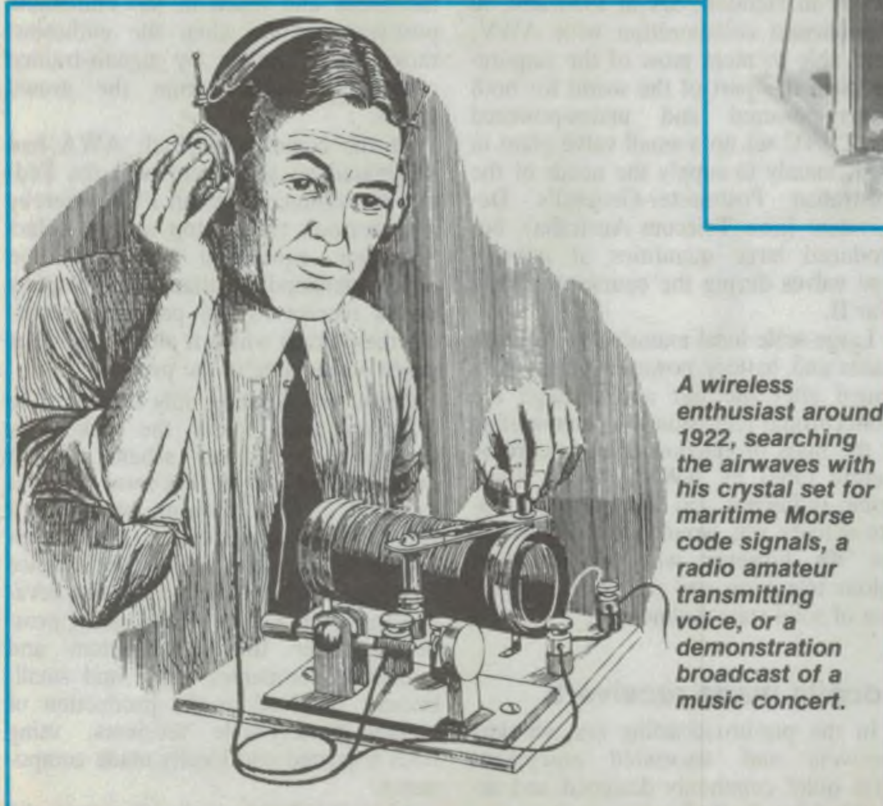
- A 4V rechargeable lead/acid accumulator (the 'A' battery) to supply the filaments;
- Two or three 45V dry-cell ('B') batteries in series, to provide 90V or 135V for the anodes (or plates);
- A dry-cell 'C' battery (with tappings of 1.5 to 9V) for grid bias.

In practice, the replacement cost of B-batteries and the need to have the A-battery recharged at regular intervals tended to restrict family listening time to selected programs, a notable exception being for those who lived close enough to a broadcasting station to permit the use of a crystal set!

For listeners in suburban areas, it subsequently became possible to invest in a mains-powered B-battery 'eliminator' (commonly Philips) and the wherewithal to maintain the A-battery – a 'Tungar' charger, a voltmeter and/or hydrometer and a supply of distilled (dill) water. What with that and the frequent need for a properly installed outside aerial and earth, complete with lightning arrester, a technically inclined relative was a decided advantage!



An AWA 'panel' receiver of the early 1920's. By purchasing additional panels, the set's capabilities could be enhanced. Note the three 'honeycomb' coils at the top, moveable to adjust the magnetic coupling.



A wireless enthusiast around 1922, searching the airwaves with his crystal set for maritime Morse code signals, a radio amateur transmitting voice, or a demonstration broadcast of a music concert.

Mains receivers & valves

In the mid 1920s, efforts were made to produce self-contained receivers which could operate directly from the AC power mains, but these only became really practical when valves were developed in which the filament (or cathode) could operate from low voltage AC. The first such valve to win wide acceptance was the UX-226 released by RCA (and others) in early 1927. A general purpose triode, it used a rugged 1.5V, 1.05A directly-heated filament, with sufficient thermal inertia to minimise temperature variation at the half-cycle rate. A centre-tap earth return for the supply winding further helped to combat hum injection into the filament/grid circuit.

By the standards of the period, the UX-226 could be used for all functions except that of detector, where a valve using an insulated, indirectly-heated cathode sleeve proved to be essential. A number of such valves had been developed during the previous 5-odd years but, once again, it was RCA that came up with the landmark 'tube', type UY-227. This was another general purpose AC triode with characteristics similar to those of the 226, except for the insulated cathode sleeve and a heater rating of 2.5V, 1.75A.

The basic 226/227 valve complement enjoyed only brief popularity, however, because of designers' overall preference for indirectly heated valves, and the further evolution of 'screen grid' (tetrode) types for RF amplification. The 227, for example, acquired a companion RF tetrode, the UY-224, in 1929 and the variable-mu or variable gain UY-235 in 1931.

The 235/224/227 complement was widely used in Australia for AC mains receivers, circa 1931, in association with a 280 full-wave rectifier, a 245 output triode or a 247 output pentode. These were followed, over the years, by the more refined '50' series, the 6.3V '30' series for automotive receivers, the 6.3V octal-based types with RMA numbering and, ultimately, the all-glass miniatures which virtually climaxed large-scale valve technology.

Local valve production

Significantly, most of the above conformed to American practice. While British and continental valve manufacturers were no less active than their American counterparts, they were handicapped in the critical early '30s by a confusing multiplicity of types – and by examples that, too frequently, could not stand up to transport to, and across, the Australian continent!

The more orderly and conservative American approach imposed first by RCA and, from 1933, by the Tube Committee of the RMA (Radio Manufacturers' Association) received majority support by the Australian electronics industry right up to the end of the valve era.

Fitting grid caps to the tops of valves in the Amalgamated Wireless Valve Company at Ashfield, Sydney in the mid 1930's.

Valves had been manufactured in Australia in small numbers since the early 1920s, principally by AWA, but large-scale manufacture did not begin until 1933, following the setting up of the Amamgamated Wireless Valve Company in the previous year at Ashfield, NSW. Philips established a valve factory in Hendon, SA in 1936 and, in unpublicised collaboration with AWV, were able to meet most of the requirements in this part of the world for both battery-powered and mains-powered types. STC set up a small valve plant in 1939, mainly to supply the needs of the Australian Postmaster-General's Department (now Telecom Australia), but produced large quantities of military type valves during the course of World War II.

Large-scale local manufacture of both mains and battery powered valves continued after the war and through the monochrome television era, culminating in the mass production of monochrome picture tubes by AWV, Philips, Electronic Industries and Thomas. The entire activity was wound down in the in the '70s, however, with the arrival of colour television and the general adoption of solid-state technology.

Locally made receivers

In the pre-broadcasting era, wireless receivers and associated equipment were quite commonly designed and assembled by Australian amateur station operators, experimenters and listeners. Encouraged by local technical magazines and component suppliers, the home construction of receivers, transmitters and amplifiers continued as a major hobby for the next 50 years, constituting a very active segment of the industry. It reached a substantial peak in the 1930s and again in the immediate post-war period, when the enthusiast ranks were swollen by signals-trained personnel released from the armed forces.

At the commercial level, AWA had negotiated an agreement with the Federal Government back in 1922, whereby it undertook to develop and manufacture radio equipment in Australia on the understanding that the company would receive royalty payments covering the patents which it already held, or might accumulate in the process.

Public broadcasting duly began in the following year, under the Fisk/AWA sponsored 'sealed set' scheme, but it proved unpopular in that form and was replaced in the following year with a system of A- and B-class stations, supported respectively by listeners' licence fees (as in Britain) and advertising revenue (as in the USA). Broadcasting prospered under this new system and numerous companies, large and small, became involved in the production of mainly battery-style receivers, using both imported and locally made components.

Around 1929/30, as already noted, the

227, 224, 235 and 247 (later known simply as the 27, 24, etc.) valves showed the way to receivers that could be powered from the mains much like any other appliance, that cost very little to run, needed only a modest antenna and no earth in urban areas – and required no special skill to operate.

These receivers set the scene for a virtual explosion in local domestic receiver production from about 1932 onwards, protected by a tariff barrier which had been erected a couple of years earlier, and that was to stay in place until 1972.

The 'golden age' 1930s

For the most part, the new-generation receivers were designed around the 50-series valves and the superhet configuration, in the quest for selectivity sufficient to cope with an ever-increasing number of stations. It was in this same period that the writer entered the workforce as an assembler/wirer for Reliance Radio, a small family company that was just then venturing into local manufacture at 45 York Street, Sydney – a site that was later to be occupied by the AWA Head Office and tower.

Most of the components used in the early Reliance receivers were locally made, obtained either direct from the manufacturer or through one or other of the then specialist wholesale suppliers. The chasses from various sources were of mild steel, pre-punched and sprayed; the tuning gangs from Airzone; the knobs and dials from Efco; and the loudspeakers from Amplion. The coils, IF transformers and power transformers came from Radiokes, Airzone or RCS; the valve sockets from Renrade or Tasma; the capacitors from Chanex, Simplex and Ducon, and the fixed and variable resistors from a variety of suppliers. In this respect, Reliance Radio would have been typical of most of the smaller manufacturers.

Larger manufacturers tended to be more self-reliant, with Eclipse Radio claiming at one stage that all components other than the valves were produced in their own factory – although not always to their credit. Companies like AWA, STC, Stromberg-Carlson (Aust), HMV, Airzone, ETC/Pye and Radio Corporation produced many of their own larger components, but most had their cabinets (mainly veneered wood) custom built by one or other specialist cabinet makers, such as Ricketts & Thorpe.

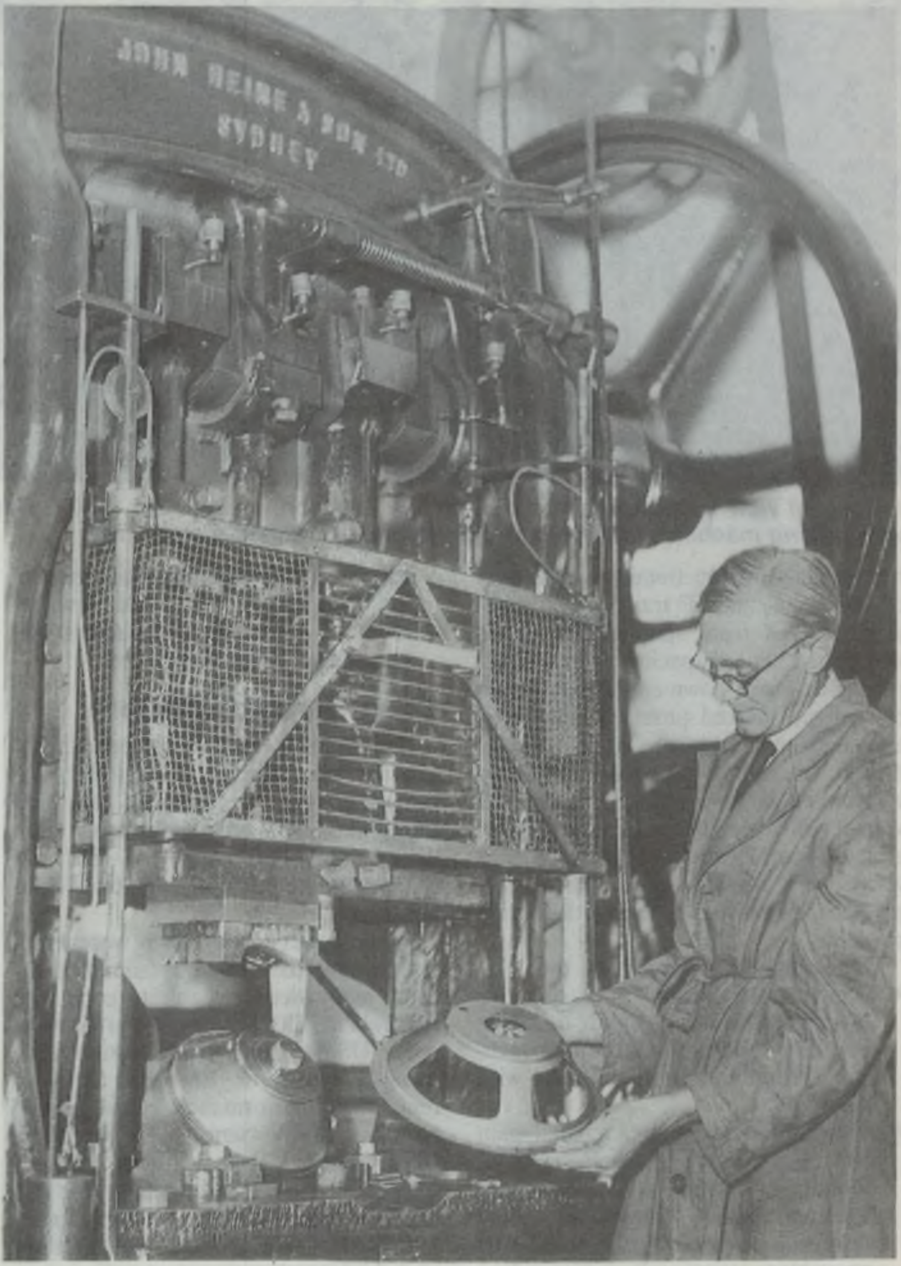
Whether small or large, however, all local radio factories in the 1930s were subject to the highly seasonal nature of the market. The long, cold nights of winter were the signal for listeners to buy a new receiver, and the industry was hard put to meet the demand. But with the onset of summer, the demand fell off dramatically and the process workers who had been eagerly sought a few months earlier were stood down – without pay – for hours at a time, weeks at a time, or until further notice.

If not already extant, a fascinating book could be written about work attitudes in Australian 1930s-style radio factories, ranging from larger-than-life big bosses to process workers who used their resentment as justification for 'pinching' anything they could get their hands on!

Component, circuit problems

An interesting book could also be written about the hassles encountered with the early mass-produced components – situations that were by no means peculiar to the Australian scene.

Power transformers suffered short circuits between adjacent turns or layers, with dire consequences; 'gang' tuning capacitor plates became misaligned, and



A power press stamping the cutouts from loudspeaker 'basket' frames, again at AWA's Ashfield factory and in the 1930's. At that time virtually all electronic components and hardware were being made in Australia.

An overall view inside the Melbourne factory of Astor, again in the 1930's. Note the overhead drive shafts and belting, with drilling machines in the centre foreground and lathes at upper left.

tuning dials malfunctioned in a variety of ways; coil and IF transformer windings suffered from spontaneous corrosion spots; paper capacitors leaked electrically or broke down completely, while electrolytics leaked physically and even exploded on occasions; carbon resistors drifted in value, wirewound resistors went open circuit, potentiometers and voltage dividers became intermittent; and, of course, loudspeaker voice coils warped and rubbed against the magnet poleface or became fouled with foreign particles.

There were circuit problems, too:

- A mandatory upwards move to an IF of 465kHz, coincident with dropping the RF stage (as a cost cutting measure) introduced new problems with selectivity.
- Without the RF stage, manual gain control presented difficulties, compounded by erratic variations in the level of signal, commonly being picked up as much by the house wiring as by an often makeshift aerial.
- AVC (automatic volume control) minimised erratic variations in volume, but aggravated selectivity problems and disguised the optimum tuning point. This led to the development of ferrite-cored inductors and 'magic-eye' tuning indicators.

Country radio listeners

Country listeners also posed a problem for the industry, in that they expected console receivers to look and sound like mains operated models, even though operating from dry cells, rechargeable accumulators or home lighting plants.

While battery type valves were available to suit contemporary superhet circuits, many were not able to cope with Australian 1930s-style road or rail transport. US-designed tubes were fragile enough, but some European low-current, high performance types proved hopeless. AWV came to the rescue in 1935 with their more rugged 2.0V/120mA series, which filled the gap until the arrival of the 1.4V miniatures.

It was in this period that vibrator type high-tension power supplies were developed as an alternative high voltage supply, taking over from cumbersome and inefficient motor-generators, at least for low wattage applications. Vibrator supplies were commonly mated with a series-parallel string of the above AWV valves, to provide a reasonably economical vibrator type receiver operating from a 6V rechargeable battery.

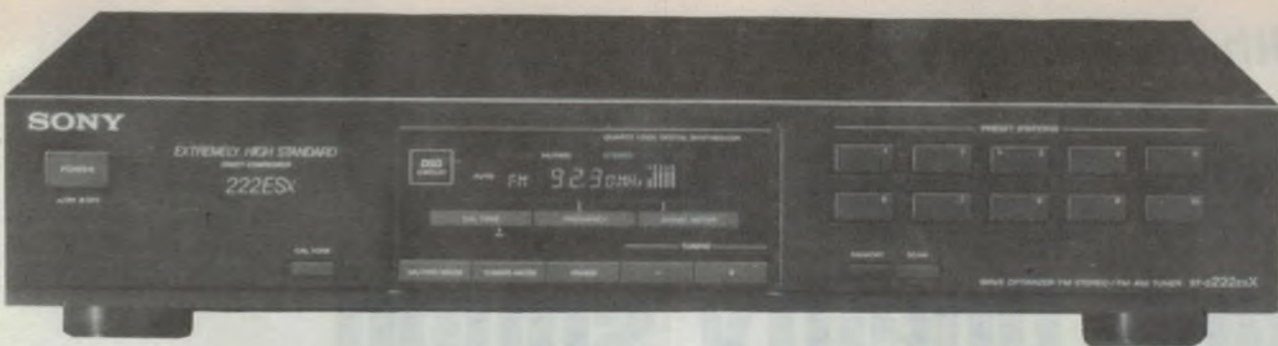
Vibrator supplies were also used in automotive receivers, generally in conjunction with normal mains type valves. They did the job but called for meticulous attention to shielding and filtering to prevent vibrator 'hash' from penetrating the equipment to which it was connected.

These and other problems were sorted out, at least in part, during the 1930s. But the radio industry still had to learn painful lessons about environmental and biological hazards when it was required to produce military equipment, particularly for the Pacific area.

Post-war production

Following the war, component and equipment manufacturers alike prepared to take up where they had left off, but the 'more of the same' period was short lived.

Production methods, labour condi-



This late-model Sony 222ESx FM Stereo/AM tuner illustrates just how far domestic radio has come since the 1920-30's. It features pushbutton digital tuning, low-distortion phase-locked loop detector and many other features.

tions and market expectations had all changed; tape recording, LP discs, television, stereo sound and transistors were all changing the face of the industry. Ducon, AWV, Philips and Fairchild were setting up transistor production lines, while other component maufacturers were facing the need to up-date their technology in line with overseas trends.

Right in the middle of it all, in 1972, the Whitlam labor government decided to remove the tariff that had protected the industry for more than 40 years – this as part of a plan to re-shape the nation's balance of trade. Within a few short months, the market was flooded with imported electronic components that were more than competitive with the locally-made product.

Even more to the point, vendors' shelves were soon stacked with imported receivers, record players and tape players at 'duty free' prices. For customers, it was a bonanza. But behind the scenes, factory after factory scaled down or closed down and, for all practical purposes, radio receiver production in Australia has since ceased.

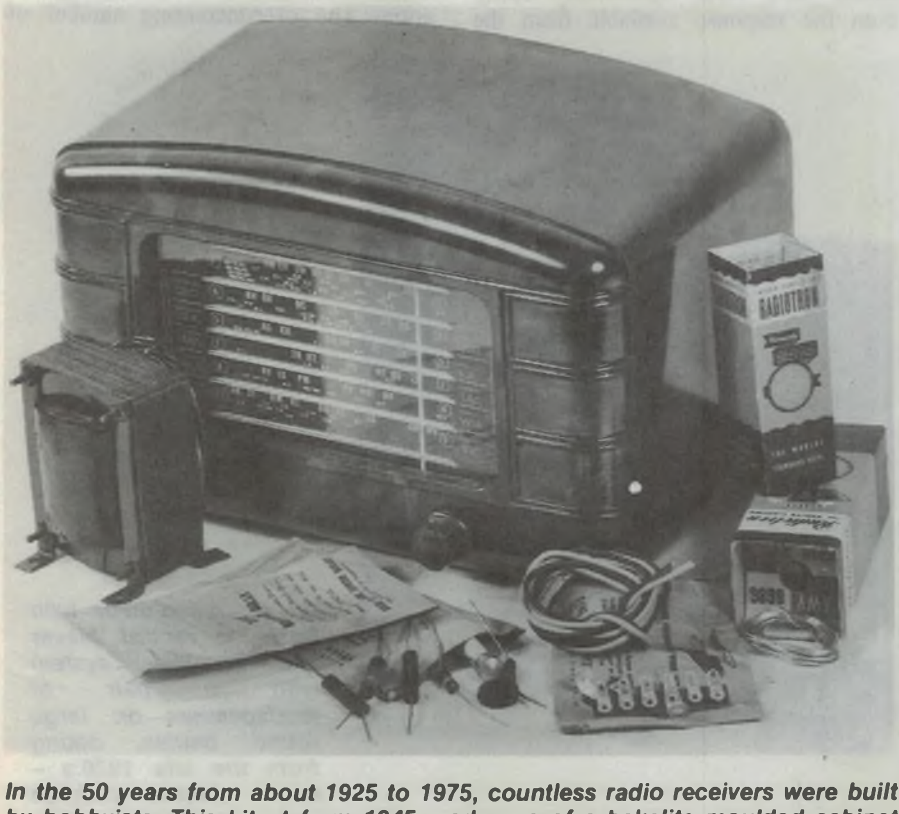
Recent developments

A decision by the Federal Government in 1974 paved the way for the establishment of full-scale FM-stereo broadcasting and this is being progressively expanded nationwide as TV services are moved out of the 88-108MHz band, mostly into UHF channels. FM is proving popular at both a regional and local community level and some major FM broadcasters are currently out-rating long-established AM stations.

Reacting to this, and in an effort to polish up their quality image, most AM stations have changed over to compatible AM stereo during the last couple of years, setting a world precedent by standardising on the Motorola C-QUAM system. This has created a market for full stereo AM/FM tuners which, at long last, have also tackled the vexed problem of switchable AM selectivity using modern solid-state digital technology.

The overall quality from AM still falls short of that available from the FM system, but the improvement is nevertheless very worthwhile.

On a national scale, the AUSSAT satellite system, which is now in place, has the capacity to bring high quality sound programs to any listener in the nation, including those beyond the reach of normal AM and FM broadcasting. But this is not history; it is very much part of the present and future.



In the 50 years from about 1925 to 1975, countless radio receivers were built by hobbyists. This kitset from 1945 made use of a bakelite moulded cabinet and other parts left over from factory production runs.

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50th Anniversary Feature:

The quest for high fidelity sound

Even before radio broadcasting began, music lovers had striven to obtain clearer and more realistic sound reproduction from the early mechanical gramophones. But it was the advent of electrical 'pickups' and valve audio amplifiers in the late 1920s that made it possible to achieve the first really significant improvements, triggering a quest for ever more faithful 'high fidelity' reproduction that has continued to the present day, and culminated in developments such as the digital compact disc.

by NEVILLE WILLIAMS

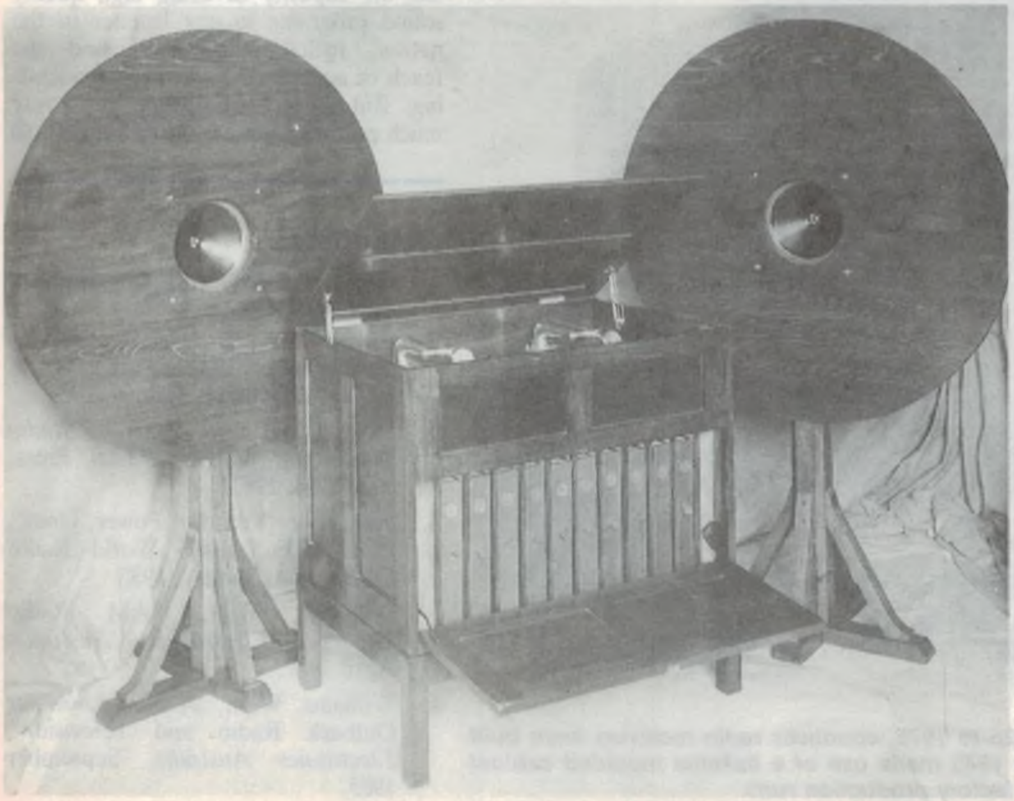
The term 'high fidelity', now commonly abbreviated to 'hifi', was reportedly coined by a British technical writer, H.A.Hartley, to describe the performance of 'high-tech' mechanical phonographs in the mid 1920s. About that same time (1926), a landmark paper to the AIEE by Maxfield & Harrison offered a detailed analysis of mechanical recording and reproduction — indicating, amongst other things, that it was then currently possible to achieve an essentially flat overall response from about 110 to 4000Hz.

Representing the end result of 40-odd years of research and development, this would have been significantly better than the response available from the majority of 1926-model wireless receivers. But by the end of the 1920s, with rapidly improving technology and the emergence of moving coil loudspeakers, the mere practicalities of receiving wireless/radio signals were overtaken by rising concern for the intrinsic quality — or *fidelity* — of the reproduced sound.

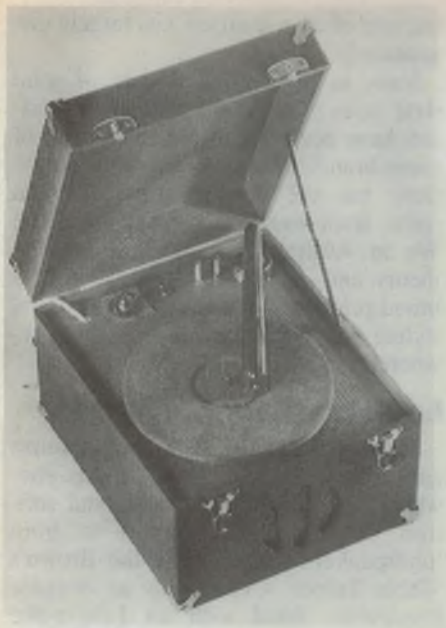
Many and varied were the arguments that followed. An example was that to do with the fundamental conflict between selectivity and audio bandwidth, in the reception of AM broadcast stations.

AM receiver bandwidth

Up until about 1930, most domestic radio receivers were of TRF design, comprising one or two tuned radio frequency amplifier stages, followed by a tuned detector with or without regeneration. The ever-increasing number of



An Australian-made twin turntable record player and amplifier system with a pair of loudspeakers on large round baffles, dating from the late 1920's — when electric pickups and amplification were just coming in.



A portable record player from the 1930's, complete with 'crystal' pickup cartridge in a moulded bakelite arm, and leatherette-covered wooden case.

stations on air, however, provided a cogent reason to adopt superheterodyne front-ends instead. These offered better inter-station selectivity, but at the expense of audio bandwidth, due to attenuation of the higher frequency modulation sidebands.

Many quality enthusiasts, however, argued for the continued use of TRF tuners (Ref.1), on the ground that wideband reception of local stations was more important than the ability to log distant, and often noisy, transmissions.

While it might have been technically feasible to design superhet tuners with variable selectivity (1,2), thereby satisfying both requirements, the idea has always presented practical difficulties and, historically, has not found wide application. Only recently, with new technology available, and with AM stations pursuing a higher quality, stereo image, has variable (or switchable wide/narrow) selectivity been taken up on a serious commercial basis.

Triodes vs tetrodes/ pentodes

Almost as an accident of timing, the changeover from TRF to superhet tuners coincided with the transition from triode output valves (e.g., type 45) to the more efficient and higher gain screen-grid tetrodes or pentodes (e.g., type 47). But quality enthusiasts didn't applaud this development either, equating 'pentode tone' to boomy bass, strident treble and a general loss of tonal 'sweetness'. This was despite the fact that the published total harmonic distortion figures for power triodes and power tetrodes/pentodes were not all that different.

The critical distinction between the two turned out to be their intrinsic *output resistance*. With a power triode, this was typically less than half that of the recommended output load; in the case of a power tetrode/pentode, it was more like ten times the figure! Coupled with this was the fact that the load presented by a loudspeaker was both complex and reactive, rising well above its nominal value in the 2-10kHz region and near the bass resonant frequency.

With its much higher output resistance, a power tetrode/pentode could not 'damp' a loudspeaker so effectively at its bass resonance (therefore producing more 'boom'), nor limit the tendency of the output voltage to rise with load impedance (a more strident treble). In addition, the shape of the plate family of curves for a tetrode/pentode cannot readily accommodate a complex reactive load – hence higher distortion when feeding a loudspeaker system, as distinct from a hypothetical resistive load.

It subsequently became evident in the mid 1930s that the disparity between power tetrodes/pentodes and loudspeaker loads could be counteracted by the use of 10dB or more voltage negative feedback around the output stage.

Australian valve application laboratories maintained by AWV, Philips and Mullard were active in researching this general area, with the late Fritz Langford-Smith delivering a definitive paper on the subject to the 1938 IRE World Radio Convention (3). Although established in the context of valve technology, the broad principles set out in the paper apply with equal force in the present solid-state era, with virtually all modern amplifiers relying heavily on negative feedback.

Direct coupling

The search for improved audio quality in the late 1920s produced an interesting 2-stage amplifier which avoided the use of either an interstage transformer or a plate/grid coupling capacitor.

In its early form, this so-called *Loftin-White* circuit employed a type 24-A screen-grid RF amplifier in the then-unique role of an audio voltage amplifier, with a resistive plate load, and with its plate directly coupled to the grid of a type 50 power triode – a valve more at home in theatre sound systems than in a domestic receiver.

While the circuit called for a dauntingly high DC supply voltage, the amplifier almost certainly owed its reputation for excellent fidelity to the big triode, with its generous power output, low source resistance and the fact that it was invariably mated with a good quality moving coil loudspeaker.

Ironically, however, the detail that caught enthusiasts' attention was the direct coupling and, in the early 1930's, simplified but much-touted look-alike circuits appeared using a more convenient supply voltage and an ordinary pentode output stage. By implication, the inherent limitations of an uncompensated output pentode obligingly disappeared, along with an inoffensive interstage coupling capacitor!

Direct coupling is certainly common in modern high performance amplifiers, but not because of any direct benefit within the audio passband. Rather, by minimising phase rotation at subsonic frequencies, it contributes to the stability of circuits involving a high order of negative feedback around multiple stages.

An Australian-made Byer 'BRS Junior' direct disc recorder and player, which used lacquer-coated aluminium discs. A worm-and-quadrant gearing system underneath drove the arm for recording.

The quest for hifi sound

Fritz Pfleumer with his first practical tape recorder, developed in Germany in 1928.

The three hoary areas of contention, as above, are typical drops in a large proverbial bucket. While hifi audio may be characterised by many things, one of them must surely be the scope that it provides for enthusiasts who enjoy a technical argument!

Local amplifiers

Up until and immediately after World War II, domestic audio amplifier design evolved mainly around beam tetrodes or pentodes in the output stage, operating in single-ended or push-pull class-A or class-AB. This was because of their ready availability and cheapness, and their higher operating efficiency.

Most used voltage negative feedback around the output stage, ranging from a simply configured 10dB loop in basic units to 20dB or more in ambitious designs, and taking in the output transformer and driver stage(s). Care was necessary, in the latter case, to ensure that the circuits were intrinsically stable but, for the most part, they worked well.

The late 1950s saw the widespread adoption of the so-called *ultralinear* configuration – an otherwise normal push-pull tetrode/pentode amplifier, but with the screens of the output valves fed from tappings on the output transformer about 10% down (in terms of turns) from the respective plate (or anode) connections (4). The promoters of the idea, Hafler and Keroes, had been able to demonstrate that tetrodes or pentodes, so connected, exhibited characteristics approaching those of a triode, without significant loss of efficiency.

With 20dB of feedback around what had been transformed into an intrinsically good output stage, ultralinear amplifiers dominated the domestic hifi scene through the 1960s, and into the stereo era, with Australian designs and output transformers ranking in world class. In the 1970s, however, valve-based amplifiers were gradually displaced by solid-state designs.

Over this whole period, from the early 1930s to the early 1970s, local radio manufacturers concentrated their efforts mainly on routine, mass produced receivers and record players, supplemented by modestly ambitious top-of-the-range models. With rare exceptions, the hifi enthusiast equipment market was left to overseas suppliers, initially British but, later predominantly Japanese.

Yet, during the same era, encouraged by local technical magazines such as *Electronics Australia*, and local valve and component distributors, Australian hobbyists built up countless thousands of hifi amplifiers and loudspeaker systems – much to the delight of kit suppliers like Instrol, ED&E Sales, Classic Radio, National Radio Supplies, ACE Radio, Dick Smith Electronics and so on! Thousands of other hifi enthusiasts, lacking the time or know-how, were able to buy them 'ready wired and tested' at extra cost.

With hindsight, Australian manufacturers would appear to have missed out on this whole market area, more through lack of initiative than of know-how.

When the protective tariff was removed in 1972 and attractively priced Japanese hifi amplifiers began to flood into the country, the opportunity for local manufacture largely disappeared. Small companies like Classic Radio, which had been operating on a cottage industry basis, found they could no longer compete and even the price attraction of do-it-yourself kits largely disappeared.

Now, in the second decade of solid state equipment, quality sound enthusiasts have never had it better in terms of name-brand hifi receivers and amplifiers; but the vast majority of them come from overseas, principally Asia. We in Australia can read up on the theory and, as always, argue about the broad principles, but the real design and styling decisions are now made elsewhere.

Loudspeakers & systems

During the 1920s, Australian wireless enthusiasts, like their counterparts elsewhere, graduated from traditional soft-iron diaphragm headphones to horn loudspeakers ranging from the Brown's 'Table Talker' – essentially an oversize headphone fitted with an Edison-like horn – to more pretentious models like the Amplion swan-neck series. In the same period, a variety of moving-armature cone loudspeakers appeared on the market, some in decorative cases, the rest in essentially free-edge form.

Some loudspeakers were popular because they were sensitive (a useful attribute) and others provided clearer speech (also helpful), but most were characterised by high distortion and a peaky response concentrated around the speech frequencies.

Moving coil (or 'dynamic') loudspeakers completely superseded the earlier types at the end of the decade, because they offered higher acoustic output, lower distortion and a wider, smoother frequency response extending well down into the bass region. Most were economy designs, intended for ordinary re-

A cabinet-model Amplion loudspeaker from the mid 1920's. Cabinets like this could house either multi-folded horn or moving-iron cone speakers, both poor in bass response.

ceivers but, even around 1930, pretentious 'high fidelity' models were available for those who could afford them.

Dynamic loudspeakers intended for use with mains operated receivers were initially *electro-dynamic* types, using soft-iron pole pieces magnetised by a field coil, usually fed from the receiver's own DC power supply. Loudspeakers intended for battery-powered receivers were fitted with permanent magnets which, at the time, were bulky, expensive and not particularly efficient. (Early 'permag' models also gained a reputation in factory and workshop situations for attracting stray metal filings, which were extremely difficult to dislodge once they had found their way into the voice coil air-gap).

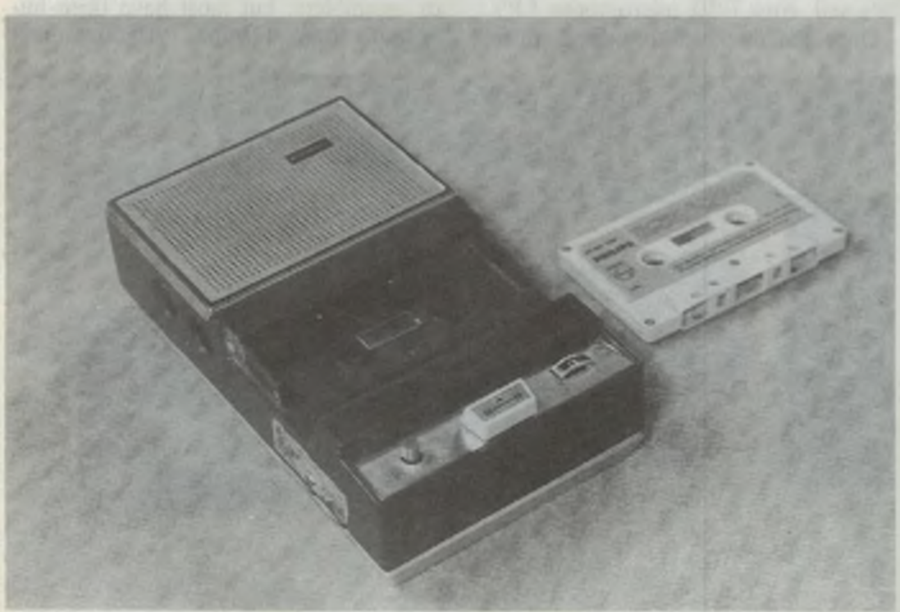
Assisted in no small measure by tariff protection, Australian manufacturers produced most of the general purpose loudspeakers required for local receivers and amplifiers, right up to the 1970s, when the tariff was withdrawn. Some companies, notably Rola, Magnavox (Aust) and AWA also won a useful share of the hifi enthusiast market – but this was dominated, for the most part, by the high profile British and American brands like Goodmans, Wharfedale, Magnavox (USA) and Jensen, with later penetration by KEF, Philips and other European manufacturers.

The period 1930-1988 saw a constantly changing emphasis in the design of hifi drivers and systems, variously attributable to musical, technical and commercial factors, and to the contagious whims of hifi buffs.

First recording of the London Symphony Orchestra and Sir Thomas Beecham on magnetic tape, at the BASF concert hall in 1936.

Seeking extended bass, the early emphasis was on large drivers (typically 29cm dia.) with large magnet structures and heavy cones. Later, in quest of a more balanced overall response, the large cones were variously modified to enhance the mid-range performance. Then caps and/or 'whizzer' cones were added, to boost the top end.

Beyond that again, some manufacturers offered 'tandem' models, with a small tweeter up front and suspended on a bracket within the profile of the main cone. Others topped this with 'concentric' or 'coaxial' designs, featuring a small mid/high range horn radiating through an orifice in the centre pole-piece of the main driver.



The first compact cassette audio tape recorder, released by Philips in 1962-63, shown with a compact cassette alongside. It began a revolution in consumer tape recording.

All of the above were based on an assumption that the total sound should emerge from a single assembly. But encouraged by companies like Wharfedale, the alternative view soon emerged that there was subjective merit in using separate and somewhat dispersed mid-range and high-range drivers, to moderate the constricted 'hole-in-the-wall' illusion of reproduced mono sound.

But this aspect aside, normal practice was to mount large bass drivers on the largest possible baffle, or in the largest possible enclosure to extend downwards the potential bass response. They relied on a high efficiency magnet system and a low impedance drive source to dampen the natural bass resonance, independantly of the baffle arrangement.

This rather accommodating situation ended with the adoption of stereo, and listener insistence on more compact loudspeaker systems – without sacrificing bass response.

The 1960s saw a plethora of suspect 'solutions' to this seeming contradiction, but it was an Australian research project by engineer Neville Thiele (5) that provided the basis for the subsequent design of most compact low-end drivers and enclosures throughout the world, at

The quest for high fidelity sound

least as far as low-end performance is concerned.

Design philosphies affecting other parts of the spectrum have been debated and exploited in Australia, as elsewhere, as diverse as phase control measures to consolidate the stereo image, and multi-driver reflection techniques to disperse it!

While the production of loudspeaker drivers in Australia has been very limited over the past decade, the local construction of wood and chipboard cabinets and enclosures has continued at both professional and hobbyist level, along with the frequancy dividing networks necessary in multiple driver systems. Interestingly enough, while most top-end, limited sale loudspeaker systems are fully imported, a number of highly specified Australian systems are in demand, locally and overseas, including Audiosound, Duntech, Krix, Orpheus and Richter.

Disc recording

Disc recording, as a major enterprise in Australia, dates back to 1926, with the establishment of a studio complex at Homebush, Sydney, by Columbia Graphophone (Aust) Ltd, and managed by the late R.V.Southey. Mergers in the early 1930s brought together names like The Gramophone Co, Columbia, HMV and EMI and saw an expansion from consumer pressings to long-playing broadcast transcriptions for both local and overseas use.

In the subsequent years, other major companies became involved in the recording industry, including Astor, AWA, CBS, Festival, Philips and RCA. Associated with them, or separate from them, has been any number of well equipped sound recording studios. The latest venture in this general area is the ultra-modern Disctronics factory in the Melbourne suburb of Braeside, devoted to the mastering and production of compact discs.

The first electrical phono pickups available to Australian enthusiasts were magnetic adaptor heads which plugged into the tonearms of 78rpm disc phonographs, producing electrical signals which could be fed to the audio system of old-style wireless sets. In most instances, they were more a novelty than an improvement.

In the late 1920s, adaptors were displaced by self-contained magnetic pickups and electrically-driven phono decks, with 'crystal' (piezo-electric) pickups making their appearance in the mid 1930s.

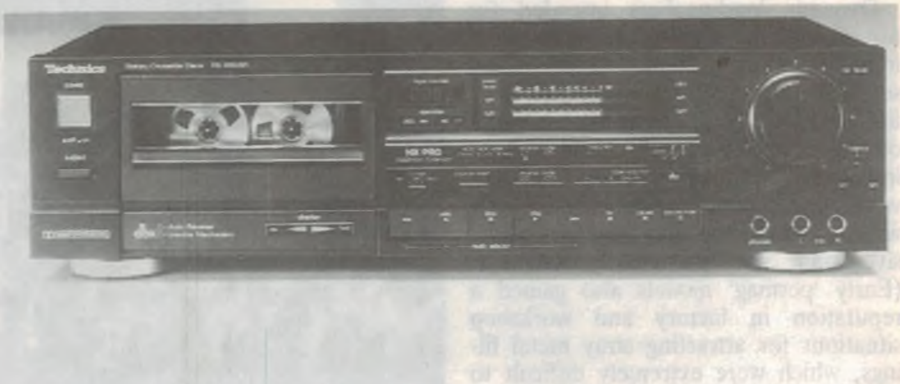
The sound quality available from phono discs was significantly up-graded in the period 1930-50, but only in the face of a dogged determination by major record producers to retain a basic format that had sufficient latent groove energy to drive traditional acoustic reproducers. In effect, it locked them into coarse and obsolete groove geometry, an abrasive (and therefore noisy) shellac formulation to cope with steel needles, high groove-speed and a short 3-4 minutes of playing time per side.

As seen from an Australian perspective, it took companies like Diaphon, AWA, Decca in the UK and CBS in America to step out of line and produce, first, up-graded extended play 78's and, circa 1950, microgroove LP's.

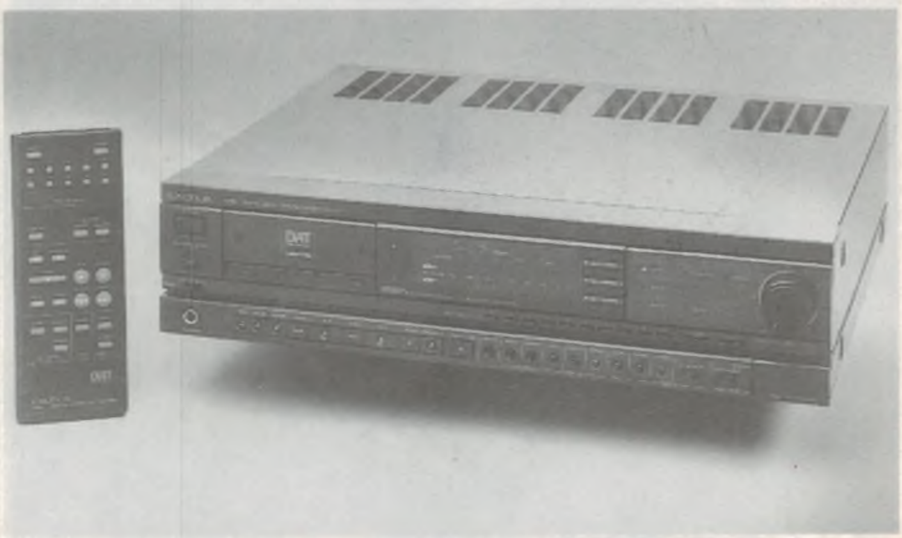
Once the dam was breached, microgroove technology opened the way to vastly improved performance figures from discs, pickups and playing decks alike, together with longer playing time and stereo reproduction. The technology reached a peak in the early 1980s with the use of digital master tapes and direct metal mastering (DMM).

Only in the last few years has the phono system been overtaken by a radically new disc system, the laser-read digital compact disc or 'CD', which offers a quantum leap in measured performance, even if the subjective difference is apparent mainly to young and perceptive ears!

In the area of phono cartridges, pickups and phono decks, a small proportion of the demand has been met, over the years, by Australian manufacturers or assemblers, but most have been imported from Europe, America and



An example of a modern hifi stereo cassette deck, the Technics RS-B608R, illustrating how far this technology has come.



The AIWA XD-001 digital audio tape (DAT) recorder, first demonstrated in Australia last year, showing what may become the 'next generation' of high quality consumer tape recorders – if the current software copyright deadlock is ever resolved.

Heralding the dawn of a new era, Sony's first CD player was released to the Australian audio-hifi fraternity around 1982.

Japan.

As for CD players, virtually all are imported from Japan, other Asian countries, Europe and America. All have performance specifications which ostensibly exceed the limits of aural perception – but arguments continue nevertheless, with promoters and enthusiasts alike claiming that hundreds of extra dollars spent on exotic refinements represent money well spent.

Tape recording

In Ludwigshafen, Germany, in November 1936, the BASF company recorded a concert by Sir Thomas Beecham and the London Philharmonic Orchestra on plastic-based magnetic tape, and proudly demonstrated to him both the equipment and the end result. Despite this, and the fact that the relevant patents were systematically filed in Switzerland and elsewhere, the exciting new technology was virtually ignored outside Germany until it was eventually 'discovered' by the occupying forces following World War II.

In the meantime, discs had continued to dominate the commercial recording scene unopposed, while semi-professionals and hobbyists alike (including this author) had endured the tortuous frustrations of 'direct cut' lacquer-coated aluminium discs and magnetic wire recorders.

Once it was publicised, however, Australian interest in magnetic tape recording was immediate, with Byer Industries, for example, releasing a basic adaptor deck (1952) which could be used in conjunction with a good quality turntable to record and replay normal tape, with quite commendable fidelity. A number of other local companies ventured into full-scale deck production, with varying degrees of success, competing with imported brands both for the domestic market and semi-professional use in schools, etc. Typical brands which come readily to mind include AWA's 'Magictape' series and models by Nova, Ferry, Classic and Magnetic Sound Industries (Aust), not forgetting the professional recorders such as those produced by Byer (subsequently taken over by Rola).

The early demand for tape recorders was such that their future seemed assured, but the confusion that subsequently developed around speeds and formats and the difficulty of handling open reel tape and keeping track of its contents proved too irksome for everyday home listening, especially when compared with LP discs.

Philips answered those objections with the compact tape cassette, released in 1963 and taken up en masse by the Japanese circa 1965. Australian receiver manufacturers were keen enough to include cassette facilities in their new models but, for the most part, they preferred to import rather than manufacture the actual tape mechanism. That attitude was confirmed by the removal of tariff protection in 1972, which saw a flood of imported portable cassette radios.

Since then, self-contained cassette decks have become a standard component in Australian domestic hifi systems, ranging from routine designs to others with all the technical features that money can buy. But virtually all of them are imported from Japan, Asia, Europe and America.

However, just as LP disc technology has recently been superseded by compact discs, so analog tape systems, open reel and cassette alike, may well be challenged by digital tape technology, typified by the new DAT (Digital Audio Tape) recorders. Australian hifi enthusiasts will then have the ability to record and play back audio signals virtually free of added distortion but, again, the chances of the hardware being designed or built in this country are minimal.

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Television, FM broadcasting & Video

Television broadcasting arrived in Australia a little later than in some other countries, but once it did begin in 1956, viewer acceptance brought about almost explosive growth. The conversion to colour in 1975, plus the development of video cassette recorders at about the same time added further impetus, so that today Australian society is at least as 'video-orientated' as any in the world. Initially this was at the expense of FM broadcasting, a mistake that was later remedied...

by NEVILLE WILLIAMS

With pressure mounting in the early 1950s for the establishment of a television service, the Federal Government set up a Royal Commission in 1954 chaired by Sir George Paton (1) to inquire into the whole matter. Based on its report in the following year, and in consulation with the radio industry, the Government decided to establish nation-wide TV broadcasting on a progressive basis, to be administered, along with radio broadcasting, by the then recently formed Australian Broadcasting Control Board (ABCB).

It was duly decided that the system would use the new 625-line CCIR System-B video standard – one of the first countries to do so. It would occupy ten available channels in the VHF spectrum (30-300MHz) which would hopefully accommodate three stations in the capital cities and two stations in strategic provincial centres across the nation. One station in each case would normally be operated by the ABC (Australian Broadcasting Commission).

The first regular TV service to go to air in Australia was launched by TCN-9 in Sydney on September 16, 1957.

By that time, most local receiver manufacturers had set up production facilities for TV sets, with a tacit agreement to concentrate first on 17" (43cm) models, thereby leaving the way clear for a mutually agreed up-market move at a later stage. But Admiral, in particular, had other ideas and opted instead for 21" (53cm) as the preferred size of picture tube, forcing other companies to follow suit.

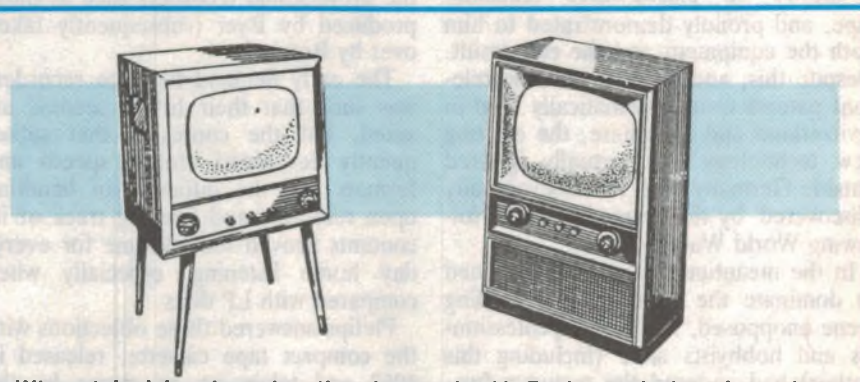
In fact, the pro-rata demand for TV receivers outstripped all expectations, peaking at 430,000 new receivers in 1959/60 – not including a very considerable number of receivers constructed by hobbyists and 'back-yarders'.

As a matter of interest, many hobbyists had been putting aside wartime surplus cathode-ray tubes, of 5-10" (12-24cm) diameter, with the idea of using them in home-made 'junk box' TV sets. Suitable circuit ideas and designs were featured in this magazine, (then called *Radio, Television & Hobbies*) during 1956-7 and quite a few readers shared the novelty of watching the early transmissions on green-screen 5BP1 and/or VCR97 tubes, with picture sizes as large as a playing card or as small as an animated postage stamp!

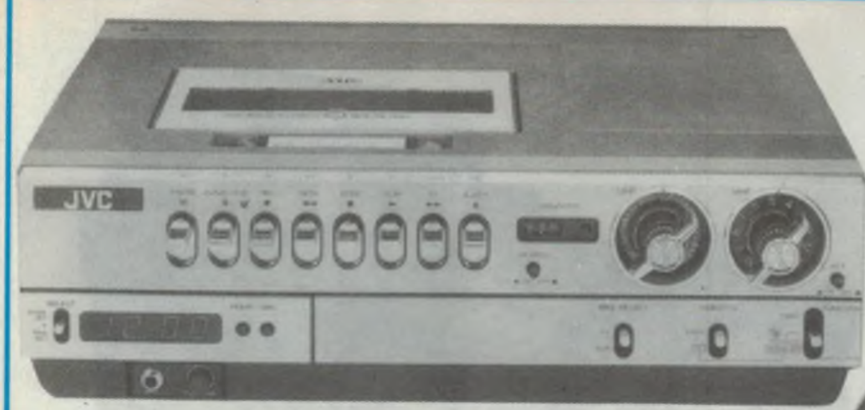
The first full-scale 17" project design to be featured in this country was presented by the author in the magazine during May-August 1957.

With the intense interest in television came public and commercial pressure for additional TV stations – resulting, in 1961, in a further Federal Government decision, based on the industry-inspired Huxley Committee report, to increase the number of UHF channels from 10 to 13 (see Table). The proposal involved shuffling frequencies not already occupied by major stations and re-locating channels 3,4 and 5 within an internationally recognised FM band (88-108MHz).

The move received widespread industry support at the time, because loss of the FM broadcast band, sparsely used in Australia, seemed a modest price to pay to perpetuate the technical convenience of an all-UHF system. It was reckoned



When television broadcasting began in 1957, the majority of receivers used either 17" (43cm) or 21" (53cm) tubes. These had a modest 70-degree deflection angle, making the sets rather bulky. But demand for the receivers outstripped all expectations.



Above is the first domestic VHS colour video cassette recorder, released by JVC in 1976. It was VHS and the Sony Betamax system which triggered the enormous growth of home video systems.

This current-model 'Minivision' personal portable colour TV receiver from Panasonic shows how far television has come since the mid 1950's. It uses a colour LCD screen and features digital tuning over both VHF and UHF channels.

that, if and when the need arose for an FM radio system, this could be set up in the UHF spectrum (300-3000MHz) using new and improved modulation parameters.

At the time it seemed likely that this would bring another benefit: if Australian FM radio were to use a band different from the internationally recognised one, our receivers would be unique, and local manufacturers would therefore be less likely to face overseas competition!

However many saw the takeover of the 88-108MHz band as a short-term expedient and, even though the scheme was implemented, the pro-FM hifi lobby ultimately managed to get the ear of the Whitlam Government, which set up an inquiry into the whole matter under the chairmanship of Sir Francis McLean.

In 1974, based on his report, that Government effectively reversed the 1961 decision, authorising partial deployment of the TV service into the UHF band and progressive reclamation of the FM band for its original purpose.

Lending point to the decision, the ABCB granted licences to the Music Broadcasting Society, forthwith, to set up 2MBS-FM and 3MBS-FM in Sydney and Melbourne respectively. Many other stations followed and, in some cases, have since won an audience share to rival that of the long-established AM broadcasters.

New licences are still being issued by the ABCB as a normal exercise of its authority and as frequencies within the FM band are vacated. As with the AM system, most of the FM receivers and tuners being used nowadays by Australian listeners are imported.

To facilitate re-deployment of TV services into the UHF spectrum, a provi-

AUSTRALIAN TELEVISION CHANNELS

ORIGINAL PLAN: Channel Number	Frequency (MHz)	1961 13-CHANNEL PLAN Channel Number	Frequency (MHz)	Refer Note:
		0	45-52	(a)
1	49-56	1	56-63	
2	63-70	2	63-70	
3	85-92	3	85-92	(b)
4	132-139	4	94-101	(b)
5	139-146	5	101-108	(b)
		5A	137-144	(c)
6	174-181	6	174-181	
7	181-188	7	181-188	
8	188-195	8	188-195	
9	195-202	9	195-202	
10	209-216	10	208-215	
		11	215-222	

MODIFIED VHF/UHF PLAN, 1974-

(a) To be used mainly for translators and RF input to TV receivers from VCRs, &c. Long-term use for major transmitters under review but doubtful.
(b) To be ultimately cleared nationwide to make room for VHF FM sound broadcasting.
(c) To be used mainly for translators. Continued use for major transmitters still under consideration.

UHF Bands & Channels:
Band IV, channels 28-35, 526-582MHz.
Band V, channels 39-69, 603-820MHz.

sion in the 1974 decision was that receivers for colour television, scheduled to begin in the following year, should include facilities for UHF reception – a requirement that later became applicable to VCRs. With most viewers having long since re-equipped for colour, and with the very high market penetration of VCRs, the gradual expansion of TV broadcasting into the UHF band by way of the SBS group of stations and repeaters has progressed fairly smoothly.

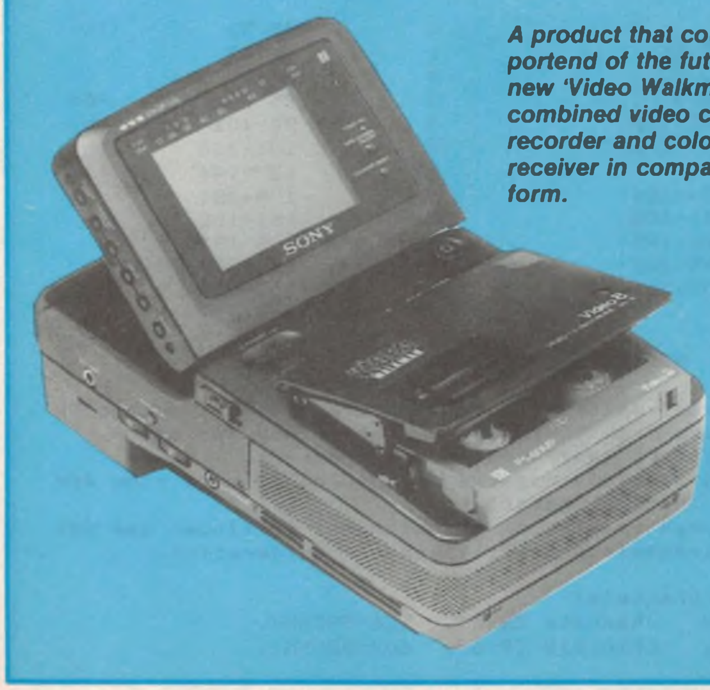
The real moment of truth lies just ahead, as whole areas (e.g., the Illawarra and Newcastle areas in NSW) become totally reliant on new UHF transmitters in place of the long-established VHF services.

As for the manufacture of TV components, picture tubes and receivers, Australian based manufacturers were largely self-sufficient until the mid '70s, operating behind a tariff barrier, as they had done with AM broadcast receivers and radiograms. If space were no object, tales could be told paralleling those already mentioned in connection with radio receivers: early design problems, hold-ups awaiting parts, troublesome components, reliable and unreliable models, and a mobile army of TV servicemen, some of them technically resourceful, others widely reputed to have been 'sharks'.

Australia was fortunate indeed, to the extent that many such problems did not carry over to the colour era, with the failure rate rising as it might otherwise have been expected in direct proportion to the number of components. A few colour receivers did, in fact, turn out to be 'disasters' but, by and large, both local and imported colour receivers benefited enormously from the new solid-state technology.

Currently, nearly all new receivers are either imported or use imported modules, while all VCRs come in from overseas. They still fail on occasions, they still have to be fixed, and fault-finding is becoming progressively more difficult with more complex technology – but reliability is vastly better than once it was.

This late-model Sony video camcorder takes advantage of the company's Video-8 format, together with a CCD image sensor, to achieve high performance in a very compact package. It weighs only a little over 1kg.



A product that could well be a portend of the future: Sony's new 'Video Walkman', a combined video cassette recorder and colour TV receiver in compact personal form.

Currently, imported or otherwise, the technology available to Australian program producers, broadcasters and viewers alike is fully current, ranging from simple community translators, through country and city broadcasters to special nationwide video services through AUSSAT. And, if some viewers have access to fewer channels than they currently would like, the past decade has seen an unparalleled penetration by VCRs, backed by an amazing network of video stores carrying a no less amazing variety of pre-recorded movie fare.

The professional video tape recorder had been developed in 1954 by Ampex in the USA, and smaller helical-scan machines using 1/2" (12.5mm) tape had been produced by various firms – mainly Japanese – in the early 1970s. However these were reel-to-reel machines and were used mainly by schools and colleges for training, proving unsuitable for domestic use.

At about the same time Philips and others had developed domestic video recorders using tape in cassettes. However apart from the Sony 'U-Matic' system, which became used for semi-professional work, these systems made little impact at the domestic level.

Above: Representing the latest development in S-VHS video recorders, this Panasonic model boasts both an infra-red remote control and a bar-code programmer for automatic recording.

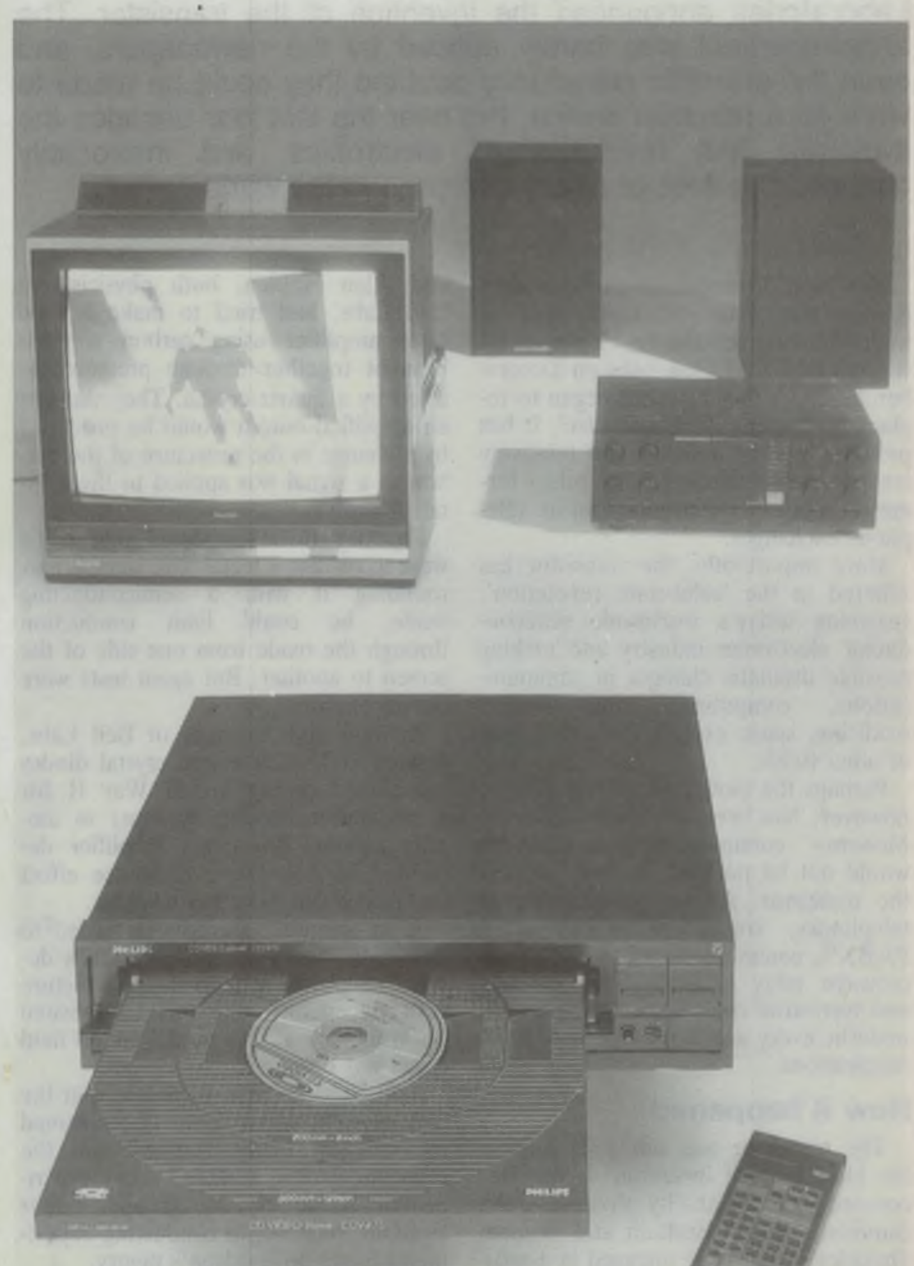
It was not until late 1974, when Sony announced the Betamax VCR, and September 1976, when JVC announced the VHS system (both using 12.5mm-wide tape in relatively compact cassettes) that the domestic VCR began to 'take off'. Since then, sales and usage of these now-ubiquitous machines have probably accelerated in Australia even more rapidly than in most other countries.

Further expansion of 'home video' activities has taken place in the last few years, with the development of compact portable 'camcorders' (camera-recorder combinations), the Sony Video-8 system using 8mm-wide tape in cassettes little larger than a compact audio cassette, and the smaller VHS-C format. And the industry is now poised for development of the next-generation 'enhanced' video formats, such as S-VHS, ED-Beta and High-Band Video 8 – not to mention the possible re-birth of laser-read video discs!

In vivid contrast to the isolation that characterised 1922, the problem for many people in this year of *Electronics Australia's* 50th Anniversary as a monthly, is to shut out the sight and sound of the outside world, for long enough to be quiet and simply sit and think!

References:

1. Fraser, B., *The Macquarie Book of Events*, Macquarie Library, pp. 142-150.
2. Williams, W.N., 'Our 17-inch Television Set', *Radio Television & Hobbies* Vol.19 No.2, May 1957.



Although the first generation of laser-read video discs did not capture the public imagination, Philips and other firms are hoping that the new CD-Video format will be more successful.

50th Anniversary Feature:

The Transistor: 40 years of revolution

Only a little over 40 years ago, on June 30, 1948, Bell Laboratories announced the invention of the transistor. The announcement was hardly noticed by the newspapers, and even the scientific community doubted they could be made to work as a practical device. But over the last four decades the transistor has revolutionised electronics, and irrevocably changed the lives of nearly everyone in the world.

The basic invention of the transistor in many ways inaugurated and continues to define the electronic age. From its invention at AT&T Bell Labs on December 23, 1947, the transistor began to replace the vacuum tube or 'valve'. It has provided a tiny, reliable and relatively inexpensive substitute for the relays formerly used in electromechanical telephone exchanges.

More importantly, the transistor has ushered in the 'solid-state revolution', spawning today's worldwide semiconductor electronics industry and making possible dramatic changes in communications, computing, entertainment, medicine, space exploration and a host of other fields.

Perhaps the most far-reaching impact, however, has been in communications. Modern communications networks would not be possible, in fact, without the transistor. As key components in telephones, computers of all sizes, PABX's, communications satellites, microwave relay systems, and undersea and terrestrial cable systems, transistors underlie every aspect of worldwide communications.

How it happened

The transistor was not a 'bolt from the blue' type of invention. It was discovered at Bell Labs by physicists John Bardeen, Walter Brattain and William Shockley – who were engaged in a project deliberately aimed at finding a solid state replacement for the valve.

Ten years before, William Shockley and Alan Holden, both physicists at Bell Labs, had tried to make a solid state amplifier using carbon contacts brought together through pressure exerted by a quartz crystal. They thought an amplified output would be produced by a change in the resistance of the carbon as a signal was applied to the crystal. It wasn't.

Shockley then speculated that if he were to oxidise a metal wire screen, surrounding it with a semiconducting oxide, he could limit conduction through the oxide from one side of the screen to another. But again tests were not successful.

Another staff member of Bell Labs, Russell Ohl, used silicon crystal diodes (developed during World War II for radar and microwave systems) to amplify signals. But Ohl's amplifier depended on a negative resistance effect and turned out to be too unstable.

After the war, Shockley returned to Bell Labs, and after studying Ohl's device, proposed a field-effect structure with silicon and germanium deposited on insulators. It was tried, but no field effect was observed.

John Bardeen then suggested that the lack of field effect could be explained by charges being trapped on the semiconductor's surface. The experimental leader of the group, Walter Brattain, then began conducting experiments based on Bardeen's theory.

On November 21, 1947, they had their first success. They observed a field effect in an electrolyte in which they had immersed an n-type germanium slice, with a metal point contact on its surface. It was only capable of operating at up to a few hertz, but it was the beginning.

By December 4th, Brattain had successfully repeated the experiments with silicon as the semiconductor. On December 15th they showed that the point contact would reverse the flow of current, and the following day they achieved power amplification.

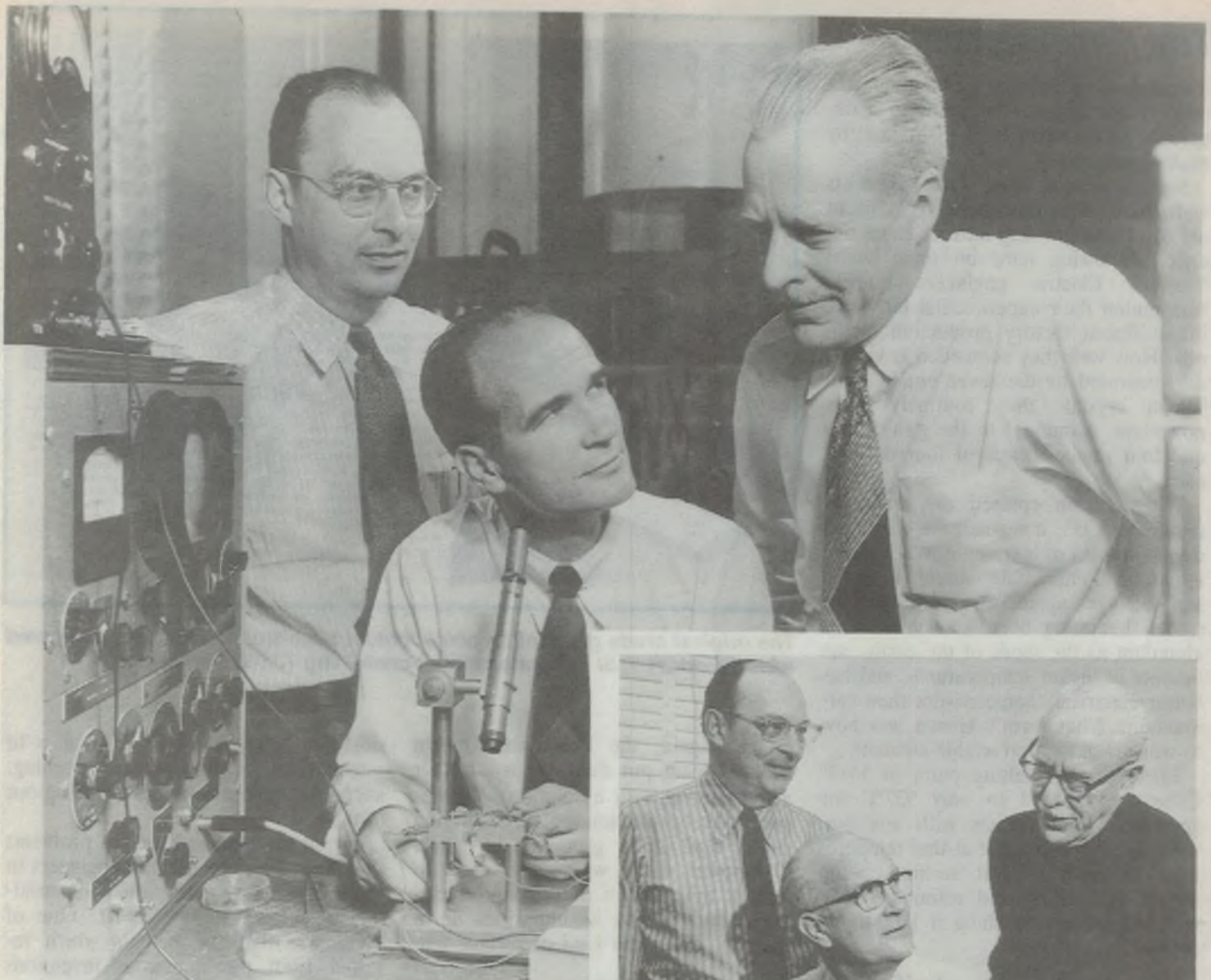
By December 23, 1947, the team had developed what they thought would be a practical device and held a demonstration in which the transistor (then unnamed) demonstrated a power gain of 18. The next day, Christmas Eve, the device was made to oscillate, and they had the device that Bell Labs had asked for.

They had discovered, however, that it was not a field effect device after all; instead, the control electrode was *injecting* the extra carriers, which were flowing into the point contact (collector) and adding to the output current.

It was the experiment of December 23, 1947, for which Bardeen, Brattain and Shockley were awarded the Nobel Prize in 1956.

Shockley continued to refine his theories and by the time the original point-contact transistor patent was applied for on June 17, 1948, he had a working model of the *junction* transistor. A patent for this improved device was applied for the same month.

The transistor owes its name to John Pierce, who was executive director of research communications sciences at Bell Labs in 1948. In a discussion with Brattain, he mentioned that since the point-contact device was the electrical dual of the valve and the most important function of a valve was *transconductance*, the dual for the new device would be transresistance. They had the idea of calling it a 'transfer resistor', then finally settled on 'transistor'.



Into production

About this time, plans were under way to start production on the point-contact device. While it became relatively simple to make one transistor, it was quite another problem to make them in quantity. For no visible reason, transistors made in the same way stubbornly refused to behave in the same fashion. Western Electric, then the manufacturing division of the Bell System, was given the job of finding the answers.

Taken in 1948, the shot above shows (L to R) Bardeen, Shockley and Brattain with the original test setup. The shot at right shows them again in 1973, posing at a reunion.

Part of the problem was the incredibly small dimensions involved in transistor manufacture. Transistor action occurs in areas so infinitesimally small, you can fit thousands of them into the thickness of a sheet of paper. Other dimensions are equally fearsome.

But the real name of the ghost in this story was *contamination*. The purity of the germanium used for transistors had to be several orders of magnitude higher than anything then available. The slightest trace of any unwanted impurity would make a transistor either behave erratically or kill it altogether .

At times, the transistor 'death rate' due to impurities was so high, harried engineers invented a mysterious (and facetious) element called 'deathnium' to explain their difficulties. This ominous, and completely fictitious element will never be found on any chemist's periodic table of elements, but the wry humour it expresses helped Western Electric through some trying times.

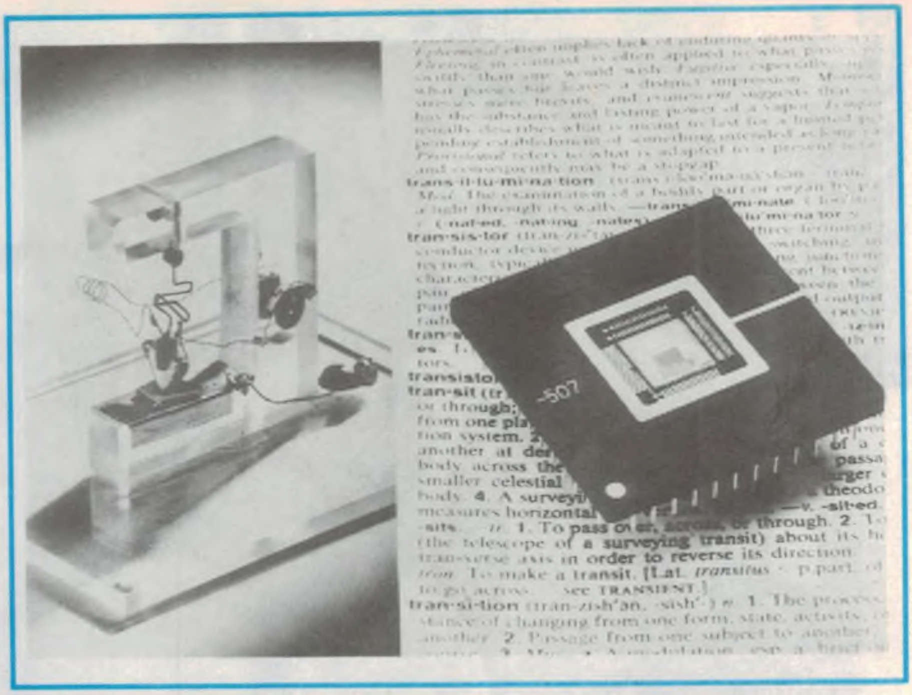
To further complicate the problem, germanium used for transistors had to be cut from single crystals of the element, and nobody had ever grown any before. This meant that, along with new methods for refining raw germanium, methods for growing perfect single crystals had to be developed.

In an example of necessity being mother to invention, Bell Laboratories came up with *zone refining*, an ingenious means of refining germanium and other semiconductor materials to a degree of purity never before obtained by man or nature.

Simultaneously, Bell Labs chemists were hard at work turning the ancient art of crystal growing into an exact science. Following hard on their heels, Western Electric engineers quickly transmuted their experimental lab work into efficient factory production methods. How well they succeeded is vividly demonstrated by the seven-pound giant silicon crystals they routinely grow nowadays, compared to the puny three and four ounce dwarfs of four decades ago.

When silicon entered the transistor picture in 1953, it seemed the whole arduous process of learning how to do the apparently impossible would have to start all over again. The advantages of silicon had long been known: it is as abundant as the sands of the earth, can operate at higher temperatures, and has better electrical characteristics than germanium. What wasn't known was how to work with this intractable element.

Silicon has a melting point of 1417° Celsius (compared to only 937°C for germanium) and reacts with any material used to contain it at that temperature. Impossible as it seemed, some means of melting and refining silicon without actually touching it had to be devised.



The original crude germanium point-contact transistor of 1947, left, compared with a modern VLSI integrated circuit containing 72,000 transistors.

Once again, the Bell Labs-Western Electric team put their heads together and came up with a solution. The answer was a variation of zone refining called *float zone growing*, in which high-power radio waves are used to melt a thin section of silicon rod and move both it and its impurities down the rod. The same kind of surface tension that lets you fill a water glass to just beyond its brim without sloshing, keeps the molten zone from spilling out of the rod.

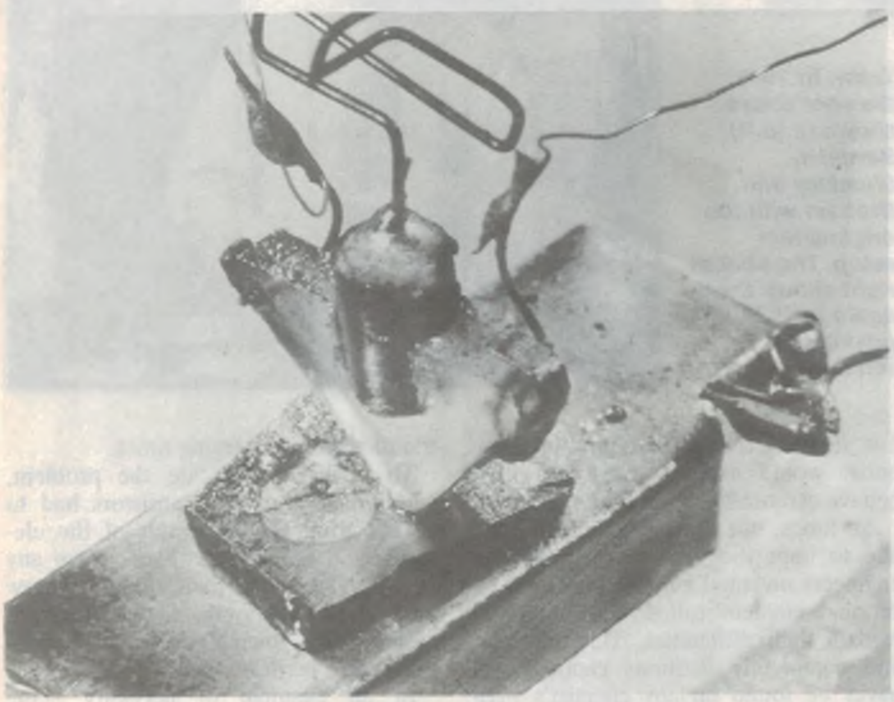
For all the endless series of problems that beset Western Electric engineers in those days, there were some compensating advantages to being first. One of these was that the patents which resulted from the numerous inventions have been an asset in negotiating cross licensing agreements with other companies in the industry.

Realising the potential impact of this technological breakthrough, in April 1952, Western Electric held the world's first transistor manufacturing symposium for its transistor patent licensees. For five very crowded days, representatives of 9 foreign and 25 American companies heard WE engineers reveal the details of what they had learned.

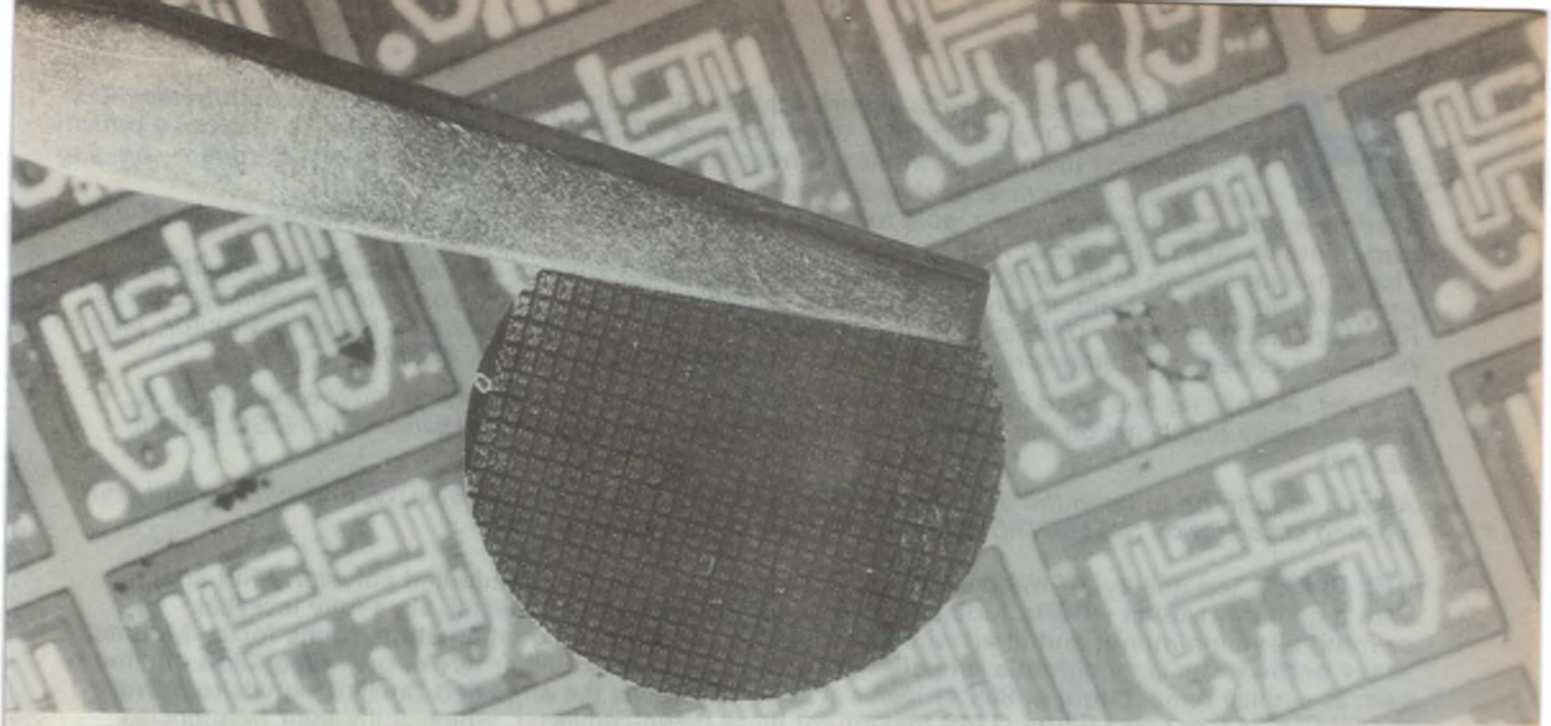
The April symposium led to the publication a few months later of a definitive two-volume work on transistor technology. Between getting out this massive work and getting the transistor into manufacture, many Western Electric engineers became almost strangers to their families.

Today the 1952 symposium is remembered not only for the impetus it gave to worldwide transistor technology, but also for a memorable bit of prophecy.

Western Electric management knew the transistor would never really get anywhere unless it could eventually be



A close-up of the original transistor, which had two pointed gold contacts pressed into the surface of a slice of germanium in close proximity.



A wafer of IC chips, 1973 vintage, with the chip pattern enlarged in the background.

made cheaply. The enormous potential was there and immediately recognizable, but would the mighty midget ever become economically feasible?

On the last day of the symposuim, after four days of discussion that sometimes seemed to make the problems of manufacturing the transistor economically and technologically insurmountable, the question of cost finally came up. One attendee, dazzled and bewildered by the technological demands of making the strange new device, asked the question that had been looming large in everyones' minds — "How much will the darned things cost?"

There was a hushed, almost embarrassed silence. Then Don Wilkes, Western Electric's general manager, boomed out loud and clear, "Twenty-nine cents!"

Wilkes' faith has long since been vindicated. At the time he spoke, transistors were running at between five and ten dollars each, and a good month's production was measured in the hundreds. Today, transistors can be purchased for well under twenty-nine cents, and annual production numbers in the United States alone run into many 1000's of million.

The future

Where do we go from here? In 1986, Bell Labs researchers built a transistor only a millionth of an inch across, in order to explore the physical limits of electronic miniaturisation. The transistor is so small that it can be used to study the behaviour of individual electrons.

Today, Bell Labs is looking to the future by seeking ways to shrink circuitry even further. Bell Labs researchers have designed an experimental optical lithography system that can print features as small as 0.25 micron – nearly four times smaller than the features in current integrated circuits.

Within the next few years, it will almost certainly become possible to produce integrated circuit chips containing as many as 20 million transistors – and possibly more. Electronics has come a long way since that fateful Christmas Eve in 1947.

The inventors now

But what happened to the inventors of the transistor?

Dr Walter Brattain died in a Seattle nursing home on October 13, 1987 at the age of 85 – just two months before the 40th anniversary of the transistor's invention. He had suffered for some time from Alzheimer's disease.

Dr Brattain had retired from Bell Labs in 1967, but continued as a professor and visiting lecturer at his *alma mater*, Whitman College in Walla Walla, Washington. He had also been visiting lecturer at Harvard University, the University of Minnesota and the University of Washington.

Dr John Bardeen, now 80, is still working in the area of theoretical physics, specialising in superconductivity. He left Bell Labs in 1951, to establish the department of engineering at the University of Illinois. His work there on the theory of superconductivity earned him a second Nobel Prize, in 1972.

Dr William Shockley is now 78, and over the years has attracted some controversy with his theories regarding 'human quality'. He has tried to prove that whites are intellectually superior to blacks, and Asians in turn superior to whites.

Of the three, Bardeen and Brattain remained in close contact throughout the years. Bardeen and Shockley hadn't spoken for several decades, until they met briefly at Brattain's funeral.

Back in 1947 when the three scientists created the first working transistor, they could scarcely have imagined the enormous impact that their achievement would have, on the world's electronics industry.

But the late Walter Brattain was more impressed by a simpler use of the transistor. Back in 1972 he explained: "The use of the transistor of which I am the proudest is in the small battery-operated radio. This has made it possible for even the most underprivileged peoples to listen. Nomads in Asia, Indians in the Andes, and natives in Haiti have these radios, and at night they can gather together to listen."

"When I was a boy, the idealists said that the only hope for future civilisation was to see that every child learned to read or write. Even if he never learns to read or write, however, almost every human learns to speak, listen and understand."

"All peoples can now, within limits, listen to what they wish, independent of what dictatorial leaders might want them to hear, and I feel that this will eventually benefit human society."

(Adapted from material supplied by courtesy AT&T/Bell Laboratories)

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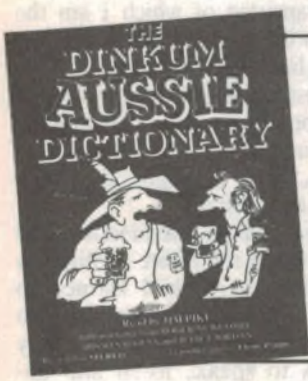
** Together with the above major components, the lucky winner will receive all cabling and connections, plus a free installation of the antenna system within Australia to the value of $1200. This is the average price for installation of an SCI 3.7m antenna system, on a concrete plinth or pad.*



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50th Anniversary Feature:

30 Years of Integrated Circuits

Bearing in mind the special emphasis on history in this issue, it is appropriate to note that one of the most important milestones for modern electronics took place almost exactly 30 years ago. This was the development of the first integrated circuit, at Texas Instruments.

Just over 30 years ago, on September 12, 1958 TI engineer Jack S. Kilby demonstrated the first working integrated circuit (IC). Since Kilby's early invention ICs have become ever-smaller in size, ever-greater in capability and reliability and ever-lower in cost, allowing development of systems once confined to science fiction.

Today, due in part to the invention of the IC and complementing developments, the electronics industry has grown from US$25 billion in 1960 to nearly US$500 billion. This growth is projected to reach $900 billion by the mid-1990s. To accommodate the market's changing needs, the latest ICs have reached densities in the megabit range and require geometries of 1-micron and below.

Kilby's invention

After the transistor became the industry replacement for the vacuum tube, the world searched for a method to connect complex configurations of components inexpensively. Kilby's invention offered a solution to this problem.

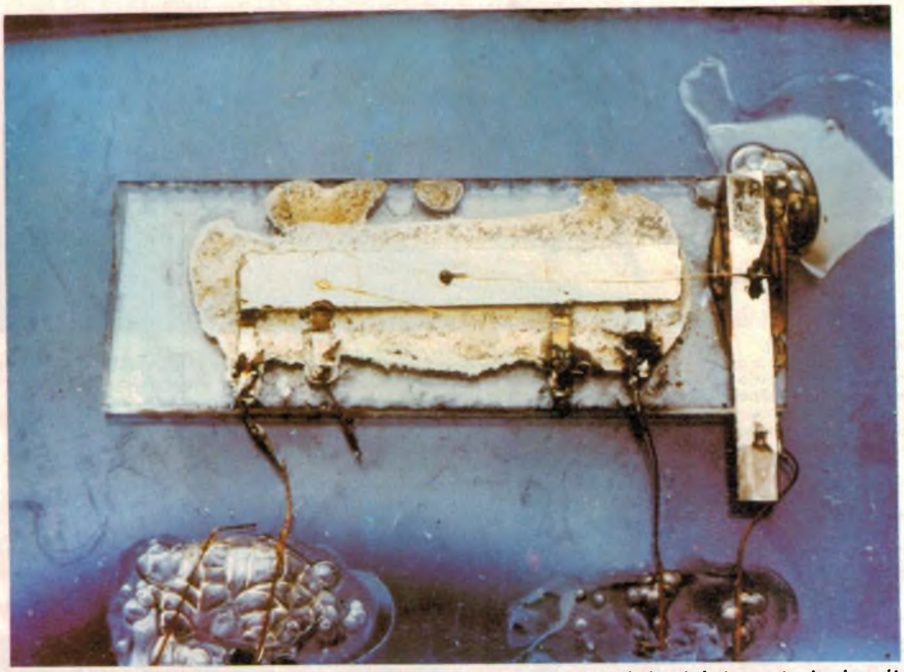
Kilby wrote in an article for IEEE Transactions On Electron Devices in 1976, "The first electronic equipments were composed of a few dozen components and could be readily assembled by hand-soldering techniques. Each component was manufactured separately by a process optimized for the purpose. As electronic equipment became more complex, shortcomings in this procedure began to appear. The cost of the equipment increased more rapidly than component count, and equipment reliability suffered a corresponding decrease."

In May of 1958, Kilby moved to Dallas, Texas, to work for Texas Instruments Semiconductor-Components Division. At that time, TI was exploring ideas in micro-miniaturisation and had a small contract from RCA to develop the Micro-Module concept, and approach entailing creation of discrete components of uniform size and shape, with built-in wiring. The Micro-Modules could then be snapped together to form circuits, eliminating the need for wiring the connections.

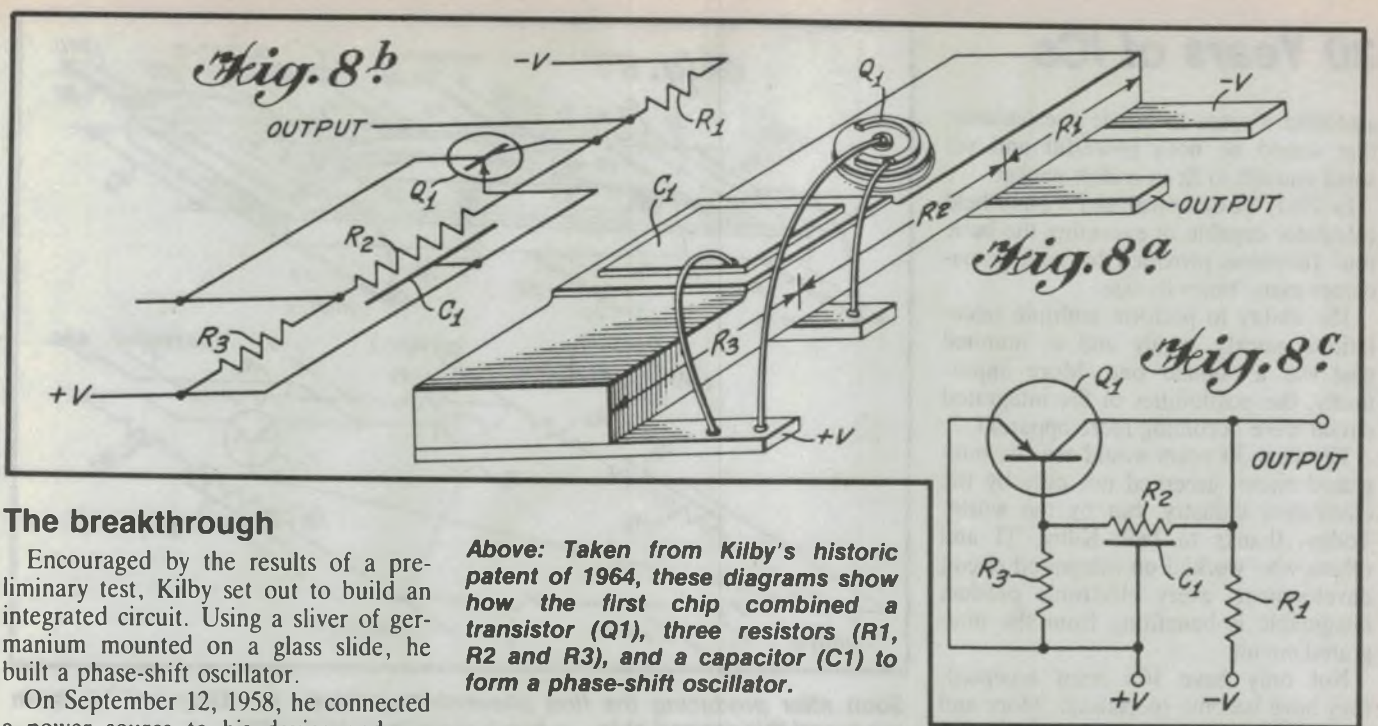
Kilby disliked the Micro-Module approach, because it didn't address the problem of large quantities of individual components in elaborate circuits. As a result, he looked for an alternative.

Rather than reworking conventional concepts of design, Kilby re-examined the problem. He later said, "I began to feel that the only thing that a semiconductor house could make in a cost-effective way was a semiconductor. Further thought led me to the conclusion that semiconductors were all that was really required – that resistors and capacitors (passive devices), in particular, could be made from the same material as the active devices (transistors)."

"I also realised that, since all of the components could be made of a single material, they could also be made *in situ*, interconnected to form a complete circuit. I then quickly sketched a proposed design for a flip-flop using these components. Resistors were provided by bulk effect in the silicon, and capacitors by P-N junctions."



A close-up photo, taken in 1958, of Jack Kilby's original integrated circuit. Although primitive, it was the first working model of a chip combining both active and passive circuit components.



Above: Taken from Kilby's historic patent of 1964, these diagrams show how the first chip combined a transistor (Q1), three resistors (R1, R2 and R3), and a capacitor (C1) to form a phase-shift oscillator.

The breakthrough

Encouraged by the results of a preliminary test, Kilby set out to build an integrated circuit. Using a sliver of germanium mounted on a glass slide, he built a phase-shift oscillator.

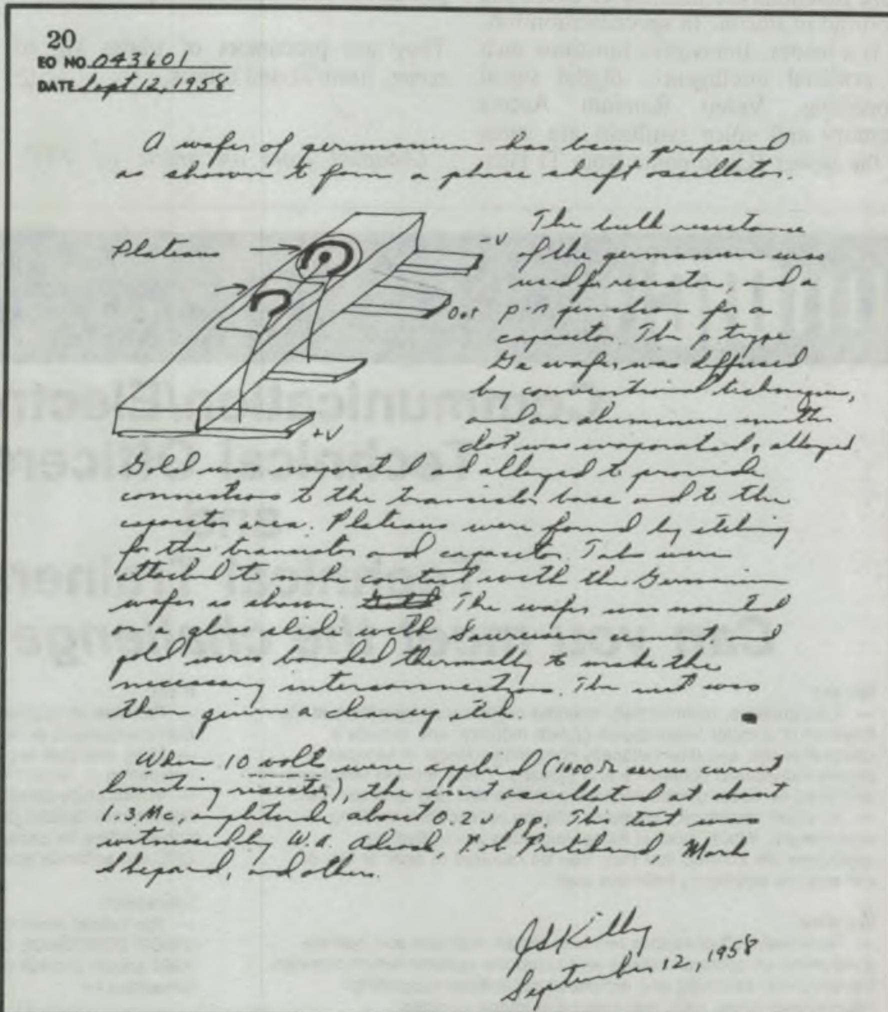
On September 12, 1958, he connected a power source to his device and applied a 10-volt power supply. A sine wave flickered across the screen of a nearby oscilloscope. The age of the integrated circuit had begun, in a Texas Instruments laboratory in Dallas.

Kilby's breakthrough was followed by TI's introduction of the first integrated-circuit computer in 1961. The design team headed by Kilby created this computer for the US Air Forces.

The computer, which was 6.3 cubic inches in volume, weighed 10 ounces and had fewer than 600 parts, proving that integrated circuits were practical and that they had the potential for making a broader impact. Built conventionally, the same device weighed 480 ounces, and had a volume of 1000 cubic inches and consisted of 8500 individual components.

Despite the promise that this new device held for making smaller, more reliable, lighter and less expensive electronic products, it was met initially with lukewarm interest. Designers did not feel comfortable with the idea that their 'components' were too small to see or work with. Long accustomed to hands-on design work in which components could be plugged in and pulled out freely, engineers were unsure how to work with this new invention too small to take apart.

TI's President Patrick Haggerty was convinced of the significance of integrated circuits. Persuading the rest of the industry would require the appropriate demonstration vehicle. With this thought in mind, he challenged Kilby to



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EO NO. 043601
DATE Sept 12, 1958

A wafer of germanium has been prepared as shown to form a phase shift oscillator.

The bulk resistance of the germanium was used for resistors, and a p-n junction for a capacitor. The p type Ge wafer was diffused by conventional techniques, and an aluminum emitter dot was evaporated, alloyed. Gold was evaporated and alloyed to provide connections to the transistor base and to the capacitor area. Plateaus were formed by etching for the transistor and capacitor. Tabs were attached to make contact with the Germanium wafer as shown. The wafer was mounted on a glass slide with Sauereisen cement and gold wires bonded thermally to make the necessary interconnections. The unit was then given a cleaning etch.

When 10 volts were applied (1000 Ω series current limiting resistor), the unit oscillated at about 1.3 Mc, amplitude about 0.2 v pp. This test was witnessed by W.A. Adcock, Bob Pritchard, Mark Shepherd, and others.

JS Kilby
September 12, 1958

A copy of the page from Jack Kilby's laboratory notebook, dated September 12, 1958 – the day the first crude working IC was produced. This is the device shown in the picture opposite.

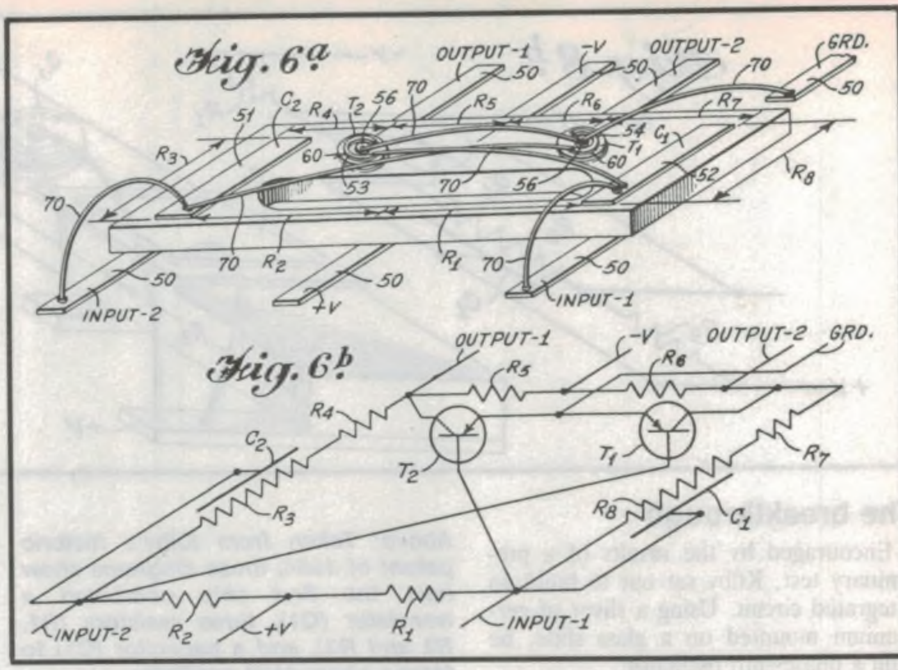
assemble a team to create a calculator, that would be both powerful and yet small enough to fit in a shirt pocket.

In 1967, TI demonstrated a hand-held calculator capable of executing the basic four functions provided by adding machines many times its size.

The ability to perform multiple calculations quickly, easily and at nominal cost was a popular one. More importantly, the possibilities of the integrated circuit were becoming more apparent.

The next 30 years would see the integrated circuit accepted not only by the electronics industry, but by the world. Today, thanks to Jack Kilby, TI and others who worked on integrated circuit development, every electronic product imaginable is benefiting from the integrated circuit.

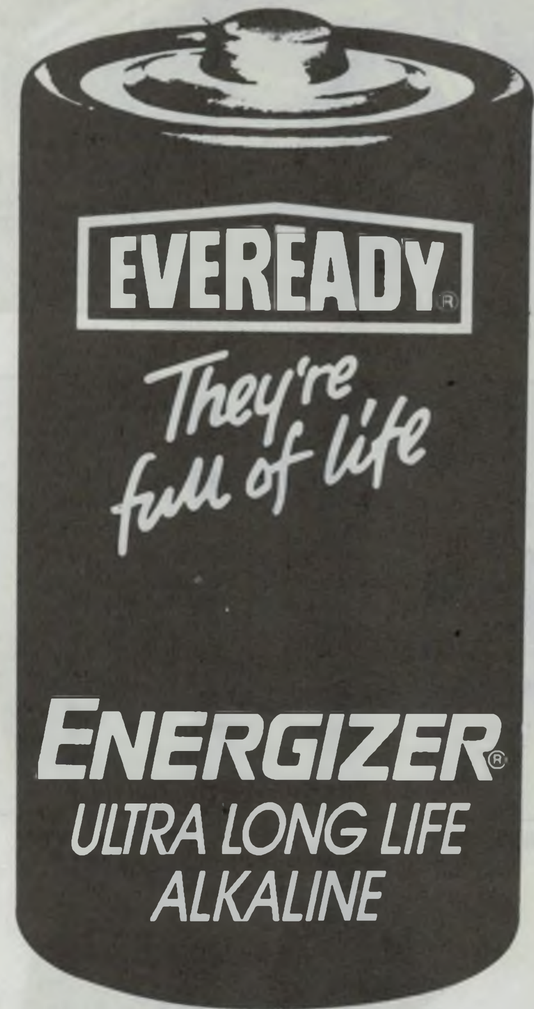
Not only have ICs been accepted, they have become specialised. More and more functions are themselves becoming captured in silicon. In specialisation too, TI is a leader. Innovative functions such as artificial intelligence, digital signal processing, Video Random Access Memory and voice synthesis are some of the newer ICs to come from TI labs.



Soon after producing the first phase-shift oscillator IC, Kilby and his team produced this second chip – a two-transistor multivibrator.

They are precursors of things yet to come, from TI and others.

(Adapted from an article in 'FYI', published by Texas Instruments Semiconductors, by permission. The photograph of the original IC was also kindly provided by Texas Instruments Australia.)



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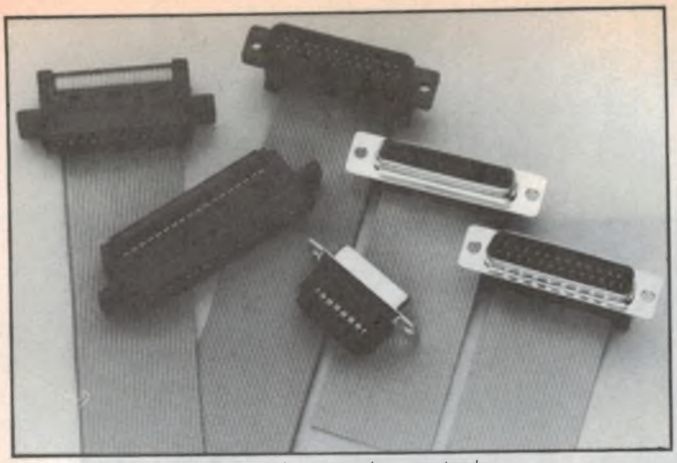
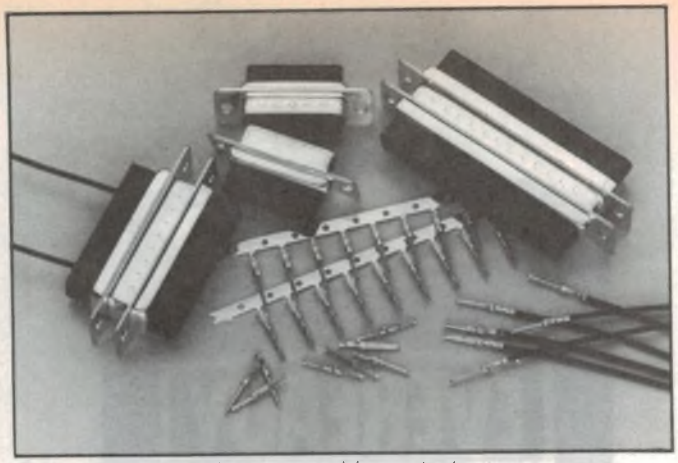
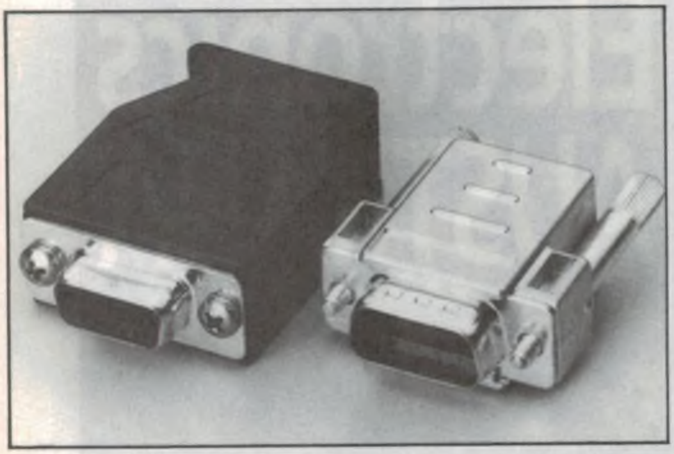


Insulation displacement plugs and receptacles



Connectors with crimp removable contacts



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Special 50th Anniversary Feature:

The story of Australia's early Radio Pioneers

Australian experimenters, engineers and scientists played a very active role during the pioneering days of radio – or 'wireless', as it was then called – earlier this century. The story of their exploits, and of how Australia's radio communications and broadcasting systems were developed, is told in the following series of four historic articles.

Electronics Australia is proud to include these articles in this, our special 50th Anniversary Issue, not the least because they make very interesting reading. The events and achievements which are documented also took place during our own development as the industry's leading publication, which seems to make it particularly appropriate that we pay tribute to them here.

The articles were originally published in our issues for May, June, July and August 1974. They were written by the late Philip Geeves, OAM, FRAHS – one of Australia's best-known popular historians, and probably the man who uncovered more knowledge of Australia's radio history than anyone else, before or since.

Mr Geeves was born in 1917, and after leaving school began a career as a radio announcer – capitalising on his rich and resonant speaking voice. But the war intervened, and he enlisted in the Army. During his 7 years of military service he rose to the rank of Staff Captain, and at the end of the war he spent a year at the University of Virginia in the USA, studying Military Government.

Following the end of the war he returned to Australia, becoming Studio Manager/Programming Director for radio station 2CH in Sydney – operated by AWA Ltd. But his interest in history had been growing, and when the station was about to scrap all of its early equipment, he persuaded AWA's then managing director Sir Lionel Hooke to appoint him company Archivist. It was in this capacity that he wrote the articles you'll find overleaf.

Philip Geeves, OAM, FRAHS

In addition to writing and researching Australia's radio history, Mr Geeves was very active in other areas. He wrote a number of books on the history of various local areas in Sydney, a book on the life of pioneer photographer Harold Cazneaux, and a weekly history column which ran for years in the 'Sydney Morning Herald'. He also wrote some 137 historical feature programs for ABC Radio, and was the ABC's 'Resident Historian' for some years, being heard regularly on the programmes of Caroline Jones and Margaret Throsby.

Philip Geeves was awarded the Order of Australia Medal, for his services to Australian history, and was a Fellow of the Royal Australian Historical Society. He died in 1983. In reprinting his articles here, we gratefully acknowledge the permission and help extended to us by his widow, Mrs Leona Geeves.

Mr Geeves' portrait is by Gervaise Purcell.

For Australia, the invention of radio was to mark the end to an era of isolation. Its introduction to Australia was due mainly to the dedicated efforts of Australia's radio pioneers, for in other quarters it was hampered by slow government thinking, and commercial rivalry. This article, the first of a four part series, describes pioneering radio activities in Australia up to World War 1.

Austr radio

by PHILIP GEEVES, OAM

Fellow of the Royal Australian Historical Society.

It is generally agreed that Australia's earliest wireless experiments took place in the physics laboratory of the University of Sydney during 1888, when Professor Richard Threlfall repeated and demonstrated the work of Heinrich Hertz. Within the next decade, as news of Marconi's pioneering achievements filtered through to Australia, a few enthusiasts began their own experiments using basic apparatus, such as induction coils, spark gaps, Leyden jars and coherers. As might be expected, some of those eager experimenters were Post Office telegraphists, whose technical training equipped them to investigate the novelty of telegraphy without wires.

In Sydney, P. B. Walker, Engineer in Chief of Telegraphs, supervised experiments with a crude spark transmitter in 1899. The equipment was set up in the GPO . . . "at the extreme ends of the building two wires were fixed, one attached to the transmitting machinery and the other to the receiveng apparatus. By touching the handle, the transmitter radiated, through space, electrical waves of very high pressure".

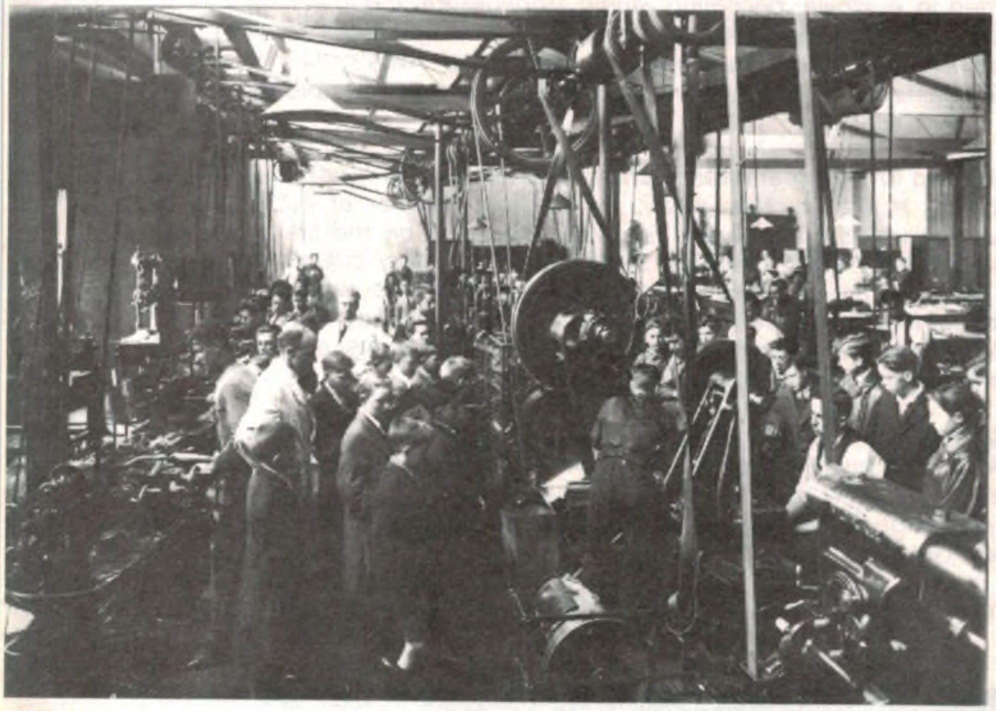
A Victorian telegraph official, H. W. Jenvey, became the leading wireless experimenter of Melbourne and inspired a number of other enthusiasts to emulate him. Walter Jenvey's leadership in the art was demonstrated during the Federation celebrations of 1901, when the Duke and Duchess of York visited Melbourne to open the first Commonwealth Parliament. Jenvey communicated successfully with one of the wireless-equipped escort cruisers and maintained contact over a distance of 17 miles in Port Phillip. This pioneer's son, W. W. Jenvey, became Chief Engineer of OTC.

But not all our early experimenters were telegraph officers. At Henley Beach, Adelaide, in 1899, Professor Bragg's aerial was said to be "the first wireless pole erected in Australia". Sydney's most advanced experimenter was a legal luminary with a passion for science and degrees in both disciplines — Frank H. Leverrier, who began experimenting in 1900, designed and made all his own apparatus, some of which is now in the Museum of Applied Arts and Sciences, Sydney.

Leverrier's first detectors comprised oxidised steel points balanced on polished steel sheet. His unique knowledge of wireless and law gained him important briefs in patent litigation. Leverrier's son, also Frank, has held an amateur licence since 1924 and remains a staunch devotee of radio.

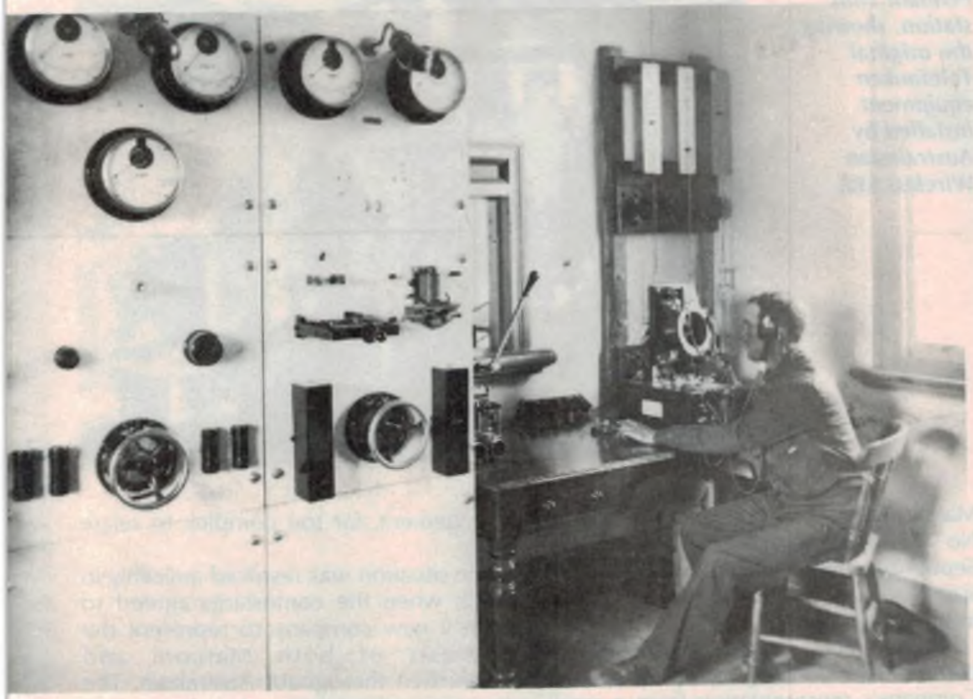
Viewed from Down Under, the success of Marconi's experiments in bridging progressively greater distances with the magic spark seemed to offer a method for linking remote settlements. When Australia's first Prime Minister, Edmund Barton, was asked about a wireless service between Tasmania and the mainland, he replied that the Marconi system had not been applied commercially to such long distances. Nevertheless, the Tasmanian Government continued to explore the possibility of wireless links with King Island and the mainland.

In October 1902 the Marconi Company submitted a proposal to the Commonwealth Government to connect Australia with New Zealand by wireless, but nothing came of the plan. The growing coolness of the British Post Office towards its imagined rival, the Marconi Company, was reflected in official Australian attitudes. Nor was the Government willing to adopt any other system, even though submissions were received from various international wireless firms, including Telefunken, Lodge-Muirhead, De Forest and Shoemaker. Australia's indecision was certainly not helped by the Admiralty recommending the adoption of Marconi's system, the same system which the British Post Office consistently opposed!



The machine shop of AWA's original factory, Sydney. Note the overhead belt drives, and the party of touring schoolboys.

alia's pioneers — 1



An operator tunes the Telefunken receiver at Pennant Hills station, Sydney, 1912.

The Marconi Company was then in a period of vigorous expansion and during 1903 another effort was made to set up a Tasmanian service: for £5000 the company offered to bridge Bass Strait with a wireless link guaranteed to handle the same volume of traffic as a submarine cable. Again the Government took no action. The time was fast approaching for Australia to announce an official wireless policy and the need became even more pressing in 1904, when the Commander of the Australian Naval Station urged the establishment of coastal wireless at strategic points around Australia's long shoreline.

When the British Government legislated to control wireless, the Commonwealth Parliament hastened to do the same. The Wireless Telegraphy Act of 1905 was the result. It gave the Postmaster-General the exclusive right to transmit and receive wireless messages in Australia, and between Australia and other countries or ships at sea, but it also provided for the PMG to grant wireless licences on prescribed terms. Harsh penalties were included for unauthorised use of wireless apparatus.

The Marconi Company was still hopeful that a practical demonstration might stir the Australian Government into adopting wireless so, following personal representations by one of its roving ambassadors, Captain L. E. Walker, the company erected spark stations at Queenscliff, Victoria, and Devonport, Tasmania. In the presence of many VIPs, messages were successfully exchanged between these stations over a distance of almost 200 miles on 12th July, 1906. The Government declined to purchase the stations, but it did agree to include in the parliamentary estimates a sum of £10,000 earmarked for wireless telegraphy.

Although "wireless" remained a profound mystery to most people, each year brought new recruits to the tiny band of enthusiastic experimenters. In 1903, for example, Father Joseph Slattery, science master at St Stanislaus' College, Bathurst, acquired a set of Marconi apparatus and, after a series of familiarisation tests, succeeded in sending messages a distance of several miles – much to the delight of his pupils and the admiration of local citizens. Another early experimenter was Charles Percy Bartholomew of Mosman, Sydney, who built his own station in 1906. Bartholomew later became a director of AWA.

The prolonged inactivity and procrastination which characterised Austalia's early flirtations with wireless ended after the important inter-Imperial Conference held in Melbourne, December 1909, at which the future provision of wireless communications in Australasia and the Pacific Islands was discussed. Australia undertook to build two land stations, one in Sydney and the other near Fremantle, to command the seaward approaches on either side of the continent.

Five tenders were received, the lowest figure of £4150 per station coming from a syndicate of Sydney businessmen trading as Australasian Wireless Limited, a firm which had hurriedly acquired the regional rights to the Telefunken "singing spark" system. The equipment for these 25kW quenched spark stations was shipped from Germany and erected here under the supervision of Telefunken engineers. The modest tender submitted by Australasian Wireless Limited contrasted sharply with the price of £19,020 per station quoted by the Marconi Company, and was eloquent testimony that Australia had become the latest battleground in the incessant commercial "war" between the two principal wireless systems of the day.

The Sydney station was eventually sited at Pennant Hills, while its Western Australian counterpart was built at Applecross. These changes of location cost the Government an additional £4000. The completion of both stations was plagued by vexatious delays, straining relations between Government and contractors. At the outset, the Pennant Hills station was designated POS (later VIS) and Applecross was originally POP (later VIP). The power for each station was supplied by 60HP Gardiner engines driving 500 cycle alternators.

1910 was a landmark year, producing a series of seemingly unconnected events which, as we now know, were to exercise a profound influence on the future development of Australian radio. Father Archibald Shaw, a former PMG telegraphist who had entered the Catholic priesthood, was granted an experimental licence for a station at Randwick, NSW; Australasian Wireless Ltd, successful tenderer for the first two coastal stations, opened experimental station AAA in Sydney which was destined to become Australia's first land station handling commercial traffic; George Augustine Taylor, a man of diverse interests and enthusiasms, formed the Wireless Institute of New South Wales, which had the distinction of being the first organised amateur wireless society in the British Empire and ultimately became a national organisation; Charles Dansie Maclurcan, later to emerge as the doyen of Australian experimenters, built his first telegraphy station on the roof of Sydney's Wentworth Hotel, which his family owned.

The high tension room at the Pennant Hills station, showing the original Telefunken equipment installed by Australasian Wireless Ltd.

1910 was also the year that Ernest Thomas Fisk made his initial visit to Australia as Marconi operator aboard the "Otranto". Finding the rival Telefunken interests firmly entrenched, he returned here the following year as Marconi's resident engineer and for the next three decades remained the dominant figure in Australia's burgeoning electronics industry.

Perceptive observers noticed clouds on the wireless horizon. In England the Marconi Company had resorted to law to protect its patents and obtained an important judgment against the British Radio Telegraph and Telephone Company. Australia's two Government stations were Telefunken installations and despite spirited assertions that the German system did not infringe Marconi's patents, it seemed that the Commonwealth might soon be engaged in litigation.

Politicians found themselves increasingly baffled by technicalities. When Marconi marine operators, in furtherance of the wireless "war" against Germany, refused to handle traffic from Telefunken-equipped ships, politicians assumed that the two systems were incompatible. After Labor Prime Minister Andrew Fisher took office in 1910, he decided to appoint a "wireless expert" to the Postmaster-General's Department.

The man selected for this key role was John Graeme Balsillie, a young Australian who had won recognition for his technical contributions to wireless and had installed stations in Russia, China, and elsewhere. Indeed, the main criticism of Balsillie's appointment was his previous association with the firm which had been found guilty of infringing Marconi's famous "Four Sevens" – Patent No 7777. Balsillie arrived in Australia in September 1911 and promptly began sizing up the fragmented wireless scene in his native land.

During 1911, 24-year-old Ernest Fisk commenced building up the Marconi Company's representation from a small office in Sydney. The sole business of the Australian branch was marine wireless so, after persuading a shipowner to fit Marconi equipment, Fisk would attend to the installation, hire a Post Office telegraphist with a thirst for travel and train the recruit in wireless procedures.

It was in 1911 that an experimental licence was issued to a Sydney schoolboy, Raymond Cottam Allsop, who had absorbed his knowledge from a kindly neighbour in Randwick, "the wireless missionary", Father Shaw. After war service as a marine operator, Allsop came to prominence during the 1920s and remained an honoured figure in Australian electronics until his death in 1972.

Predictably, Balsillie's appointment as the Federal "wireless expert" was viewed with apprehension by the big international firms. Their concern turned to alarm when it became known that, apart from the Telefunken stations at Pennant Hills and Applecross, all future coastal stations would use Balsillie's own circuitry and, moreover, their equipment would be supplied by Father Shaw's Randwick workshop. This bombshell touched off a spate of writs for patent infringement, far too complex to relate here.

The situation was resolved amicably in 1912, when the contestants agreed to form a new company to represent the interests of both Marconi and Telefunken throughout Australasia. The merger company, Amalgamated Wireless (Australasia) Ltd, was inaugurated in Sydney in July 1913 with Fisk as technical manager. Staffed by seasoned wireless men and with access to the patents of the world's leading systems, the firm had a formidable reservoir of technical expertise.

The formation of the company was indeed timely. The heroic role played by wireless in saving life during the "Titanic" disaster of April 1912, focused world attention on the new science. Shipowners hastened to equip their vessels with spark transmitters and adventurous Australian youths flocked to become marine operators. The Marconi School of Wireless, with George Apperley as chief instructor, was organised to train them.

And although no one realised it in 1913, there was an even more compelling reason for Australia to be self-sufficient in wireless. During the coming year a Serbian zealot would murder an Austrian archduke, lighting a powder trail that exploded around the globe. The demands of war would extend the horizons of wireless enormously and affect Australia's future in countless ways.

Aust radio

Realising the strategic value of radio, and as a direct result of the First World War, Australia entered the early 1920s determined to build up an independent radio communications industry. Here the author examines the role played by Australia's radio industry during and after the First World War.

by PHILIP GEEVES, OAM

Fellow of the Royal Australian Historical Society.

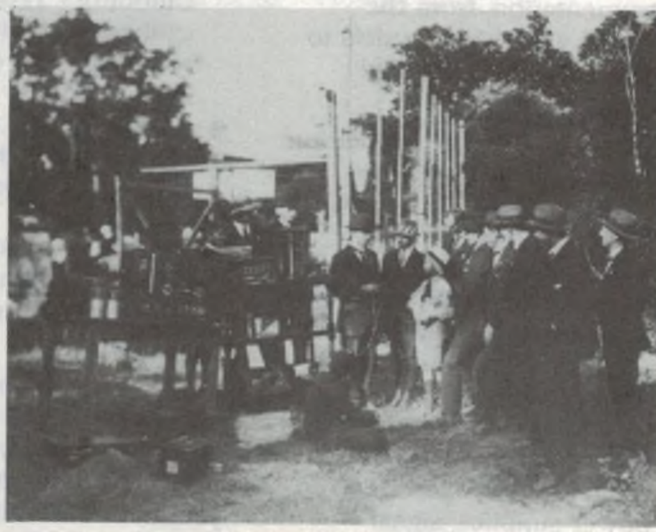
Australia had enjoyed her newly-won nationhood for little more than a decade when, in August 1914, she was suddenly plunged into war. Among the "urgent imperial services" asked of Australia by Great Britain was the task of silencing the powerful radio stations in Germany's Pacific colonies, including New Guinea, which were capable of relaying instructions to naval raiders. At minimal notice, Australia mustered wireless operators and equipment for island outposts, installed a station at Sydney's Garden Island naval base in four days, and set up monitoring posts. This proud chapter of our wireless history deserves to be better known.

At the outbreak of war the Postmaster-General's Department was operating some 20 coastal wireless telegraphy stations around Australia. Apart from the two 25kW quenched spark Telefunken stations at Pennant Hills and Applecross, all the others were 5kW transmitters designed by the Commonwealth "wireless expert", J. G. Balsillie, and manufactured by the Maritime Wireless Company, the corporate offspring of Father Shaw's Randwick workshop. A special feature of Balsillie's spark discharger was that one electrode was shaped like a nozzle, through which air under pressure was blown. By preventing arcing at the spark gap, the system produced clear and easily readable Morse.

At that time most radio amateurs — officially "experimenters" — maintained receiving stations. Only a minority had the requisite knowledge and affluence to own a transmitter, as wireless components were both scarce and expensive. Indeed, most of the advanced amateurs lived in what were then the "establishment" suburbs. The first impact of the war on the experimental fraternity was a directive to dismantle their equipment and deliver it to the nearest post office for impounding. By May 1915 more than 400 licensed and 200 unlicensed experimental stations had been dismantled. It was not until long after the Armistice that amateurs were belatedly freed from wartime restrictions and again permitted to pursue their hobby. By that time radio telephony was already well advanced and, consequently, its novelty soon captivated Australia's experimenters whose ranks had been swollen by an influx of ex-servicemen with wireless experience.

Quite early in the war it became apparent that the management of radio was creating intense rivalry in official circles. The Navy considered that it should have overall control of wartime wireless and when a Post Office operator unwittingly transmitted an uncoded message concerning a troop convoy, this security breach became a cause celebre. During the latter half of 1915, following Australia's numbing losses at Gallipoli, control of wireless telegraphy throughout the nation passed progressively to the Navy. A year later, with the intention of giving governmental wireless its own manufacturing facilities, the Commonwealth purchased Father Shaw's enterprise, the Maritime Wireless Company, for £55,000. Father Shaw died suddenly in curious circumstances shortly after the money was paid over. A subsequent Royal Commission was extremely critical of the whole transaction and resulted in the dismissal of a former Navy Minister and the resignation of a senator, who admitted receiving money from Father Shaw. The Navy's venture into wireless administration had been something less than auspicious.

Australia's only direct links with the great centres of world power were submarine cables, and destruction of these cables by an enemy raider could have isolated the Australian continent. The Marconi Company had proposed the establishment of an "Empire Wireless Chain" before the war but indecision on the part of the British Government had caused the scheme to lapse. During the early part of the war. Australia's coastal stations at Pennant Hills, Applecross and



Left: a facsimile souvenir of the first direct radio messages from Britain in September 1918. Above, the ten valve set used to receive the first messages, at Wahroonga, NSW.

alia's pioneers — 2

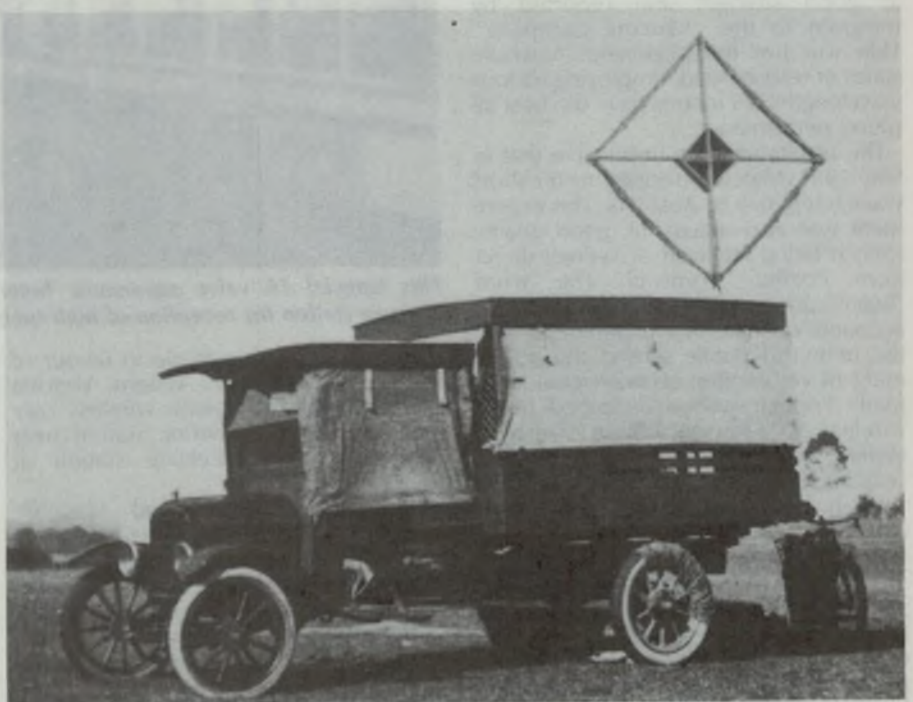
Townsville were equipped with valve receivers for the first time, thus making possible the interception of European transmissions, especially from the powerful German station at Nauen, near Berlin. German propaganda messages were copied daily in Australia.

In 1916, while on a visit to England, Ernest Fisk arranged for a series of test transmissions from the Marconi long wave (14,000 metres) transatlantic station at Caernarvon, Wales. Returning to Australia, Fisk obtained official sanction to use a receiver at his Pymble, NSW, residence, and subsequently at his Wahroonga residence. He succeeded in receiving Caernarvon with a 10 valve set employing plate potentials in excess of 300 volts although, as he later wrote, "at that time it was generally considered that no more than three valves could be used in cascade."

After months of experiments, with increasingly better results, Fisk arranged for Caernarvon to transmit special messages addressed to Australia by Prime Minister "Billy" Hughes and Navy Minister Sir Joseph Cook, who had just returned to London from the battlefront. That historic exchange of messages in September 1918 established the practicability of direct wireless communication between Australia and Britain. The achievement also made a profound impression on Hughes, who was later responsible for Australia's decision to create her own global communications links.

At the Imperial Conference of 1921 Hughes informed Britain with characteristic vigour that Australia was not prepared to settle for anything less than a direct wireless link with England. Rejecting a plan submitted by a prestigious British committee for a relay scheme, which would have left Australia dangling at the end of a fragile radio chain passing through countries of dubious stability, the Commonwealth Government commissioned Amalgamated Wireless to set up a direct service to England and, as an expression of faith in the future of radio, acquired a major equity in the company, a partnership that endured for almost 30 years. That same 1922 agreement empowered AWA to take over the operation of coastal radio stations.

At that time, the prevailing technique for long distance transmission was essentially a combination of high power and long wavelengths. The super station planned for Australia's transocean service was to have been of 1000 kilowatts, with a huge antenna system supported on 20 steel masts, 240m high. The capital cost of such a station was considerable and, as Marconi veterans still recall, the atmosphere around these stations was rather eerie; birds or cats seldom ventured near a high power station, where the air fairly crackled with radio frequency during transmission.



Ford van out-fitted by AWA as a mobile radio laboratory, used for testing reception at various sites considered for the long wave transocean service.

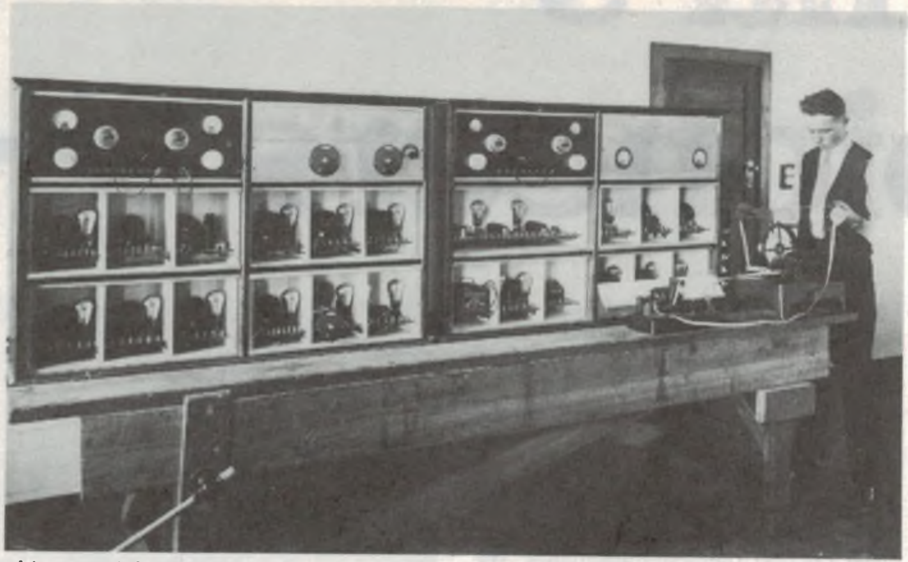
To obtain reliable data on reception from Europe, AWA established an experimental monitoring station at Koo-wee-rup, Victoria, in 1921. A puzzling phenomenon soon became apparent. Two daily reception peaks were noted, but the reason was not understood until a rotatable loop aerial revealed that signals from European stations were following the great circle route of maximum darkness. This was confirmed independently by two Marconi engineers who visited Koo-wee-rup in 1922. Later that year, AWA outfitted a Ford van as a mobile laboratory to explore possible sites in New South Wales for the proposed high power station. Locations examined included Campbelltown, Mulgoa, Mount Victoria, Richmond, Singleton and Maitland. Results obtained were very similar, but slightly inferior, to those at Koo-wee-rup.

At these field investigations were proceeding, no one in Australia suspected that the future course of global communication would soon be decided by Marconi's renewed interest in the behaviour of short waves. Marconi himself was surprised at the distances achieved by short wave transmissions when his principal assistants, Franklin and Round, succeeded in designing transmitters using thermionic valves and special reflector antennas at wavelengths below 100 metres. For obvious reasons, these Marconi discoveries were kept "under wraps", so it was with considerable astonishment that in February 1924 AWA engineers read a cable from Marconi asking them to listen on 90 metres for a station in Cornwall, call sign 2YT. That message was to become the death sentence of Australia's planned transocean wireless service and of Britain's entire scheme for a long wave relay chain.

There was not a set in Australia capable of receiving 90 metres, so AWA built two immediately, installing them at Willoughby and Vaucluse. One of the engineers involved, Eric Burbury, recalls . . . "to our surprise, at 5.30 the following morning signals were received at good strength and reported by telegram to the Marconi Company". That was just the beginning. A whole series of tests ensued, employing various wavelengths: 25 metres gave the best all round performance.

The results were so impressive that in May 1924, Marconi decided to try short wave telephony to Australia. This experiment was also successful, good quality speech being received at Sydney direct from Poldhu, Cornwall. The word "beam" appeared increasingly in press accounts of Marconi's experiments and the bemused public sensed the attainment of yet another technological landmark. Popular writers described beam wireless as "a narrow ribbon of energy girdling the earth like an invisible searchlight".

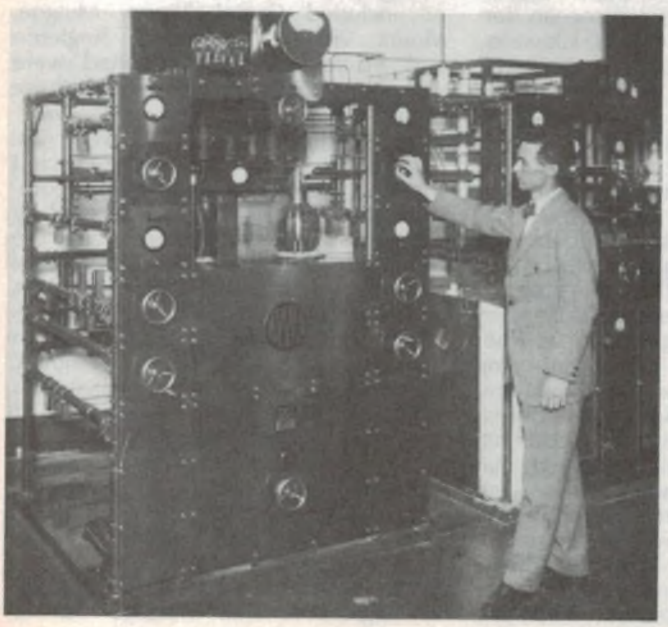
Yet the discovery of beam propagation created a fine dilemma for the Marconi Company, as well as for the governments with which it was dealing. The beam was still experimental, so no one could really be sure that the results obtained were not merely freakish propagation effects. In Australia, a veteran Marconi engineer, Harold Drake Richmond, was already busy on preparatory work for the long wave station, but the beam breakthrough put the expensive high power scheme into abeyance. After some agonising soul-searching, the crucial decision was made in favour of the short wave beam system. Victoria became Australia's beam wireless centre, with the transmitting station near Ballan and the receiving station at Rockbank.



This 'special 16 valve supersonic heterodyne receiver' was used at AWA's La Perouse station for reception of high speed morse from Melbourne in the '20s.

The service to England was inaugurated in April 1927. The result was a triumph and the beam rapidly became the world's trusted messenger. Indeed, its speed and economy soon created a serious situation for the cable companies, but that is another story altogether.

The year 1927 proved to be a vintage year for Australia's growing international outreach. In September, AWA's 20kW experimental short wave (28.5 metres) transmitter at Pennant Hills launched Empire broadcasting with an ambitious presentation by Australian artists and notables. The program was intercepted by the BBC and re-broadcast to millions throughout Britain. Before the year ended, a total of five global programs had been transmitted in this way, and Australia's characteristic accent, as well as the kookaburra's laugh, were familiar in many countries long before the BBC established Empire broadcasting. Much of the credit for VK2ME's successes belongs to veteran AWA engineer, S. M. Newman.



AWA engineer Sydney Newman with the company's experimental 20kW shortwave transmitter, Pennant Hills, 1928.

Following the spectacular success of beam wireless, it was inevitable that international duplex telephony would be the next refinement, and after considerable experimentation it became a reality for Australia in 1928. VK2ME, the powerful "maid-of-all work", was again pressed into service. On October 31, 1928, a select group of VIPs and pressmen gathered at AWA's Sydney office to exchange greetings with confreres in other countries, merely by speaking into a domestic telephone. And although male voices dominated those tests, it should be mentioned that Mrs Albert Deane, the American wife of an Australian-born film executive, had the distinction of being the first woman in the United States to converse with Australia by radio telephone. The regular radiophone service to England was opened with due ceremony on April 30, 1930.

The next logical step was a facsimile service, a facility with many applications, including news photographs, cartoons, fashion sketches and fingerprints. The first experimental essays in the genre shuttled between England and Australia in 1929, but it was not until October 1934 that AWA opened a fully-fledged picturegram service. Among the earliest

Continued on page 58

World War I created a group of experienced radio operators who were to have a profound experience on Australia's fledgling radio industry during the next decade. This article, the third of a four part series, highlights the work of the amateur radio movement during the 1920s and sketches the origins of our broadcasting system.

Australia's radio pioneers – 3

by PHILIP GEEVES, OAM
Fellow of the Royal Australian Historical Society.

World War I made unprecedented demands on scientists, hastening the development of the triode valve and its offspring, radio telephony. When the war ended it was clear that vacuum tubes would dominate the future of radio. Another byproduct of the war was a sizeable contingent of experienced radio men, veteran operators from the armed forces and the mercantile marine, some of whom had squeezed more adventure into a few years than most men know in a lifetime. That happy breed included the past doyen of our electronics industry, the late Sir Lionel Hooke, who after serving as wireless operator to Shackleton's 1913/4 polar expedition, donned naval uniform and saw plenty of action in the ensuing years.

The hard school of war produced a generation of operators who had a genius for improvisation and "could read Morse in their sleep, even through a welter of static," the sort of rugged individualists who, before the war, had carried their own crystal receivers to supplement the regulation shipboard "Maggie" – Marconi's clockwork magnetic detector. Later they acquired their own valve receivers and used them wherever they went.

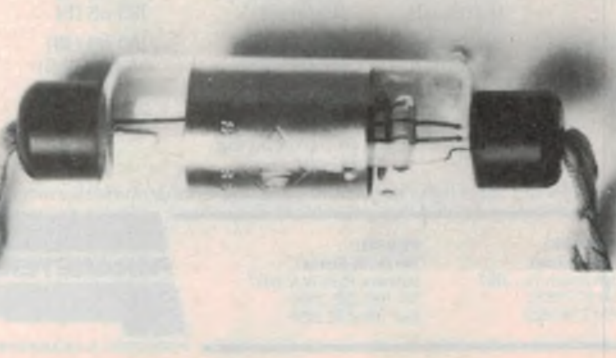
On returning to Australia for demobilisation, many operators brought with them a precious triode valve swathed in cotton wool, because men of that generation never forgot the thrill of their first exposure to radio telephony. Harry de Dassel remembers hearing a 1916 transmission of speech and music from San Francisco when he was operator aboard the "Moana" . . . "the captain swore it was the ships' engineers playing a practical joke."

Early in 1919, AWA decided to test the local potentialities of radio telephony. First it was necessary to build a transmitter, a task assigned to William Bostock, a decorated war veteran who subsequently rejoined the RAAF and became an Air Vice Marshal. Bostock's little transmitter used a single Marconi Q valve. One of the project engineers, Eric Burbury, recalls . . . "the normal anode voltage was about 40, but we gave it 240 volts and hooked it up into an oscillatory circuit. The anode glowed a bright cherry red and the valve radiated quite a bit of power." When tested in coastal vessels, this transmitter amazed the monitoring team by sending clear speech to Sydney from as far south as Gabo Island.

Radio telephony was given its first public demonstration on August 13, 1919, when Ernest Fisk addressed the Royal Society of New South Wales, ending his lecture with a recording of the National Anthem played on a hand-wound gramophone five city blocks away. The tiny transmitter used in the coastal tests was again pressed into service, feeding a T aerial on the roof of "Wireless House." As no loudspeakers were available, a number of Baldwin earphones, hastily fitted with tin horns, were strung along the ceiling of the lecture hall. Everything worked splendidly. For the first time in history an Australian audience stood to attention as a recorded orchestra played the National Anthem by radio. Perhaps the sharpest response came from the Government, which promptly amended the Wireless Telegraphy Act to give the Commonwealth control of radio telephony.

The next step was to convince Australia's lawmakers of radio's capability. Two Marconi 500W speech transmitters were imported from England and one was installed at the Middle Brighton home of AWA's Melbourne Manager, Lionel Hooke. On October 13, 1920, a distinguished audience of parliamentarians and their guests crowded Queen's Hall and listened in awed silence to an entire program from Hooke's drawing room, the first

* Philip Geeves has been awarded the Order of Australia Medal for services in the field of Australian history.



Facing page: the earliest known photograph of an Australian broadcast –2FC's studio in 1924 with Horace Keats at the piano. This page, top: 2FC's original 5KW transmitter. Centre photograph shows a corner of the transmitter hall at AWA's Pennant Hills radio centre, 1927. Bottom: Australia's first locally made valve, the AWA 'Expanse B' of 1920, is now a valuable collector's item.

Australian broadcast to feature a live artist. Some astute politicians quickly sensed radio's value for dispelling the isolation of outback settlers.

More than a year after the war ended, wireless was still under Navy control and amateur radio was a wasteland. Nor surprisingly, there was mounting pressure for the PMG to take it over. Faced with this loss of authority, the Navy complained that any change in the status quo could result in naval dispositions beconing "known to the enemy at the outbreak of the next war." Despite these protestations, the Postmaster General resumed control of wireless and the amateur fraternity set about exploring the applications of the triode valve. Australian valve manufacture commenced in 1920, when AWA began making the double filament Expanse B. A "soft" valve, its performance improved measurably when the first filament burned out, thus increasing the vacuum. David Wyles was in charge of the Expanse B project, assisted by chemist Wallace McSkimming.

As the amateur movement gained momentum, many electrical traders began stocking radio components as a sideline and dispensing advice to experimenters. Within a few years some of those traders helped to launch broadcasting. The hobby, incidentally, was not entirely a masculine preserve because Sydney could boast a lady wireless dealer, Miss F. V. Wallace, who was a licensed electrician.

Early in 1921 AWA, using a 500W Marconi transmitter, initiated weekly broadcasts of recorded music for Melbourne experimenters. For a time Sydney Newman ran this "concert service" from his suburban home on 1100, and subsequently 400 metres, using the call letters 3ME. The duration of each concert was about an hour, after which the energising current began overheating the carbon microphone. One wonders if this was the origin of announcers' hoary jokes about slaving over a hot microphone!

A similar service was later provided for Sydney's amateurs from a makeshift studio in AWA's Knox Street factory. It was conducted by Alton Vipan, whose long experience in wireless included being rescued from the torpedoed "Aparima," still wearing his operator's headphones.

Real world signal components

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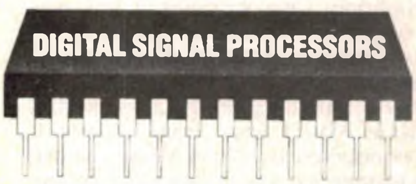

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Australia's radio pioneers

There was a growing demand, especially among experimenters, for the introduction of broadcasting. The United States was the clear leader, with conservative Britain watching to see what mistakes the Americans made. Australia was blandly content to follow Mother England. Meanwhile, radio telephony demonstrations continued to introduce many people to the medium. Probably the most ambitious broadcast of that era was on March 31, 1922, when Lionel Hooke transmitted a program by top professional artists from the stage of Her Majesty's Theatre, Melbourne, for the entertainment of convalescent ex-servicemen.

Licensed amateurs were rapidly becoming a potent force – Culliver and Howden in Melbourne, Maclurcan and Pike in Sydney, Hume in Adelaide, McDowell in Brisbane and Coxon in Perth. Charles Maclurcan was Australia's acknowledged pacesetter. This pre-war pioneer of spark transmission was converted to radio telephony by C. V. Stevenson, a Sydney electrical trader and the original licensee of 2UE. Maclurcan's station at Strathfield, 2CH, enjoyed a far-flung audience for its regular Sunday night gramaphone concerts, which were advertised in the press. Perhaps Maclurcan's most memorable coup was a broadcast by musical comedy star, Josie Melville.

Other leading amateurs of that period included Ray Allsop, R. R. (Jack) Davis, Oswald Mingay, Otto Sandel and Len Schultz. Sandel was an innovator, as the output of his station 2UW proved, and Schultz quickly graduated to professionalism by helping to build two commercial stations, 2KY and 2GB. He became chief engineer of the latter. The amateur fraternity achieved further recognition in August, 1922, when another experimenter, W. J. Maclardy, established "Wireless Weekly," the first regular radio journal in the southern hemisphere. In the second issue Maclardy trumpeted . . . "wireless telephony is now out of its experimental stages and it is time the authorities came to realise this." The active campaigning for broadcasting was hotting up.

Oswald Mingay, secretary of the Wireless Institute, organised Australia's first radio exhibition in September, 1922, at a Sydney church hall. The function enjoyed a vice-regal opening and gave a host of curious visitors their first audition of radio music.

Other interesting developments of that period were radio clubs, where young men of modest means could pool their skills and resources to build club sets and spend their evenings logging reception of amateur transmissions. By September, 1923, no less than 37 of these clubs were flourishing in New South Wales alone.

Despite endless talk about broadcasting, officialdom seemed in no hurry to introduce it. Someone had to take the initiative. Documents of that era show that AWA served the first volley on November 1, 1922, by formally applying to establish stations. Thereupon the Government issued revised wireless regulations creating a new licence category – "Broadcasting Stations."

The origins of our broadcasting system were publicised widely during the 1973 golden jubilee, so most readers probably know that Australian broadcasting was launched with "sealed sets." In addition to purchasing a Government licence, listeners were required to subscribe to a program service of their own choice, their sets being sealed by the PMG's Department to receive only the nominated stations. Four stations in three States commenced operation under this scheme – 2SB (later 2BL) and 2FC in Sydney, 3AR in Melbourne and 6WF in Perth. The sealed set was short lived. A mere 1400 listeners throughout Australia bought licences, although innumerable others, including a small army of artful schoolboys, built "open sets" and listened to whatever took their fancy.

A change was overdue and in July, 1924, new broadcasting regulations created two distinct categories of stations, A Class and B Class. Payment of a licence fee permitted the public to listen without restriction, and so Australia's dual broadcasting system began. A number of advanced experimenters acquired B Class licences and those with a flair for show business soon made their presence felt. Otto Sandel, for instance, demonstrated considerable resource in his conduct of 2UW and even broadcast the first political programs.

Continued on page 58

At left, Charles Maclurcan, Australia's acknowledged pacesetter in amateur radio in the 1920's. Above: Eric Burbury shown testing components in the AWA laboratory, 1924.

The Radio Super was very popular in the 1920s, chiefly because it needed no outside antenna.

The late 1920s to World War II proved to be the golden era of radio experimentation and home construction in Australia. In this, the final article of our four part series, the author looks at this era, and discusses the audio revolution that took place during this period and the introduction of stereo sound reproduction and experimental television.

by PHILIP GEEVES, OAM
Fellow of the Royal Australian Historical Society.

Australia's radio pioneers — 4

Most Australian families of the 1920s heard their first broadcasts on a crystal set. It was a modest investment and needed no batteries, yet it opened the door to a new wonderland. More affluent, or trendy, people often began with a valve set, perhaps even a multivalve receiver capable of driving a loudspeaker. These sets, with tuned RF stages on breadboard layouts mounted in coffin-like cabinets, enabled their owners to demonstrate the occult art of "tuning" for the benefit of wide-eyed friends. A large outdoor antenna was the distinctive hallmark of a radio home, at least until the first prosecutions of unlicensed listeners, when "there was a rush, not towards the licence counter of the GPO, but to get the backyard aerial down before the postman appeared the next morning."

One of the chief disabilities of early broadcasting was poor reproduction of recorded music. Because small synchronous or induction motors and electro-magnetic pickups had not been perfected, a spring-driven gramophone did duty as a studio record player: The vibrations of the heavy tone-arm were magnified by the gramophone horn and picked up by a carbon microphone. Discs were still made by the original acoustic process, their restricted dynamic range suggesting that all vocalists were singing at the end of a tunnel. The complex tonal patterns of keyboard instruments defied faithful reproduction from acoustic recordings. Consequently many broadcasters relied on the pianola as a musical reproducer, which anyone with two feet could play like a virtuoso.

The invention of electrical recording changed all that. The vastly improved frequency response of the new discs turned the gramophone into something of a vogue, prompting a noted Australian composer to comment on "the disconcerting popularity of music". The new process coincided with the introduction of dynamic cone speakers, so it was only a short step to electronic reproduction, with the output of a pickup feeding into an audio amplifier.

The first pickups used in Australia were heavy devices, with magnets and armatures in full view. To avoid distortion, announcers changed needles after each record. Although this was an exciting period, it meant endless frustrations for professional radio men. Improvements in valve performance and amplifier design caused broadcasters to invest substantial capital in new audio equipment, but listeners with outmoded receivers could not enjoy the enhanced sound, or even notice it.

The new breed of "wireless addicts" preferred to build their own receivers. Radio magazines were largely responsible for the home construction craze, which gained momentum during the 1920s. They printed illustrated articles showing how to build receivers of every genre, explained circuit diagrams and even ran courses in simplified electrical theory. When technical editors published constructional details of popular models, radio dealers offered kits to home hobbyists. Regular radio exhibitions and amateur displays allowed laymen to study receiver layout and wiring techniques at close quarters. Most sets were battery operated until 1928, but increasing availability of domestic electricity produced the battery eliminator, which freed experimenters from the replacement of expensive B batteries and culminated in the triumph of the 1920s: the all-electric receiver.

The development of radio owed much to engineers who never lost the lively enthusiasms of their amateur days and, in fact, a number of professionals devoted their spare time to ham radio, thus enjoying the best of both worlds. Ray Allsop, who in 1925 became chief engineer of 2BL, was one of them. He relished the challenge of DX communication and allowed the general public to hear the results. In February 1925 Allsop's experimental station, 2YG, was heard in Europe on 80 metres. That same month he intercepted a shortwave test transmission from KDKA, Pittsburgh, the world's first broadcasting station, and relayed the program over 2BL.

In 1927 Allsop organised a similar rebroadcast of PCJJ, Hilversum, and the public response to this novelty gave him an even more ambitious idea. The BBC had not yet begun its overseas service so Ray Allsop arranged, through the Netherlands Consul in Sydney, for 2LO, London, to be relayed from Hilversum on 30 metres for rebroadcast over 2BL. This triple transmission proved enormously successful — the first time that Big Ben and the voices of London announcers were heard in Australian homes. It was not until May 1928 that the BBC was heard here somewhat more directly, when the Marconi Company relayed to 2LO through its own shortwave outlet, 5SW at Chelmsford.

Red-blooded Australians felt an intense involvement with Kingsford Smith's epic trans-Pacific flight from Oakland to Brisbane in 1928 and, because the "Southern Cross" carried radio equipment, it became possible to follow the aircraft's progress. Sydney Newman transmitted continuous Morse homing signals from AWA's radio centre, Pennant Hills, while Ray Allsop and Tom McNeil shared a long listening vigil, interpreting the cryptic messages from the "Southern Cross" and keeping 2BL's audience aware of every development. An American, Jim Warner, was the plane's radio operator and his gear was built by Heintz and Kaufman of San Francisco. The original transmitter may be seen in the National Library, Canberra.

Looking back, it seems that 1929 was a watershed year for Australian electronics. Overseas, the development of efficient audio amplifers and loudspeaker systems had hastened the introduction of sound films — "talkies". In Australia, Ray Allsop took up the challenge. As early as 1921 he had succeeded in synchronising a wax cylinder recording with motion picture film; now he perfected his own Raycophone system which, despite bitter opposition

Spark transmitters were widely used in Australian merchant ships. Pictured above is the radio cabin of S.S. 'Burwah', fitted with an AWA 1/2kW quenched spark set.

Marconi's research chief, H M Dowsett (centre) operates an early TV receiver at La Perouse during his 1934 visit.

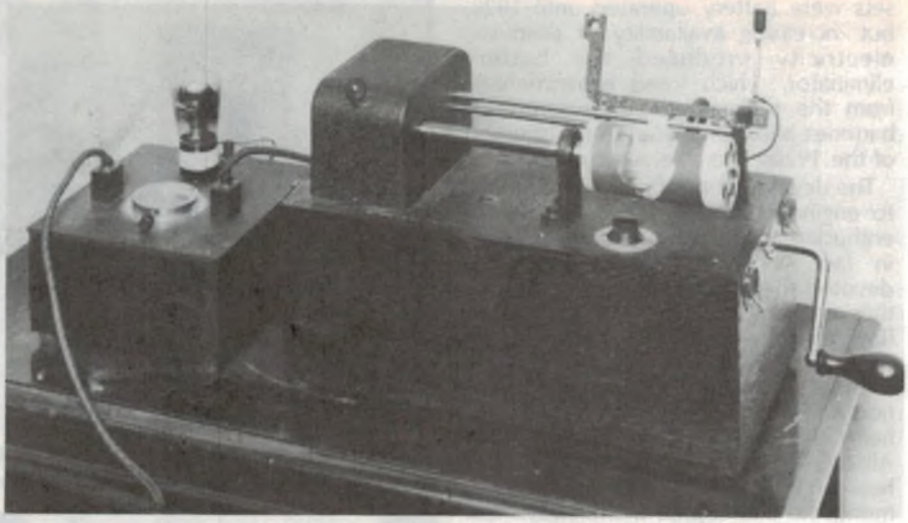
from American interests, supplied the sound in almost half Australia's cinemas at a fraction of the cost of imported equipment. 1929 was also the year that AWA introduced its first domestic radiogram, the "Duoforte". Coinciding with the debut of sound films, the radiogram enjoyed widespread popularity as an exciting home entertainment package.

Many improvements in components and circuitry date from that time. One veteran remembers it as a stimulating epoch . . . "every week the radio papers printed a new circuit, so we would rush home to build it. Screen grid valves and power pentodes gave radio new horizons and, of course, the superheterodyne was a winner." Housed in splendid, handcrafted cabinets, console receivers of the 1930s were often the most impressive pieces of furniture in average homes and became the focal point of the family circle.

Public fascination with sound films soon generated a belief that television would not be long in coming and, it must be admitted, a few local visionaries were not averse to suggesting that television was just around the corner.

An experimental TV station, using Baird's techniques, was built in Brisbane by T. M. Elliott and limited work was done by other experimenters. Three commercial radio stations, 3UZ, 3DB and 2UE, toyed briefly with the novelty of transmitting still pictures, but their enthusiasm outstripped the state of the art and public demand. A Melbourne firm, Television & Radio Laboratories Pty Ltd fostered the idea of Radiovision, which reproduced simple geometric figures on a special receiver. Experimental transmissions over Melbourne stations were soon abandoned. 2UE's interest centred on the Fultograph system, canvassed ardently by its British representative who, however, was realistic enough to concede that "transmissions will be of no value until the Fultograph receivers are distributed." And all this in a time of worldwide depression!

Some unusual hookups were adopted to carry film soundtracks to remote places, but few captured the public imagination so completely as the 1930 transmission from VK2ME which enabled Admiral Byrd's expedition in Antarctica to hear Chevalier's film "The Love Parade" direct from the projection box of Sydney's Prince Edward Theatre. Spectacular achievements of this kind served to remind "John Citizen" that the unfolding science of radio was capable of infinitely more than simply producing agreeable sounds in his living room "wireless". And although Marconi never found time to visit Australia, the very association of his name touched any occasion with magic. It is impossible to convey the feeling of wonderment which engulfed Sydney in March 1930 when, from his yacht "Elettra" in Genoa harbour, Marconi switched on 2800 lights in the Town Hall to inaugurate that year's radio exhibition.



The Fultograph experimental picture transmission equipment of 1929.

Dual wave receivers of the 1930s gave Australians a window on the world at a time when European dictators were exploiting the power of radio propaganda. Short-wave broadcasts became commonplace and, through the crackle of atmospherics, that generation listened to history in the making. In Australia, too, short-wave techniques were given some imaginative tests, such as the great Southern Seas broadcast on Empire Day 1933, the first major hookup in this part of the world. One report mentioned . . . "Nauru transmitted a word picture of natives listening with expressions of awe to the strange voices that came from the air. In New Guinea, miners on the goldfields were sitting around expensive receivers, bought with their newly-acquired wealth, listening to the flashing Empire messages. The minds of many went back to 1914 when intercommunication in the south seas depended on a few strands of cable."

The Wireless Institute of Australia was the sole active national body of its kind until 1932. Each State had a separate Division and the members' prime interest was amateur radio. However, industry leaders, immersed in the rapidly developing science of electronics, felt the need of a more professional organisation. As a result, the Institute's membership began crystallising at two different levels. As early as 1924 Fisk, Mingay and other professionals had the foresight to register the Institution of Radio Engineers, Australia, but the planned organisation remained dormant for eight years when, by common consent, the IRE hived off from the NSW Division of the Wireless Institute.

The new body quickly established an enviable reputation by snaring some of the front runners of electronics as lecturers. In May 1934 Marconi's research manager, H. M. Dowsett, delivered a paper on "Television and its possibilities in Australia" and four years later the IRE had attained the requisite stature to host the first world radio convention ever held in the British Empire.

That prestigious conclave, which was part of Australia's 150th anniversary celebrations, attracted to Sydney many international figures, including General James Harbord, Chairman of RCA, and TV inventor John Logie Baird. More than sixty papers were read, a goodly proportion being contributed by Australian engineers.

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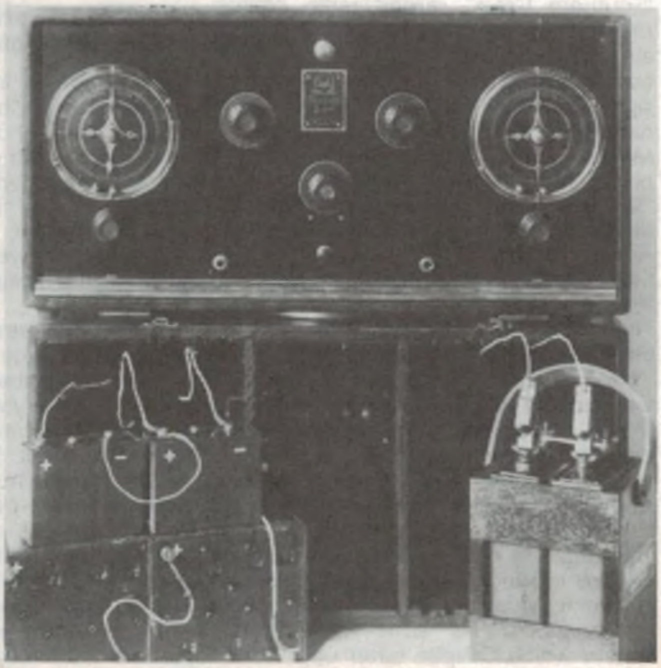

AWA engineer Harry De Dassel making frequency measurements in a 1925 laboratory. At right is a battery model Radiola receiver, 1927 vintage, without loudspeaker.

Radio Pioneers 2

Continued from page 48

transmissions were prints of movie frames from the newsreel coverage of an England-Australia air race. In London, these radio pictures were reconverted to movie film and screened in British cinemas the next day.

This article has merely established the guide posts for Australia's early overseas radio outreach. It should be added that not a little of the public pressure for improved communications stemmed from a vocal lobby of radio amateurs and pioneer broadcasters, to whom only passing reference has been made. Our next article will highlight the sterling work of Australia's amateurs during the 1920s, as well as sketching the origins of our broadcasting system.

Radio Pioneers 3

Continued from page 53

Amateur radio began to take wings during the early 1920s. A series of trans-Pacific tests in 1923, when many American stations were logged, raised the question as to what distances could be achieved on low power. AWA arranged for Maclurcan and "Jack" Davis, then a teenager, to travel to America and back aboard the "Tahiti" using a small 10 watt transmitter of Maclurcan's own design. The results exceeded all expectations: with a power of only 7.6 watts, coded Morse was received right across the Pacific to San Francisco, and voice and music up to 7680 kilometres.

In November, 1924, Maclurcan logged his first CQ from an American "ham," 6EKY . . . "called him back on 90 metres and he replied immediately. My hand trembled so with excitement that I could hardly separate the dots from the dashes." The same month he transmitted the first amateur greeting from Australia to King George V through 2OD, England. Maclurcan's next triumph was the first 20 metres communication with England using 50 watts of power.

Even assuming that they could be verified, it would be pointless to begin listing the DX achievements claimed by amateurs of that period, but no one has ever questioned Charles Maclurcan's primacy. He remained the paterfamilias of our amateur scene until 1927 when, like Alexander the Great with no more conquests to make, he retired from experimental activities.

One major promotional undertaking of that decade is worth mentioning, because it gave countless country families their first taste of radio. During 1925/6 the Great White Train toured New South Wales advertising Australian-made products. AWA's carriage was equipped with 500W transmitter, 2XT (for Experimental Train), operating on 850 metres and at each stop, as local dignitaries welcomed the train, the proceedings were broadcast. 2XT was under the charge of a former marine operator, Harry Tuson, whose odyssey on this puffing iron horse was responsible for introducing many Australians to radio.

Public interest in broadcasting assisted other facets of radio. As dealerships multiplied a wider range of components became available and, in response to popular demand, radio journals devoted more space to technical articles. Another source of enthusiasm stemmed from some high school science teachers, who formed radio clubs and initiated their students into the new science of electronics. Many found it so fascinating that it claimed them as staunch devotees.

Radio Pioneers 4

Continued from page 56

One of the most memorable occasions of that 1938 convention was Ray Allsop's stereo demonstration – the first in Australia and only the second in the world. An audience of 2000 in Sydney's Plaza Theatre listened to an orchestra playing in the nearby Regent Theatre, the stereo components being carried by two equalised PMG landlines to a sophisticated array of loudspeakers backstage at the Plaza (even in those days the terms "woofer" and "tweeter" were in use). In addition, Allsop treated his captive audience to some specially produced short films with stereo soundtracks, including a table tennis match which "was particularly realistic in that the bounce of the ball from side to side was easily followed, both visually and aurally". It is interesting to recall that this historic demonstration was described as "stereoscopic" sound, because it was thought that the word "stereophonic" had been copyrighted by overseas interests.

The 1938 World Radio Convention provided international recognition that Australian electronics had come of age and, as the stern lessons of history were to show, not a moment too soon. Within a few years Australia would be virtually isolated by the tides of conquest and would become the main strategic base and arsenal of the Allied war effort in the South West Pacific. When that occurred, the professional capability of the electronics industry would be taxed to the limit in producing the tools of victory on a scale that would have seemed impossible only a few years before.


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50th Anniversary Feature:

The Growth of Digital Computers

Undoubtedly one of the most significant events that took place in the electronics industry over the last 50 years was the development of digital computers. No other class of machine has contributed so much to the growth of human knowledge, or to systems which help us cope with the enormous mountain of information which our society has accumulated.

by JIM ROWE

The first electronic digital computers may have appeared in the mid 1940's, but like most other inventions they were anything but a 'bolt from the blue' which sprang fully developed from the mind of a single genius. Many of the key ideas involved had been grasped by people in earlier eras, but they were unable to build upon them – because science and technology had not as yet reached a stage where the tools or components were available to allow them do so.

The events of the pre-computer era do indeed demonstrate that like seeds, crucial ideas can only 'take root' and grow when the time and conditions are right. Having an innovative idea too early can be almost as unproductive – and probably much more frustrating – than having it too late!

Building foundations

All through history, people had been fascinated by the idea of a machine able to carry out calculations or so similar things 'all by itself'. The ancient Greeks are said to have had an 'astronomical computer', with dials driven by gear wheels to show the position of the planets on any given day.

That incredible genius Leonardo da Vinci apparently invented a mechanical calculating machine around 1500, although it's not certain that it was ever built. In 1653 the French mathematician and philosopher Blaise Pascal built a similar adding and subtracting machine, the 'Pascaline'. It was based on gear wheels and ratchets, and apparently made Pascal famous throughout Europe.

Twenty years later, the famous German philosopher Gottfried Leibnitz developed the mechanical calculator even further, producing one which could multiply and divide as well as adding and subtracting. For a machanical device it worked surprisingly well – so much so that apart from relatively minor improvements, the basic design for this type of mechanical calculator remained almost unchanged for around 250 years. Accountants and book-keepers were still using very similar units well into the 1930's!

Sometime early in the 17th century also appeared another idea that was ultimately to be of crucial importance in the development of today's electronic computers: the idea of a *binary* number system, based on 2 rather than 10. This is generally credited to either Sir Francis Bacon, or the Scottish mathematician John Napier (the inventor of logarithms).

The idea of actually *programming* a machine to do a job automatically and repetitively was probably first brought to fruition in 1801, by the Frenchman

John Mauchly (L) and J. Presper Eckert, who produced the first fully electronic computer, 'ENIAC' in 1946 at the University of Pennsylvania. The picture shows them receiving the Philadelphia Award in 1973.

Joseph Jacquard. Controlled by holes punched in a series of thin wooden cards, linked by cords to form a crude 'punched paper tape', Jacquard's weaving looms could automatically produce fabrics with almost any desired patterns.

Probably the next milestone in pre-computer history came in the 1820's, when British mathematician Charles Babbage developed what he called his 'Difference Engine'. This was a machine designed to work out automatically any type of astronomical, nautical or similar reference tables which are based upon a fixed mathematical relationship or 'law'.

Due to financial troubles, Babbage never fully perfected this machine, but before his death in 1871 he designed an improved 'Analytical Engine' which was in many ways a mechanical version of modern computers. It had a 'mill', or processor, and a 'store' or data memory. Babbage planned to control its operation using Jacquard's system of punched cards, and had even worked out a way to make it able to 'jump' back and forth in the 'program' by winding the cards forward or back!

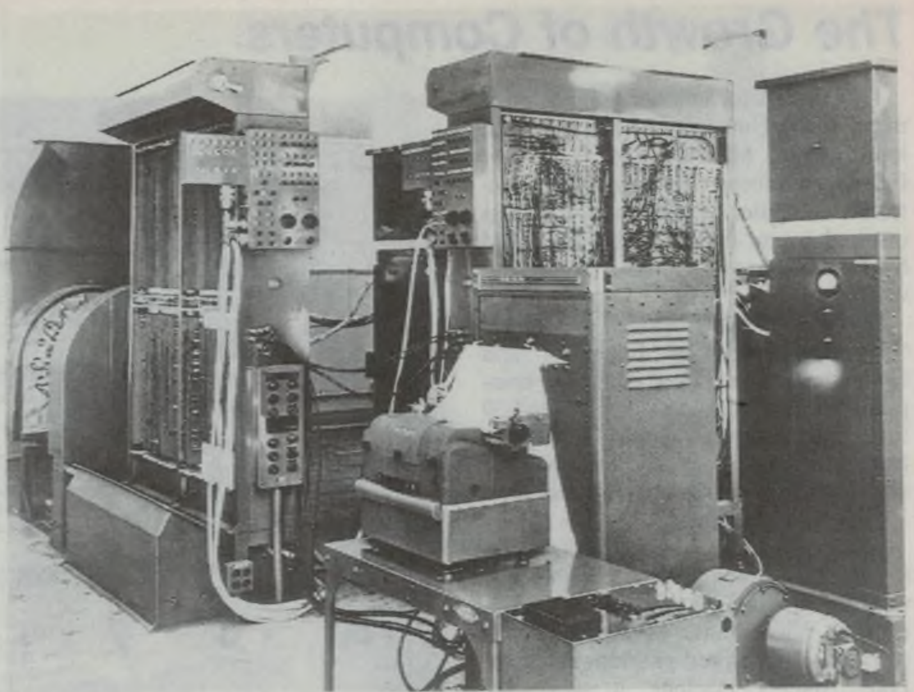
Incidentally, Babbage received quite a lot of help from the woman who is generally credited with being the first computer 'programmer': Lady Ada Lovelace, Lord Byron's daughter.

A brilliant mathematical thinker, Lady Lovelace not only helped Babbage perfect the design of the Analytical Engine, but it was apparently she who discovered important programming ideas like the use of a single set of instructions for repetitive operations. So we really must credit her as the inventor of the program *loop* and *subroutine*.

In 1890, raw information for the 11th Census of the United States was processed by mechanical punched-card tabulating machines invented by Herman Hollerith. As a result, the Census information was processed in less than a third of the time taken for the previous 1880 Census, with a dramatic reduction in human effort – even though the population had grown by 25%, and many more questions had been asked.

Back in 1854, an obscure and largely self-taught mathematician called George Boole had demonstrated that mathematics was basically a highly developed and 'symbolic' form of logical reasoning. In his historic book *An Investigation of the Laws of Thought*, he also developed the basic elements of symbolic logic – a set of conceptual 'building bricks' which could be used to construct logical and mathematical functions.

But it wasn't until 1937 that someone was actually able to build upon Boole's work. In that year, American electronics engineer Claude Shannon published a now famous paper, showing how Boole's principles could be used to design electrical switching circuits.



Eckert and Mauchly's second 'BINAC' machine, narrowly beaten by Wilkes' EDSAC as the first working stored-program computer, in 1949. Wilkes had previously worked with Eckert, Mauchly and Von Neumann.

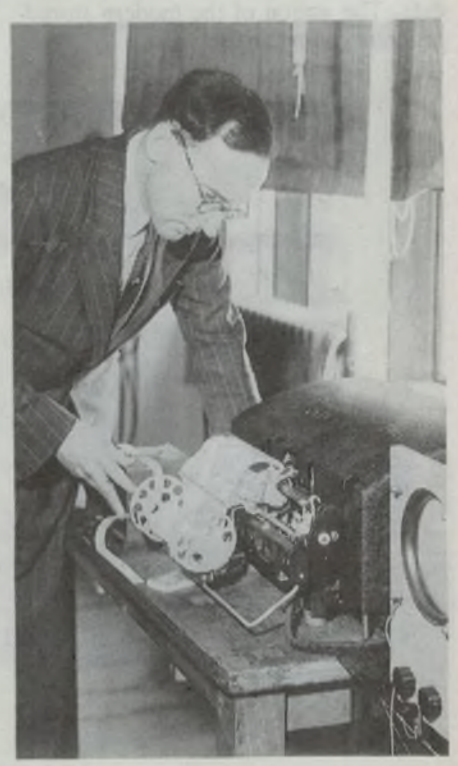
A couple of years later, Shannon went on to show how virtually any kind of information or 'data' could be encoded in the form of binary codes (1's and 0's) – so that it could be reliably stored, processed, or transmitted from one place to another using electrical or electronic circuits.

Thanks to Babbage, Lovelace, Hollerith, Boole and Shannon, all of the main parts of the computer puzzle were finally in place – along with the technology to achieve its practical realisation. From then on, the developments came thick and fast.

The computer age

In the early 1940's, a group of scientists and mathematicians in England developed a series of special-purpose computers, to crack the secret message codes being used by the Germans during the war. Working at Bletchley Park in Hertfordshire, they first produced machines using relays, then more refined models using thermionic valves or 'vacuum tubes'. Although these 'Colossus' computers were designed specifically for code cracking, they were strictly speaking the world's first fully electronic computers.

Then in 1944, at Harvard University in the USA, the first general-purpose *programmable* digital computer was produced using both vacuum tubes and relays. Called 'Mark I', it was developed by a team of researchers led by Howard Aiken.



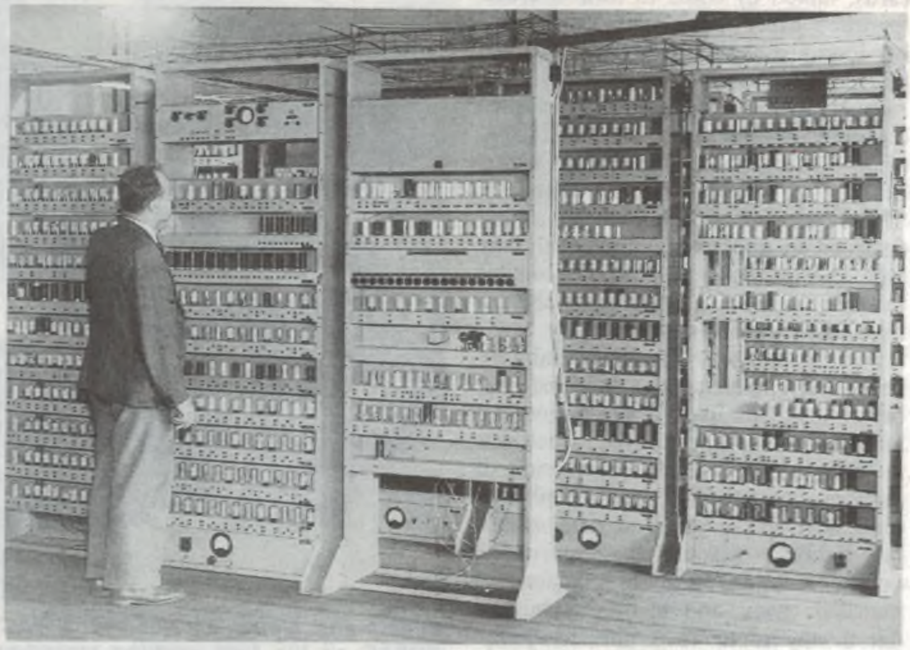
Dr Maurice Wilkes shown adjusting the printer of his EDSAC machine, at Cambridge University in 1949. It was the first working stored-program machine.

The Growth of Computers

Two years later another team of engineers at the University of Pennsylvania, led by John Mauchly and J. Presper Eckert, produced the first fully electronic computer. Apparently this was inspired by an earlier design produced by John Atanasoff, at Iowa State University.

Dubbed 'ENIAC' (which stood for 'Electronic Numerical Integrator and Computer'), the Eckert-Mauchly computer was a monster weighing around 30 tons and covering about 150 square metres of floor space. It also contained about 18,000 vacuum tubes, and used 150 kilowatts of power.

ENIAC operated about 1000 times faster than Aiken's Mark I, and was used for all sorts of scientific and engineering calculations. However it was still not a true stored-program machine. Like Aiken's machine it was programmed by 'hard wiring'.



EDSAC, the machine built at Cambridge University by Maurice Wilkes' team in 1949. It was the first stored-program computer, using over 3000 valves.

Stored programs

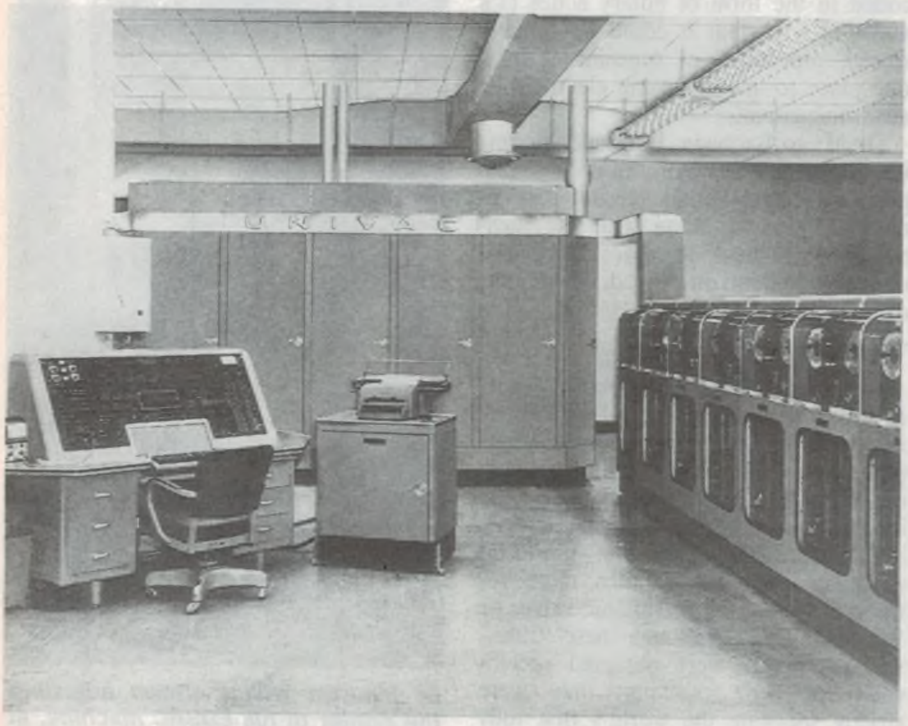
In 1945, Eckert and Mauchly had been joined by John Von Neumann, a Hungarian mathematician. After building ENIAC the team then came up with the idea of storing the computer's program in its memory, along with the data. The notion of the modern *stored-program* computer was born.

Surprisingly, however, its was not the Eckert-Mauchly-Von Neumann team which produced the first working model of a stored-program computer. This was achieved in England in 1949, by a team at Cambridge University led by Maurice Wilkes. But Wilkes had actually studied with Eckert, Mauchly and Von Neumann in the USA, and happened to complete his 'EDSDAC' machine some months before his tutors finished their own 'BINAC'.

In 1951 Eckert and Mauchly produced the first commercially available stored-program computer, UNIVAC-1. By this stage they were working for Remington Rand, later to merge with Sperry. A UNIVAC-1 was used to process the votes for the 1952 US presidential elections, allowing President Eisenhower to be proclaimed the winner only 45 minutes after voting finished.

Things really started moving after that, because the transistor had been invented at Bell Labs in late 1947 by Shockley, Bardeen and Brattain. By 1950 the new devices had been developed to the point where they represented a practical alternative to the thousands of vacuum tubes used in the first generation of computers. This opened the way for smaller, faster and much more reliable computers – which also didn't need their own power substation.

In the early 1960's the next generation of large 'mainframe' computers appeared, with fully solid state circuitry based on discrete transistors. IBM produced the 7000 series, while Control Data produced the 160-A which had been designed by Seymour Cray.



UNIVAC-1, Eckert and Mauchly's first commercially available stored-program machine which appeared in 1951. One of the first units was used to process votes for the 1952 US presidential elections, in record time.

But of course in 1958 the monolithic integrated circuit or 'IC' had been developed by Jack Kilby, at Texas Instruments. This made it possible to compress at first tens, then hundreds and finally thousands of transistors and their associated components into tiny chips of silicon, which could be housed in packages no larger than the first transistors. The IC was to trigger the next phase and in some ways most dramatic round of computer developments, by allowing both a further dramatic increase in the computing *power* and reliability of the machines, and at the same time a dramatic reduction in their relative size and power consumption.

In early 1964, on its own 50th Anniversary, IBM released the six models of its new System/360 range of mainframes. These used hybrid IC modules, rather than the still-developing monolithic chips, but provided a new standard of performance which immediately made all of its previous models – and those of most of its competitors – obsolete.

The British firm ICT released its 1900 series of small mainframe machines in early 1968. These used the recently developed TTL (transistor-transistor logic) ICs.

Mainframe computers were entering their 'third generation'. Development of the new range was said to have cost IBM over US$500 million, a far cry from the US$600,000 expended by Eckert and Mauchly in producing ENIAC.

The ICT 1902A commercial/scientific computer, released in early 1968. It used TTL integrated circuits, and sold for around $200,000.

Digital Equipment Corporation's PDP-8, the first commercially successful minicomputer. It appeared in 1965. A Teletype ASR-33 terminal is at lower right.

Minicomputers

Even the development of transistors had made it possible, by the early 1960's, for designers to squeeze a basic computer into a box the size of a small refrigerator. The era of minicomputers was about to dawn.

In 1965, the Digital Equipment Corporation (DEC) of Maynard, Massachusetts announced what was to become the first commercially successful *minicomputer*: the PDP-8. The 'PDP' stood for 'Programmed Data Processor'. The basic machine sold in the USA for under $20,000 – far less than existing mainframe machines, and regarded as a breakthrough at the time.

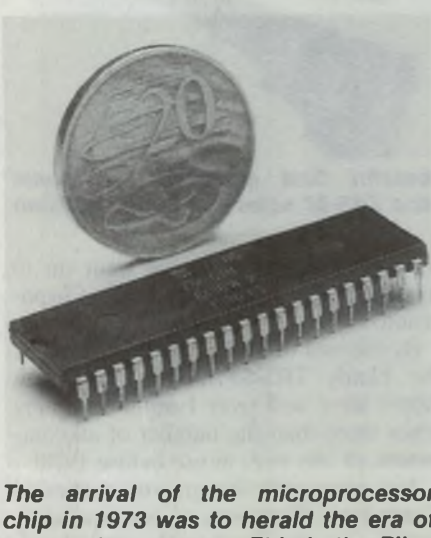
Based on 12-bit binary words, the PDP-8 contained a modest magnetic core memory of only 4096 words and a machine-language instruction set so limited that programmers could remember it all in their heads. Initially it used only a Teletype ASR-33 teleprinter for input and output, with inbuilt paper tape reader and punch for 'loading' and 'saving' programs.

I was lucky enough to be able to 'play' with one of the first PDP-8 machines to reach Australia, thanks to the good nature of John Cockram, then EDP manager at John Fairfax and Sons. I was able to spend many lunchtimes feeding in and running the first programs I ever wrote – and also many evenings poring over print-outs, trying to find their bugs!

I remember vividly that before you could even load a program into the memory after switching on the power, you had to key in a short 'bootstrap loader' routine, via the front-panel switches. This was to remind the machine how to load in the real programs, through the teletype's tape reader.

The PDP-8 was extremely crude by modern standards, with far less computing power than the smallest modern desktop PC. But in the late 1960's, it and the other minicomputers which soon appeared were responsible for a dramatic expansion of the impact of computers in areas such as science and engineering.

For the first time, there were computers which were not huge and incredibly



The arrival of the microprocessor chip in 1973 was to herald the era of personal computers. This is the Zilog Z-80, slightly oversize.

expensive monsters, costing so much to run that they could only be made available to a select body of 'high priests'. The minicomputer at last made it possible for ordinary scientists and engineers to get access to computers – not just for calculations, but also for monitoring and controlling lab experiments and industrial processes.

The first PDP-8 used discrete transistors, but DEC came out with an IC version in 1967. They also came out in 1970 with the larger and considerably more powerful PDP-11, which expanded the applications of minicomputers even further. Other firms soon produced similar small 'instrumentation' computers, such as the model 2116A from test equipment maker Hewlett-Packard. The age of *automation* began to dawn.

The microprocessor

But the real breakthrough which led to the development of today's personal computers or 'PCs' came in 1973, when the Intel Corporation in California's 'Silicon Valley' developed the *microprocessor*. IC technology had finally reached a point where just about all of the parts for the processor section of a computer could be squeezed into a single tiny chip of silicon, a few millimetres square.

At first, these microprocessor chips sold for hundreds of dollars. But within about four years, manufacturing techniques and yields had improved dramatically, and the cost plummeted to less than $25. Not only this, but IC technology also made it possible to provide the *memory* section of a computer with a mere handful of RAM and ROM chips, whose prices began falling in the same fashion.

It now became possible to make a practical general-purpose *microcomputer* that was even more powerful than the first minicomputers, and little larger than a desk model typewriter – for less than $1000. In a little less than 12 years, computers had become more than 10 times smaller and more than 50 times cheaper, for the same amount of computing power.

The age of the personal computer had arrived. At first they were like smaller versions of the first minicomputers, intended mainly for use by scientists, engineers and electronics hobbyists keen to try their hand at computing.

But then in 1977 the first true 'appliance' personal computers appeared, designed especially for use in the home,

Above: Not the original Tandy TRS-80 model 1 personal computer, but its successor the model 3. The earlier unit had the computer, monitor and floppy disk drives as separate units.

The Apple II, another extremely successful 'first generation' personal computer. By late 1981, combined Apple and TRS-80 sales were over 1 million units.

school and office – by people who had never used a computer before.

Probably the first of these to become really successful was the TRS-80 model 1, developed in the USA by the Tandy Corporation and sold by them very widely throughout the Western world. Another very successful model in the first generation of machines was the Apple, the first of which was produced by a pair of young enthusiasts in a garage in Los Altos, California. Steve Jobs and Stephen Wozniac went on to found today's Apple Computer Corporation.

By the end of 1981, combined sales of the Tandy TRS-80 model 1 and the Apple were well over 1 million – many times more than the number of all computers, of any size, in use before 1978!

And along with this growth in sales of 'hardware', there was a corresponding growth in the 'software' market. A whole new industry had sprung up, producing pre-written software programs to run on the new machines.

In late 1981, an event happened which was to trigger the most recent almost explosive growth in personal computers. Deeply involved in mainframe computers since the 1940's, the huge IBM Corporation finally entered the market with its own PC based on the Intel 8088 16-bit processor.

The arrival of the IBM PC gave the personal computer much greater credibility as a personal productivity tool and office appliance. It also set new records for sales: over 200,000 units were sold in the first 15 months.

Following the huge success of the IBM PC, many other companies entered the market, many producing machines designed to be software compatible with the IBM machine – so they could use all of the programs written for it. Asian manufacturers in particular were quick to produce these 'clones', which generally sold for much less than the original IBM machine.

Needless to say IBM came out with enhanced models of its own PC, which grew into the PC-XT and PC/AT. These in turn also spawned lower cost clone equivalents, expanding the 'PC family' of machines into what is today's largest single group of personal computers.

More recently IBM has introduced a new 'System/2' series of machines, not directly compatible with the original PC. These may ultimately replace the existing series, but as yet do not seem to have met with a great deal of market acceptance.

Apple Corporation also came out with more powerful models, following the original 8-bit machine. The most notable of these is the 'Macintosh' – head of what is now the second largest family of personal machines.

Of course mainframe and mini computers have not faded away with the enormous growth of personal computers. The larger machines have also taken advantage of the same advances in technology, undergoing almost continuous improvement in terms of both speed and computing ability.

The latest machines are many thousands of times faster and more powerful than those first clumsy machines of the late 1940's, and in comparative terms much less expensive.

Computers have come a long way – and apart from the events which laid the pre-computer groundwork, it has all happened in the last 45 years. The next 45 years should be even more interesting, judging by the way computer technology continues to accelerate.

The Microbee, first and one of the very few personal computers to be made in Australia. It was widely used by schools and hobbyists.

The original IBM PC, whose release in late 1981 gave the personal computer full credibility and triggered the latest round of enormous growth in the use of computers.

Apple Computer's 'Macintosh' personal computer, which pioneered the use of a user-friendly graphics based operating system.

Special 50th Anniversary Feature:

Australia's role in the development of Radio Astronomy

As part of our celebration of 50 years of publication as a monthly, Electronics Australia is proud to pay tribute to fact that during those 50 years, Australian scientists have played a leading role in the development of today's science of Radio Astronomy. They are still very much in the forefront of this science, also – a fact that became obvious with the opening last September of the Compact Array section of our dramatic new Australia Telescope.

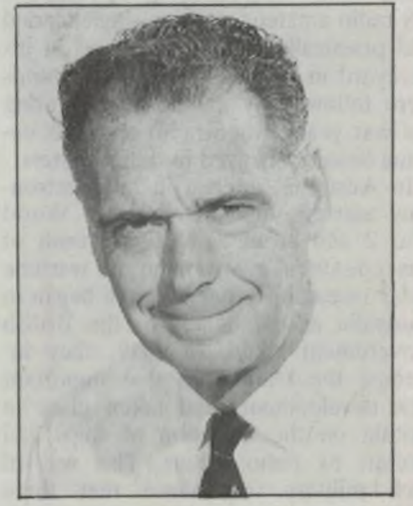
After the end of World War 2, the CSIRO Division of Radiophysics found itself with a staff of highly trained scientists and engineers who had been working on wartime projects which had broken new ground in the areas of radar, antennas and radio reception. They were eager to apply this knowledge and skill to expand human knowledge, for peacetime purposes. By a happy combination of circumstances, they were able to devote themselves to the development of the fledgling science of radio astronomy, and over the years bring great credit to both themselves and Australian science.

The intriguing inside story of how Australia came to play such a crucial role in the development of Radio Astronomy is told on the following pages, explained by no lesser person than the man who was Chief of the CSIRO Division of Radiophysics from 1946 to 1971: Dr E.G. Bowen, CBE, FRS.

No one is better qualified to tell this story. Dr Bowen began his career in 1935, working with Watson Watt in Britain on the development of the first experimental air-warning system. He went on to lead a team which designed and built the first airborne radars, used during the battles over Britain in 1941 and in subsequent Atlantic sea battles. In 1940 he went to the United States as a member of the Tizard Mission, which revealed the secrets of radar to that country and enabled the Americans to gain an invaluable lead over the Germans.

Dr Bowen's many achievements as CSIRO Radiophysics Chief included the construction of the Parkes Radio Telescope in 1961. From 1967 to 1971 he was Chairman of the Joint Policy Committee of the Anglo-Australian Telescope. He then became Chairman of the Anglo-Australian Telescope Board into 1973, when he went to the USA as Science Counsellor to the Australian Embassy in Washington. He is currently an Honorary Fellow of the CSIRO Division of Radiophysics, as well as a Fellow of the Royal Society.

The article on the following pages has been specially adapted from a Bicentennial Paper published in the 'Journal of Electrical and Electronics Engineering Australia', Vol.8 No.1, by kind permission of the Institution of Radio and Electronics Engineers Australia.



Dr E.G. Bowen, CBE, FRS

50th Anniversary Feature:

From Wartime Radar to Radio Astronomy

Here is the intriguing story behind the special circumstances which led to Australia playing a leading part in the development of the new science of radio astronomy, after World War 2. It tells of the breakthroughs that were made in the late 1940's and 1950's, using makeshift 'war surplus' radar equipment and lots of enthusiasm, and then the transition to the 'Big Science' era of radio astronomy – including the construction of the Parkes Radiotelescope.

by DR E.G. BOWEN, CBE FRS

It is now well known that radio astronomy began with the pioneering observation made in 1933 by Karl Jansky at the Bell Telephone Laboratory, that in addition to the radio noise coming in from terrestrial sources, there was another component coming in from outer space. This was an observation of fundamental importance, which was made in the course of a purely engineering study of the origin of the many noises received in a sensitive radio receiver.

At the time, this observation was almost completely ignored by the astronomical profession and it might very well have died at birth. However the subject was miraculously kept alive because of the interest of Grote Reber, a US radio amateur working singlehanded and practically without resources in his backyard in Illinois. These observations were followed by a long hiatus during the war years, when radio scientists became heavily involved in other matters.

In Australia, interest in radio astronomy started immediately after World War 2 and arose as a direct result of this country's involvement in wartime radar research. Radar research began in Australia at the behest of the British Government when, in 1939, they informed the Dominions that important new developments had taken place in Britain on the detection of ships and aircraft by radio means. This was of such military importance that there were strong reasons why the Dominions should embark on research and development on their own account.

The Division of Radiophysics was therefore set up in Sydney in 1939, under the auspices of the Council of Scientific and Industrial Research (later the CSIRO). It became responsible for developing radar for the Australian Army, Navy and Air Force and later for the American Forces in the South-West Pacific.

In the next few years, it pioneered some outstanding developments in this field, notably the famous LW/AW air-warning radar (see Fig.1). This was a lightweight, air-transportable ground radar which could either be landed through the surf from landing barges or air-lifted to forward areas. It played a vital role in the island-hopping campaign through the Pacific which led to final victory against the Japanese.

When the war ended, the thoughts of scientists in many countries, victor and vanquished alike, turned to reviving old lines of research and to opening up entirely new avenues of investigation which had grown out of wartime work.

It happens that it was in England and Australia that the greatest attention was paid to a study of the radio noise known to be coming from objects like the Sun and from outer space. This was the subject which ultimately became known as *radio astronomy*, but it had not yet earned that name.

There are good reasons why this development took place in these two countries, but it is an abiding mystery why the science did not also re-start in the United States, where it all began. This is discussed in Professor Woodruff Sullivan's book *The Early Years of Radio Astronomy*, published by Cambridge University Press (1984), to which the reader is referred.

Fateful decision

What were the special circumstances which led to the development of radio astronomy in Australia in 1946? The first and probably the most important ingredient was the decision by the Chairman of CSIRO, Sir David Rivett, that at the conclusion of World War 2, CSIRO would devote itself to peacetime research and that defence research would be carried out by other agencies. This meant that the Division of Radiophysics, a highly developed laboratory with a superlative staff, became available for a wide range of researches and practical developments directed towards peace-time ends.

It would be easy to underestimate the importance of this decision by Sir David Rivett: witness the fate of several overseas laboratories which, for a number of years after the war, were saddled with the problem of trying to combine two quite incompatible subjects under the same roof – namely civilian and military research. We were spared this problem, and Australian science has reason to be grateful to Sir David for the clarity and firmness of his decision.

The next ingredient was that the staff of the Laboratory, about two hundred strong, was already highly skilled in electronic and radio research. They ranged from professors of physics to practical engineers from industry. Many of them had spent months, if not years, at the best overseas laboratories and were saturated with the most recent technology.

However a singular fact stands out. In view of the way in which events subsequently unfolded, it is astonishing that there was not a single *astronomer* on the staff of the Division – nor, for that

Australian resurgence of research at the end of the war. Many scientists, especially those from nuclear physics, came out of the war with severe reservations about the part they had played. They were worried by the fact that their products had been used for unprecedented destruction, often at the expense of civilian populations, and they were horrified by it.

Radar scientists, on the other hand, had no such qualms. Radar had been used predominantly to detect enemy aircraft and enemy submarines, with the prime objective of destroying them. In other words, radar had been a means of destroying the engines of destruction and we were comforted by this fact. At the same time, we knew for certain that after the war there would be an enormous number of peace-time applications, like the navigation of ships and aircraft, to which radar could contribute and which were waiting to be exploited for the benefit of mankind.

So here was a well-equipped laboratory with a highly talented staff, with permanent buildings, excellent workshop facilities, a command of modern technology and a bountiful supply of equipment, who were simply burning to apply these things to peace-time use. Who could fail to react to the challenge?

Some of the staff had unbreakable commitments to return to positions in universities or industry, from which they had departed at the outbreak of war. Others, like Sir Frederick White, who was then Chief of the Division, moved up in the hierarchy of CSIRO to direct the future destinies of the organisation. However, a hard core of some 60-70% of the staff remained in the Laboratory and for most of us the future prospects were enthralling.

I myself had been involved in radar research since the beginning of the British developments and had completed 11 years of unbroken commitment to the war effort. This included thousands of hours in night-fighter and sea-search aircraft, seldom under the safest or most salubrious conditions. I was heartily tired of it and looked forward to less demanding pursuits.

There were any number of research directions to follow, all of them attractive. Our broad policy was to try them all and, if they showed promise of useful scientific results or of practical applications, we poured in the manpower and resources. Of many such ventures which we embarked upon, radio astronomy proved to be one of the most productive.

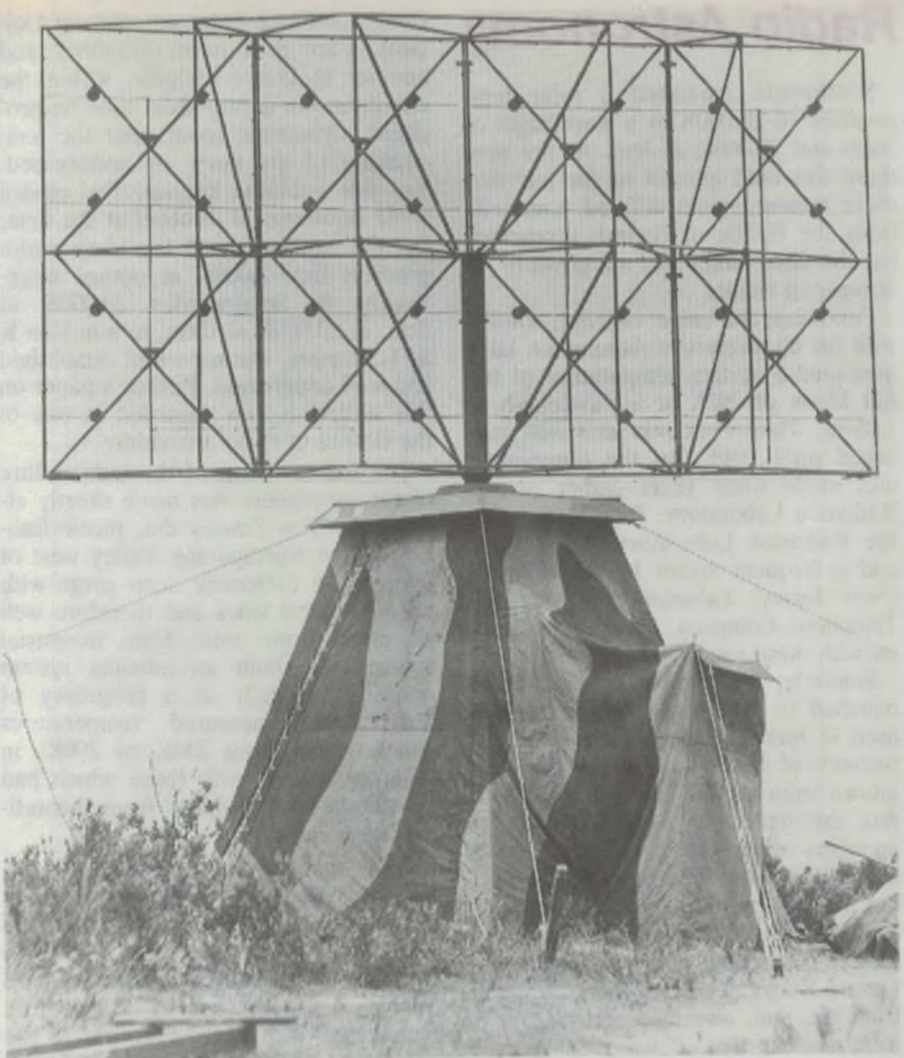


Fig.1: The lightweight air-warning radar system developed during World War II by the CSIRO Radiophysics Division.

matter, anyone who had done a university course in astronomy. It would be interesting to speculate how the subsequent history of the Division of Radiophysics would have turned out had there been an astronomer on the staff in 1946.

Next in importance, to people and technology, was the enormous store of special components of all kinds which the Laboratory had accumulated during the war years – magnetrons, klystrons, pulse-forming networks, pulse-counting circuits and so on. The Laboratory held a gigantic catalogue of parts indicative of the new electronic era. This was augmented by an unusual event which occurred a few weeks after the end of the Pacific war, an episode which turned out to be particularly fortunate for the Laboratory.

A large segment of the Pacific Fleet had assembled in Sydney Harbour prior to returning to the USA; already in Sydney were gigantic stores of radar and communications equipment assembled for the final stages of the Pacific war. It was impracticable to return much of this to the United States, and orders were given to destroy the surplus.

So, huge quantities of technical equipment – including whole aircraft – were loaded on the deck of aircraft carriers, taken a few miles outside Sydney Heads and bulldosed into the Pacific.

Our friends in both the US and the Australian Services were disturbed by all this destruction, and encouraged us to salvage all we could lay our hands on. After a frantic few weeks loading our own trucks at the dockside, we ended up with a cornucopia of invaluable equipment, often brand-new and in the original crates. I seem to remember two large warehouses full of these things near Botany Bay, which we were to draw on for many years to come.

In retrospect, it is clear that morale was another important factor in the

Wartime Radar to Radio Astronomy

Early concepts

Everyone has his own story of how he first became aware of radio noise from outer space, and the possibilities of learning about the universe around us by a study of such signals. My first exposure to this problem came in 1935, when I joined the small team which Sir Robert Watson Watt assembled to build the first air-warning radars in Britain.

In detecting the extremely small signals coming from an incoming aircraft, we were particularly concerned about the noise background which appeared in our receivers when a directive or semi-directive antenna was pointed towards an object in the sky, in this case an invading aircraft. The radar equation had not yet been formulated in explicit terms but the factors involved were beginning to form in our minds.

My colleague, A.F. Wilkins, probably had the clearest ideas about this but I also remember a senior engineer of the Plessey Company, Bailey by name, who gave a lucid account of the type of coupling which must exist between a directive antenna and outer space, both in the receiving and transmitting modes. These ideas were not in the literature at the time, but they were very real to us and were of enormous practical significance to our day-to-day operations.

We were well acquainted with Jansky's results and recognised that, after the many sources of noise to which our radar system was exposed had been reduced to a minimum, we were ultimately exposed to Jansky's cosmic noise coming from outside the atmosphere. We called it just that, *Jansky noise*, by analogy with the Johnson noise and the Schott noise generated within the receivers themselves.

I hesitate to put a date on when these ideas crystallised out. However, the concept that a radio receiving system behaved like a *radiometer*, and was thus able to measure the black-body temperature of an object at which the antenna is pointed, was clearly expounded in a paper by Burgess in the Proceedings of the Physical Society in 1941.

This concept came directly from our radar experience at Orfordness and Bawdsey but, for secrecy reasons, this was not mentioned in that paper. The radiometer concept was also described in Southworth's pioneering measurement of solar temperature in 1942-43 although, once again due to wartime secrecy, this paper was not published until 1946.

Southworth measured a solar temperature of 20,000K at a wavelength of 10cm and 10,000K at 3cm. At the time there was mild interest in the fact that these measurements differed materially from the 6000K of optical astronomy, but the discrepancy was put down to instrumental factors.

Following the same concept, Dicke, with his ultra-sensitive radiometer, later measured a surface temperature of the full Moon of 292K at a wavelength of 1.25cm. This result was also not published until 1946, but the observation was made some years earlier at the Radiation Laboratory. As a member of the Radiation Laboratory at that time and a frequent visitor to the Holmdel (New Jersey) Laboratory of the Bell Telephone Company, I was quite familiar with these results.

Similarly, the concept of an antenna matched to free space became formalised in terms of the characteristic impedance of free space, having the well-known value of 377 ohms. I first heard this expounded in a factual way by members of van Atta's Antenna Group at the Radiation Laboratory about 1942, but the idea may have existed earlier.

With these ideas as background and Hey's pioneering observation in the United Kingdom of long-wave radiation from the Sun, also made in 1942, it is little wonder that it was radar people who pioneered the re-birth of radio astronomy innediately after the war.

Solar radio astronomy

At the Division of Radiophysics it was the great J.L. Pawsey who was fascinated by the concept of an antenna as a radiometer. He was an antenna man from way back and, as an engineer employed by the EMI Company in England in the 1930's he had been involved in antenna design for the first BBC television transmitting station at Alexandra Palace. He was a master of antenna theory and had many original design concepts to his credit.

He began two experiments. One was to measure the temperature of the Sun at 200MHz, a standard radar frequency much lower than that used by Southworth. His second experiment was to measure the temperature of the ionosphere at a wavelength short enough to be completely absorbed by the ionosphere – i.e., at a wavelength such that the ionosphere acted as a perfect black body.

For the solar experiment he used existing Air Force radar antennas at Collaroy, a few miles north of Sydney, and another at Dover Heights, within the city limits. In a very short time he produced a dramatic result: that the temperature of the quiet, or undisturbed, Sun was a million Kelvins. This caused some rumblings of disbelief at the time, but the explanation of the temperature gradient from 6000K at optical wavelengths to Southworth's 10,000K at 3cm, to 20,000K at 10cm, to a million K at 1.5 metres, was soon well established and well understood. Pawsey's paper on this subject is now regarded as one of the classics of radio astronomy.

The measurement of the temperature of the ionosphere was made shortly afterwards. This Pawsey did, picnic fashion, in the Burragorang Valley west of Sydney, an extremely deep gorge with nearly vertical sides and therefore well protected from noise from terrestrial sources. He built an antenna system pointing vertically at a frequency of 2MHz and measured temperatures which varied from 240K to 290K, in good agreement with those which had previously been deduced from theoretical considerations.

Following Hey's suggestion of enhanced noise from sunspots, Pawsey also noticed that the noise level from the quiet Sun increased many times in intensity when sunspots were present. Within a few weeks, by a delightful technique which became known as the *sea interferometer*, he accurately located the source of this enhanced noise on the face of the Sun and showed unequivocally that it came from the vicinity of sunspots.

I have a vivid recollection of describing these results, prior to their being published, at a lecture I gave at the Cavendish Laboratory in Cambridge on September 20th, 1946. For good measure I also mentioned D.F. Martyn's observation of circularly polarised radiation from sunspots, similarly unpublished. About thirty or forty members of the postwar Cavendish team were there, including Martin Ryle.

At the end of the lecture, Ryle rose quickly to his feet and assured the audience that on two counts I was dead wrong. The solar temperature could not possibly be a million degrees and there was something very wrong about Martyn's observation of circular polarisation. It was some time before they were to change their minds!

There was a very different response in the USA a few months later when, in December, I delivered a similar lecture at the newly built RCA Research Labo-

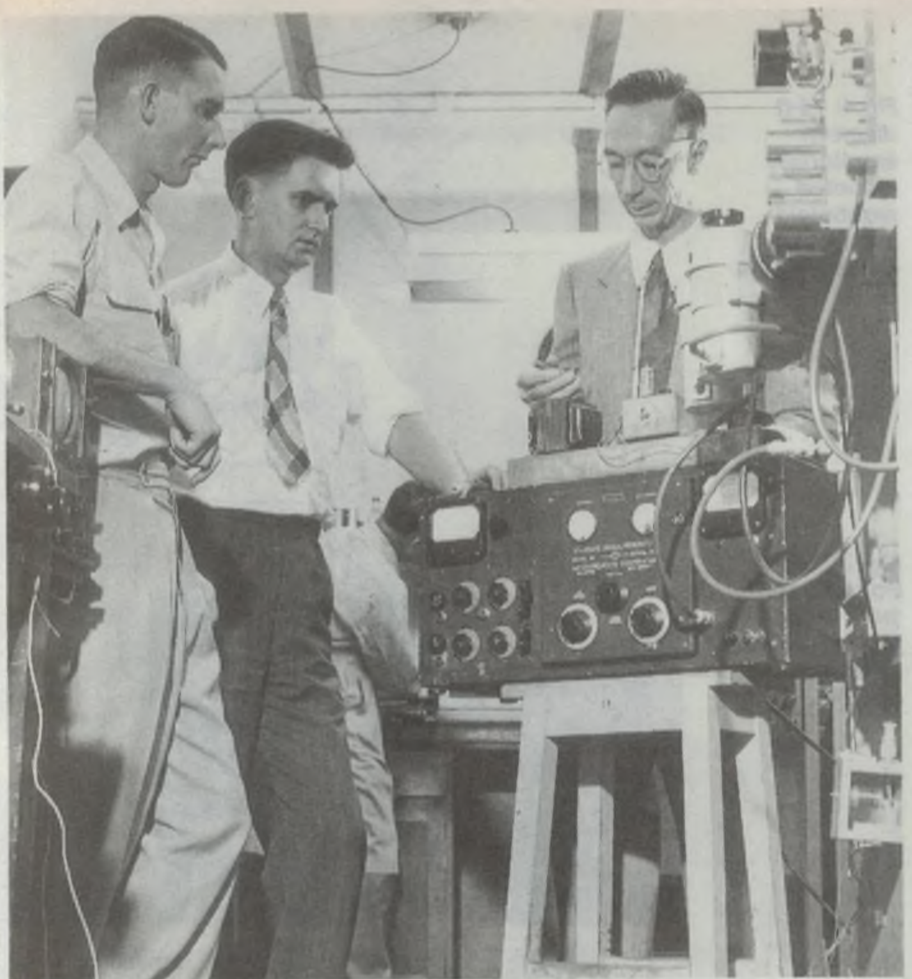


Fig.2: John Bolton, Gordon Stanley and Joe Pawsey (L to R) conferring in the Radiophysics laboratory in the early 1950's.

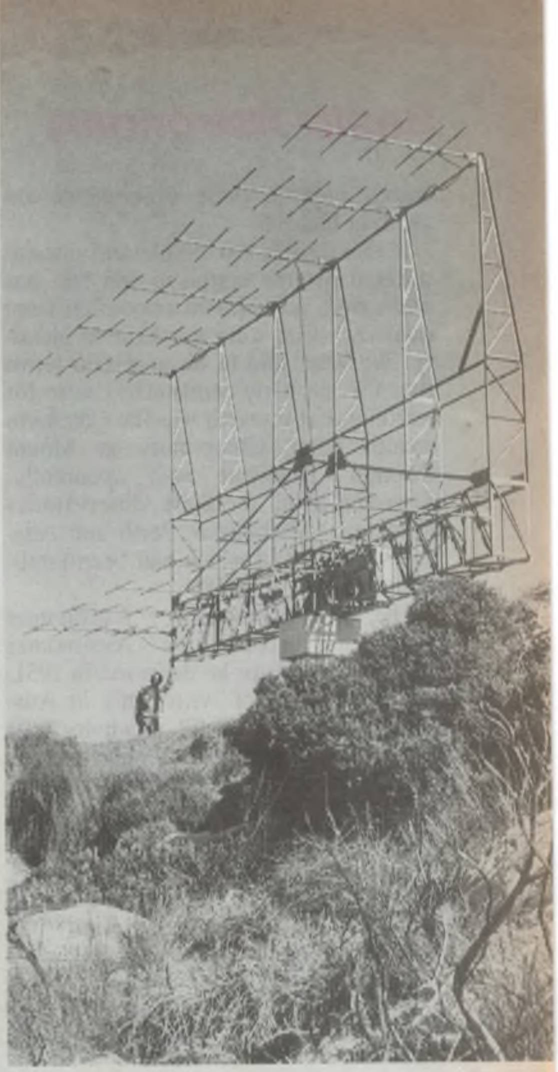


Fig.3: The 100MHz broadside array at Dover Heights, used as a sea interferometer around 1947. The human figure shows its size.

ratory in Princeton, NJ.

I knew many of the senior staff from the war years, but sitting in the front row was an individual I had never seen before. He was virtually jumping up and down with excitement at what he heard. After the lecture, he introduced himself as an optical astronomer who had been interested in radio astronomy since he was a graduate student at Harvard. His name was Jesse Greenstein. I like to think that he was the first of the optical astronomers to be converted to radio astronomy.

Further afield

John Bolton was among the first to turn his attention to galactic radiation. He had been trained at Cambridge University, had taken a commission in the British Navy and finished up as Radar Officer on an aircraft carrier in the pacific Fleet. At the end of the war he elected to be paid off in Sydney and, in answer to one of our regular advertisements, was appointed an Assistant Research Officer in 1946. He was in fact the first of the recruits to be appointed to the Division postwar.

He was an extremely talented researcher, with a yen for working on his own with a minimum of assistance. He applied the technique of accurate position-finding pioneered by Pawsey and focused his interest on some broad peaks in radiation from the galaxy, reported by both Reber and Hey. With further refinement of the direction-finding technique, Bolton showed that these peaks were very sharp indeed and he was able to put a limit on their size of 8 minutes of arc.

To us, this for the first time suggested that they were indeed 'point sources' and, assisted by Gordon Stanley (Fig.2), Bolton was soon able to identify three of them with known optical objects. In all cases they turned out to be astronomical freaks: the remains of the supernova of AD 1054 known as the Crab Nebula, and two unusual galaxies M87 and NGC5128.

There has been controversy over who first discovered discrete sources. At different times this has been attributed to Reber, to Hey and even to much later workers. To me the real discoverer was John Bolton. A careful reading of Reber's original papers shows that he only conceived of a broad maximum in galactic radiation, which was generally understood at that time to be due to emission from hot plasma in interstellar space, a concept which I personally could not swallow. When Bolton came along with his three identified sources, this opened up a whole new concept of galactic radio astronomy, one which is very much like that which we know today.

These were the first successes of the Radiophysics Division's radio astronomy program: Pawsey's observations of noise from the quiet and the disturbed Sun and Bolton's identification of discrete sources, and they were tremendously exciting. These were the events which persuaded us to pour considerable resources and manpower into the program, and in this we were fully supported by the far-seeing Executive of the CSIRO. Photographs of some of the aerials used in these experiments are given in Figs.3-5.

If this sounds too simple and uncomplicated, let me hasten to add that our plans were not without opposition from quarters which were not hard to identify. We were told in no uncertain terms that the 'properly constituted centre for astronomical research was the Commonwealth Solar Observatory at Mount Stromlo'. Someone had, apparently, forgotten about the State Observatories in Sydney, Melbourne, Perth and Adelaide, the first of which had been established as early as 1858!

The Commonwealth Astronomer (soon to become the Astronomer Royal) at a lecture he delivered in 1951, on 'The Future of Astronomy in Australia', managed to fill a whole hour without once mentioning radio astronomy. When asked afterwards "Where do you think radio astronomy will be in ten years' time?", he replied "It will be forgotten".

Fig.4: 16-ft diameter equatorially mounted paraboloid antenna at Dover Heights.

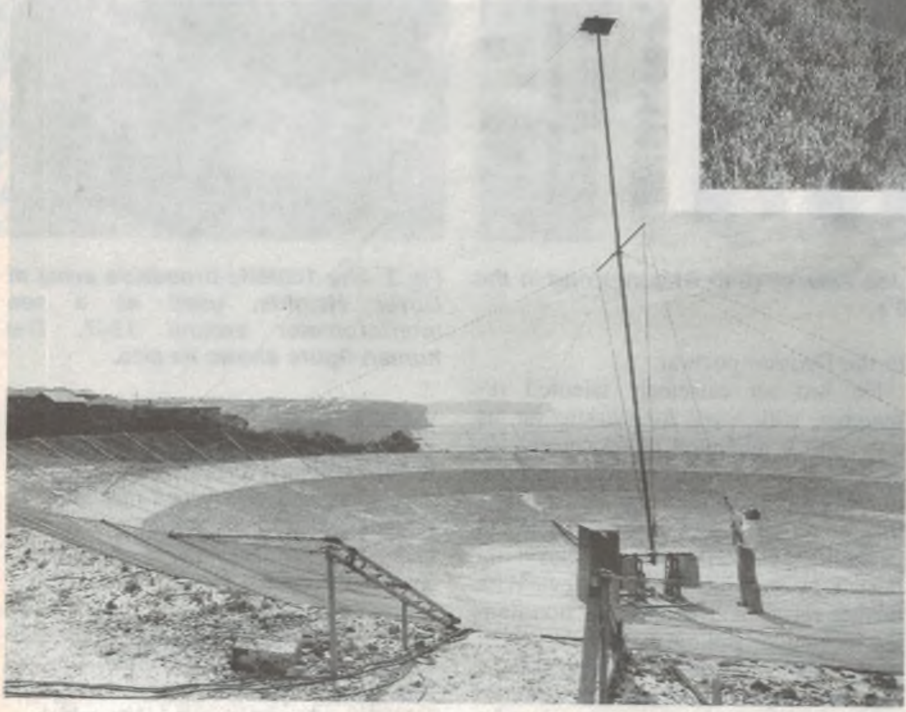


Fig.5 (below): Bolton's 80-ft 'hole in the ground' antenna at Dover Heights.

With that kind of advice being delivered in the nation's capital, our task was not always easy.

Progress in the 1950's

By 1950, the Division's commitment to radio astronomy had advanced well beyond the exploratory stage and was beginning to consolidate. For the next 30 years it was to continue as the main part of the Division's program and to command the greater part of its budget.

The program itself soon diversified to cover a complete range of solar, lunar, planetary, galactic and extra-galactic studies and was to involve a whole series of original instrumental developments, of a variety which would be difficult to find in any other establishment.

Within a year of Pawsey's original observations on sunspots, Ruby Payne-Scott, Yabsley and Bolton, observing independently at Dover Heights and Potts Hill (another Radiophysics field station) noticed that 'bursts' of noise coming from sunspots arrived at quite different times when observed at different frequencies.

It happened that during the war the Division, as part of a secret within a secret, had been involved in the construction of receivers for surveillance of enemy radio and radar transmissions. The basic method of carrying this out was to scan rapidly over a 2:1 frequency range and to cover the whole band of usable frequencies in a series of 2:1 steps.

Within the Division there was a substantial store of such receivers. These were ready-made for spectral analysis of the noise from the Sun and they were quickly pressed into service. In the inventive hands of Lindsay McCready and Paul Wild, a 'radio spectrometer' evolved which was to dominate the field of solar studies for the next 20 years. This was another instance of a device, designed in the first place for military use, repaying a massive debt to fundamental science. An early example of the antennas for such a spectrometer at the Division's field station at Dapto is shown in Fig.6.

In 1948, Piddington and Minnett refined Dicke's original measurements on the Moon and gave accurate surface temperatures for both the bright and the dark side of the Moon at a wavelength of 1.25cm. These showed a most intriguing fact, namely that the surface temperature lagged a whole 45° behind the actual phase of the Moon.

From a detailed consideration of the thermal conductivity, the electrical conductivity and the dielectric constant of different models of the lunar surface, they were able to deduce that the Moon was probably covered with a layer of non-conducting dust about 20mm deep. This prediction was confirmed in a spectacular fashion, when Armstrong and Aldren made their landing on the Moon in 1969. The antenna on which these measurements were made is shown in Fig.7.

About the same time, Frank Kerr, following earlier work by the US Signal Corps and by Bay in Hungary, received echoes from the Moon on frequencies of 17.84 and 21.54MHz. With the low resolution then available it was difficult to extract good physical information from these observations, but some information complementary to that of Piddington and Minnett was gleaned about surface roughness.

A significant 'miss' about this time was a failure to follow through on a hint about line radiation. Well before 1949, I had been urged by Rabi and Zacharias of Columbia University to look for spectral-line radiation in the Galaxy. Unfortunately, we were to focus our attention on the lines known to be most easily excited in the laboratory, like those from caesium and related elements.

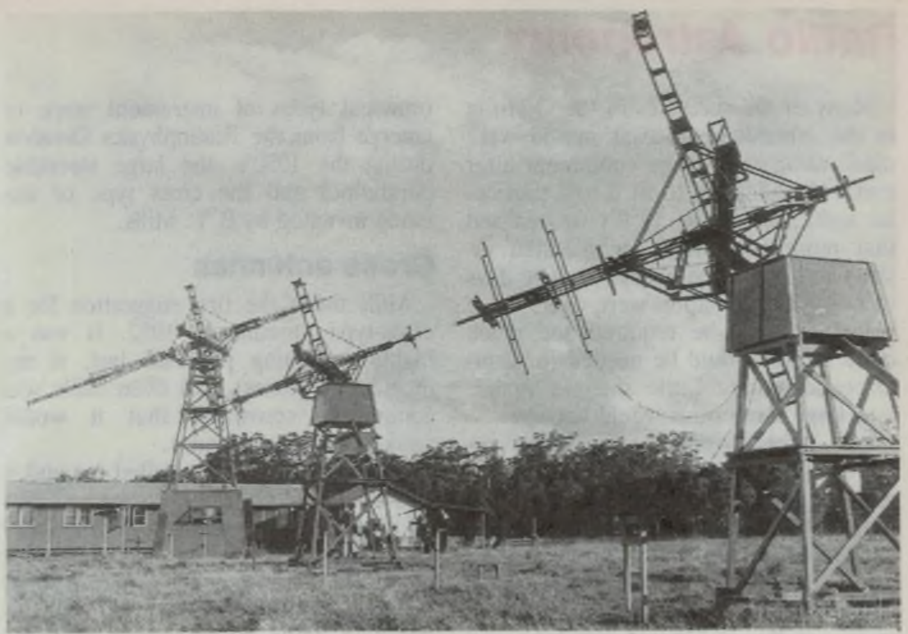


Fig.6: Rhombic antennas for one of the Division's early radio spectrometers, at Dapto, NSW. It was used for studying noise from the Sun.

We simply did not know about Van de Hulst's wartime suggestion of the 21cm line of interstellar atomic hydrogen as the most likely candidate. However, in 1951 Ewen and Purcell were kind enough to let us know of their discovery of the H-Line prior to publication, and we were able to verify it three weeks later.

Frank Kerr became our principal worker in this field and, in a fruitful collaboration with Oort and his coworkers at Leiden, gave an early account of the spiral structure of our own Galaxy. The aerial at Potts Hill which he used in these observations is shown in Fig.8.

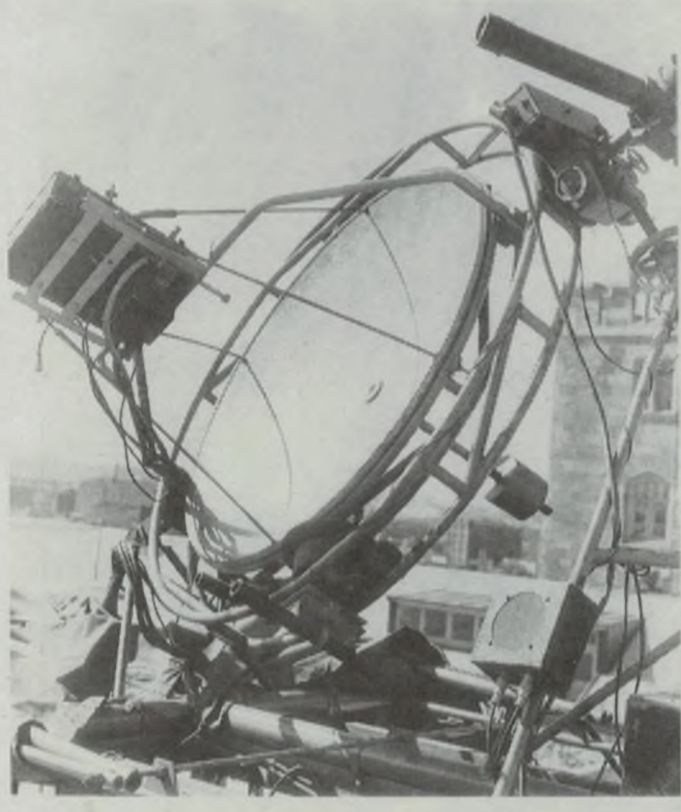


Fig.7: Piddington and Minnett's 1.25cm tracking antenna for measuring the surface temperature of the Moon, in 1949.

Fig.8 (below): 36-ft diameter transit instrument at Potts Hill, used mainly for H-line work.

Radio Astronomy

Many of the successes of the Division in the immediate postwar period were made using ex-wartime equipment after minor modification to fit it to a particular task. During the 1950's we realised that more and more sophisticated instruments would be necessary. The days of hasty improvisation were over; more planning would be required and much more money would be needed for capital expenditure. Little did we realise how large those sums would become.

For galactic and extragalactic research, two principal types of instrument were possible: the large steerable paraboloid and multi-element interferometer, of which many different varieties were proposed. At the technical level, argument about the relative merits of the two types was long and often vehement.

Fortunately, from a management point of view, our choice was easy. We simply decided to support both to the best of our ability. In this way, two principal types of instrument were to emerge from the Radiophysics Division during the 1950's, the large steerable paraboloid and the cross type of antenna invented by B.Y. Mills.

Cross antennas

Mills made the first suggestion for a cross-type antenna in 1952. It was a highly intriguing proposal but, if my memory is correct, not even Mills was completely convinced that it would work in the first instance.

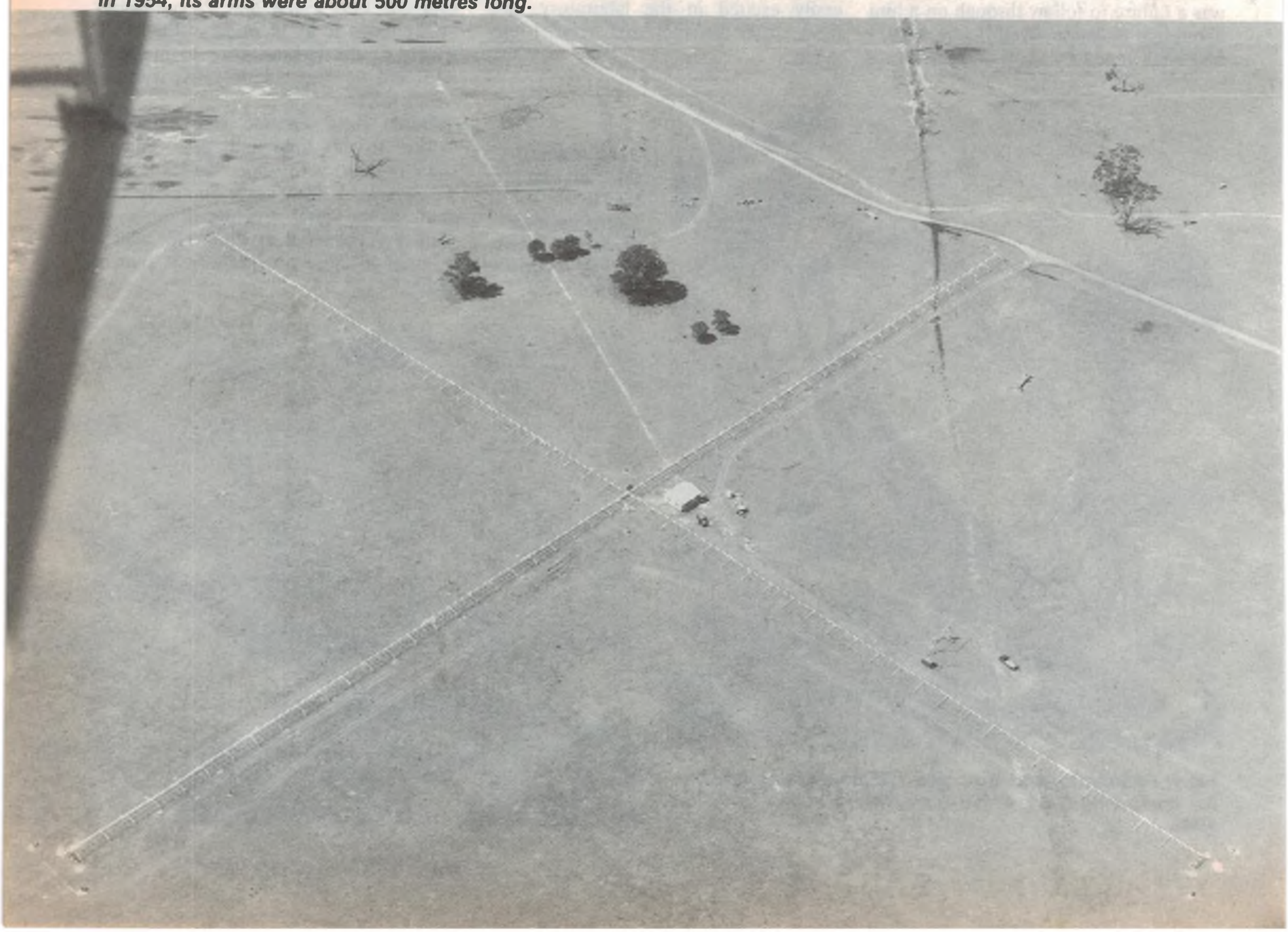
Obviously a trial was called for and it was typical of the way we worked that an experimental model with arms 120 feet long and operating on a frequency of 97MHz, was quickly constructed at our Potts Hill field station. With this instrument Mills demonstrated that the principle of the cross antenna was sound. It worked first time and, although small in size, successfully gave a profile of the Sun and several radio sources.

This success enocuraged us to increase the size of the instrument and therefore the resolving power, and during the next few years the Division was to build no fewer than three large crosses at a larger field station located at Fleurs – about forty kilometres west of Sydney. These were the Mills Cross (85MHz), completed in 1954, the Shain Cross (19.7MHz) completed in 1956 and the Chris-Cross (1410MHz) in 1957. They were among the great successes of the 1950's, and were responsible for a large part of the Division's research output over that period. Photographs of the Mills Cross and Chris-Cross aerials at Fleurs are given in Figs.9 and 10.

The Parkes telescope

As in optical astronomy, steerable parabolic antennas are a basic part of the instrumentation for radio astronomy; they played a prominent part in early galactic research, particularly in investigations of line radiation. As in other establishments, there was an urge to increase the aperture of such instruments to the largest possible dimen-

Fig.9: The 85MHz Mills Cross interferometer array at Fleurs Field Station, used for galactic and extragalactic work. Built in 1954, its arms were about 500 metres long.



sions.

Among the first options to be explored was a collaborative effort with our friends in the RAAF, with whom we had maintained a postwar connection. As early as 1949, we discussed with them the possibility of building a really large air-warning antennna, with linear dimensions of several hundred feet. Several designs were roughed out and costed, and at one stage there even seemed to be a possibility of going to a horizontal dimension of 500 feet.

Our interest in the project was based on the real hope that, if such an instrument were built for defence purposes, we would have the use of it for radio astronomy. Unfortunately, this expectation was not realised and it became clear that the RAAF would be even more squeezed for funds than the CSIRO. Slowly but surely, the prospect evaporated and some way had to be found for funding the project from within the Division's own budget.

So in 1952 a proposal was made for a cylindrical antenna lying on its back, 1000 feet long by 200 feet wide, constructed of five adjoining elements each 200 feet square. The cylinder would lie along an east-west line and would be steered by an arrangement of cables and winches in the north-south direction.

An important characteristic of the plan was that the units would cost about $25,000 each (a decidedly large sum in those days) and that one segment would be built each year for five successive years at a total cost of $125,000.

Had such an antenna been built, we would soon have realised the advantage to be gained by spreading the segments over a longer baseline. Sad to relate, this proposal was not proceeded with for lack of assurance that the money would continue to be available through the five year period.

Then a new factor appeared. During my frequent visits to the United States I used to discuss this and related problems with my old friends and colleagues from the war years. These were people with whom I had been involved in the days of microwave radar: Vannevar Bush, Chairman of OSRD (Office of Scientific Research and Development) during the war and at that time President of the Carnegie Institution of Washington; Alfred Loomis, Chairman of the OSRD Microwave Committee during the war, a multi-millionaire, a Trustee of both the Carnegie Corporation and the Rockefeller Foundation and a genuine scientist in his own right; Karl Compton, Deputy Chairman of OSRD and at that time President of MIT; Lee Dubridge, ex-Director of the Radiation Laboratory of MIT and then President of Caltech; all men of enormous stature in American science.

Fig.10: Closer view of the dishes forming the 1410MHz Chris-Cross array at Fleurs Field Station, built in 1957.

They were all concerned by the fact that the USA seemed to be falling behind in an important branch of science, and they asked my advice on what should be done about it. My advice was very simple: to set up an establishment with radio astronomy as its main objective, and a large steerable telescope as its principle instrument.

The proposal fell on receptive ears. It was these same people – the Carnegie Institution in collaboration with Caltech, who founded and ran the largest optical telescope in the world, the 200-inch instrument at Palomar. The world's largest radio telescope would fall nicely into place alongside it.

We settled on a diameter of 300 feet and, in reponse to a request from Lee Dubridge, I wrote a detailed specification for such an instrument in May 1952. This included approximate costs, together with a program of scientific activities which the telescope might be engaged upon.

This plan was not proceeded with in quite that form. At a later date (in January 1955) I arranged for Bolton and Stanley to be seconded to Caltech. This was to prove the starting point for radio astronomy in California.

Back in Australia, fortune turned our way once more. For reasons which I have never completely understood, Van Bush and Alfred Loomis rather suddenly took the view that the giant telescope could just as well be built in Australia, with financial backing from the USA.

Perhaps it was the feeling that America already had too many of the world's good things and that it was time to come to the help of other parts of the world. Certainly, the large foundations like Ford, Rockefeller and Carnegie itself were soon to change their emphasis from support for science to assisting social changes in various parts of the world.

A contributory factor was that, since the start of the war, the Carnegie Corporation had accumulated $250,000 which they were required to dispose of within the British Commonwealth. This was made up of several smaller sums, payment of which had been suspended pending the cessation of hostilities.

In April 1954, the Trustees of the

Radio Astronomy

Carnegie Corporation announced that the full sum of $250,000 would be granted towards the construction of a giant radio telescope in Australia. These were the very fortunate circumstances under which the Parkes radio telescope finally got under way.

This was followed, not entirely by chance, by a further quarter of a million dollars from the Rockefeller Foundation in December 1954. The person mostly responsible was Warren Weaver, Director of Physical Sciences for the Foundation. He again was an associate from the war years, a highly talented mathematician with responsibilities for anti-aircraft and naval gunnery predictors at OSRD.

But there is no doubt that in the background Alfred Loomis also played a prominent part, as he had done for many years in support of many different branches of science.

When this grant was made, Warren Weaver made a most important stipulation. It was that the $250,000 from Rockefeller would only be paid if the Australian Government matched it pound for pound – not only the Rockefeller grant, but all other grants from outside bodies.

On hearing this, the response was immediate. Sir Ian Clunies Ross, the Chairman of CSIRO, went straight to the then Prime Minister, Robert Menzies, and within a week or ten days the answer came that the Government would indeed match the grants. In the event, the Australian Government did even better because they over-matched, providing not only their share of the capital costs but the running costs as well.

The $250,000 from the Rockefeller Foundation was followed by a generous addition of $130,000 about a year later, when it became clear that costs were escalating beyond the original estimates. We had already cut the size of the telescope from 300 to 230 feet in an effort to contain the costs and, in the end, a further cut to 210 feet was necessary. Australian scientists will always be grateful for the extraordinarily generous grants from our American colleagues which made this project possible.

On receipt of the grant from the Carnegie Corporation, the project became active and we engaged in preliminary design studies. The basic concept was quite clear: a parabolic antenna of the largest possible aperture, steerable over a large part of the sky, but the options were wide open.

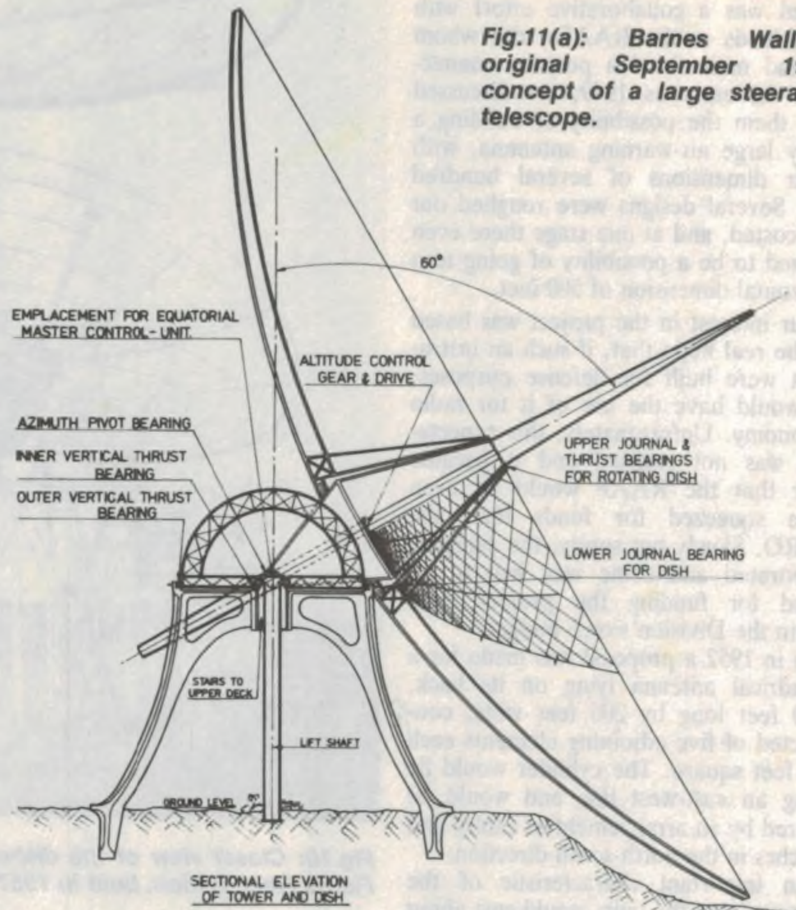


Fig.11(a): Barnes Wallis's original September 1955 concept of a large steerable telescope.

We looked at everything: alt-azimuth and equatorial mounts, holes int he ground, virtually nothing was excluded at that stage. We sought advice from the engineering fraternity in Australia, the USA and Britain and several things became very clear.

In those days there was simply no-one in Australia who could handle the design work. Professor Roderick of the School of Engineering at Sydney University and H.A. Wills of the Aeronautical Research Laboratory were extremely helpful, and both advised that we should go to Britain for the design work. We knew that the USA could certainly do it, but the costs were likely to be beyond our means.

So to Britain we went. There it was the great Sir Henry Tizard, who played such an important role in wartime radar, who advised us first of all to talk to Barnes Wallis. Incidentally, we also asked Tizard about the possibility of raising extra funds from philanthropic bodies in England, like the Nuffield Foundation. This turned out to be unproductive and he advised that our only hope lay in America, what about the Carnegie Corporation? He did not realise that we already had a grant from that source, or were about to get it.

So Barnes Wallis was the first person we talked to, a man with a tremendous reputation as the 'dambuster', the designer of the Wellington bomber and the builder of Britain's only successful airship, the R100. He was immediately enthusiastic, and full of ideas about the structural design of a giant steerable telescope.

These discussions started towards the end of 1954, and in September 1955 his ideas had formed sufficiently for him to write a report, which looks as impressive today as it did when we first received it. To illustrate how advanced his thoughts were, Fig.11 shows a sketch taken direct from his report and placed alongside a schematic of the Parkes telescope as actually built. Many details are the same or closely related, including the geodetic structure supporting the

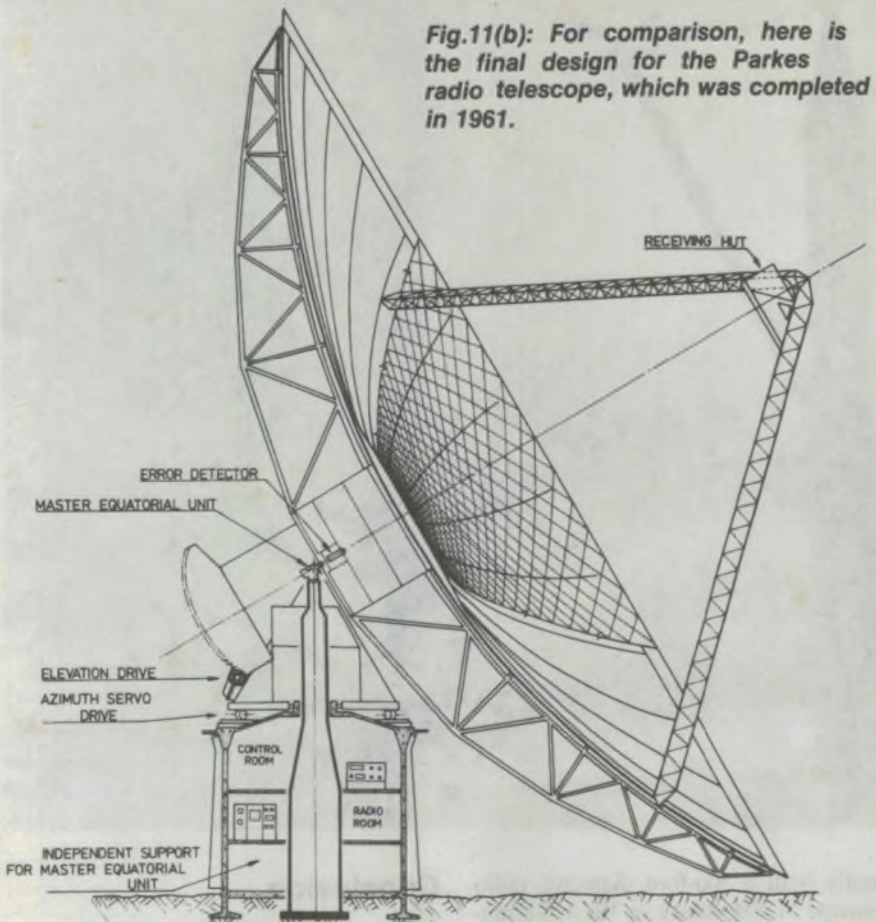


Fig.11(b): For comparison, here is the final design for the Parkes radio telescope, which was completed in 1961.

mesh and details of the azimuthal and elevation drive system.

Characteristically, his original drawing did not give a diameter, but he was quite certain that such an instrument could be built up to a thousand feet in diameter and he encouraged us to go for it and hang the cost! He refused to see any problems.

Deflection? He had two ways of solving this. At that time he held patents for incompressible columns – that is, columns of steel or aluminium which incorporated a servo compensator to adjust for any change of dimension under stress. One could break a structure made of such columns but one could not bend it!

His other solution was one which has been advocated by any number of people, namely automatic compensation of the parabolic shape. As is well known, we did eventually build a form of compensation into the Parkes telescope, the parabola-of-best-fit concept but this came from Freeman Fox and Partners, not from Barnes Wallis.

Not only did Barnes Wallis lay down important guidelines on the structural design but, virtually out of thin air, he invented the master equatorial drive system. He did this over lunch at the Athenaeum Club in London, a haven where distinguished scientists are apt to congregate to discuss their problems with kindred souls. Among others, Tizard is reputed to have solved many a wartime problem within those very walls.

About halfway through lunch, Barnes Wallis asked "How do you propose to drive this machine?" I gave him the conventional answer, which was that we would do it, analog fashion, from a small equatorial mount built alongside the main telescope.

It took him about 30 seconds, certainly not more than a minute. He pointed a finger at me and said "You're wrong. The place to put the equatorial unit is at the intersection of the two axes of rotation. You derive an error signal and servo this back to the main telescope. It's perfectly obvious that's the way to do it".

He went away and patented it that same afternoon, and from that moment it was part and parcel of the design. It was an enormously successful idea, which was to be incorporated in many other giant telescopes.

It was one thing to have concepts from Barnes Wallis, but something else to have a feasible engineering design. We were still to face the problem of who would do the detailed engineering and carry out the calculations necessary to establish the integrity of the structure. Again we focused on Great Britain and, after a further search, settled on Freeman Fox and Partners of London in 1956.

We sent Harry Minnett to act as our liaison man and to participate in the design of the drive and control system, on which Freeman Fox did not claim to have particular expertise. There followed a three-year period, the engineering design phase and, although it bothered us at the time, it was time extremely well spent.

In the event, the telescope took three years to design and only two and a half years to build. There is an important message there, for builders of exotic devices. There is no substitute for extremely careful study at the design stage; this is the way to save endless headaches later on.

The Freeman Fox design contract was completed in 1959, after which the MAN Company (Maschinenfabrik Augsberg Nurnberg A.G.) of West Germany was selected as prime contractor for construction of the instrument. We were extremely well served by both organisations and the telescope was completed in 1961.

It was commissioned at an impressive Opening Ceremony peformed by the Governor-General of Australia, Lord de Lisle, on October 31 1961, during which he amused his audience by reciting a delightful ditty which read as follows:

Twinkle twinkle radio star.
We can't see you; you're too far.
Now we hear from outer space.
How you run your cosmic race.

This is something which might serve as the theme song of radio astronomers everywhere. To us, the ceremony was a very satisfying and extraordinarily rapid culmination of our dreams.

After the Parkes Telescope was commissioned, a careful survey of the reflecting surface showed that it was an instrument of extraordinary precision. The surface accuracy originally called for was such that it should operate at

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full efficiency at the hydrogen line wavelength of 21 cm; in practice, it turned out to be considerably better than that and, when commissioned, it was already good for a wavelength of 10cm.

We soon realised that the back-up structure of the telescope was so stiff that the central parts of the surface could operate down to millimetre wavelengths, which made it a prime instrument for the study of the spectra of molecular lines of great significance like those of H_2O and CO.

In much the same way, the drive system also turned out to be of superlative performance. The telescope was a massive instrument of more than 500 tons of steel which, unlike an optical telescope was exposed to the open air. It was found that, even when subject to moderate winds, the accuracy with which it could track an object in the sky was better than that of any astronomical telescope yet built, with the possible exception of the famous 200-inch telescope at Mount Palomar.

During the next few years, it made an extensive survey of the radio sources in the southern sky and was the breeding ground for some important discoveries in radio science.

Apart from astronomical studies, it is not generally known that the Parkes Telescope also played an essential role in NASA's Moon landing program. It was an integral part of their tracking system for Apollo II and, although it was not publicised as such, it was the instrument which relayed pictures of man's first landing on the Moon to the rest of the world. During the ill-fated Apollo 13 mission, it played a crucial part in bringing the crew back to Earth at a time when they hovered on the brink of disaster.

The Parkes Telescope became a Mecca for designers of similar instruments elsewhere in the world and the lessons learned during its construction were passed on, notably to NASA in the USA. That organisation subsequently built no less than three 210-foot telescopes of very similar design for their space-tracking program. One of these was erected in the USA, one in Spain and another at Tidbinbilla here in Australia.

Similar lessons were learned by the MAN Company, which had played such a great part in the construction of the Parkes instrument. In collaboration with the Krupps Company, they subsequently built a 300-foot diameter radio telescope at Effelsbury in West Germany, currently the largest steerable telescope in the world.

At the time of writing, the telescope has completed 25 years of sterling service as a research instrument, during which a total of over a thousand research papers have been published. It seems destined to remain an important component in the Australian research scene until at least the turn of the century. Photographs of the telescope during construction and after completion are given in Figs.12 and 13.

The construction of the 64m telescope at Parkes meant that more and more of the Division's resources were steered in that direction, and it was inevitable that less attention could be given to the three cross antennas at Fleurs.

Reluctantly, it was decided that the Division could no longer provide support for them and in 1962 they were handed over as a going concern to the Electrical Engineering Department of Sydney University. There they continued to produce good research results under the guidance of Christiansen, who had become a Professor at that Department. They continued to give a good account of themselves until converted to synthesis instruments several years later.

Conclusion

The work which I have just described was instrumental in giving Australia world-wide standing in an important new field of science, a situation which has been maintained to this day.

They were exciting times and those who participated in them will always remember the camaraderie and the sheer joy of living which went into it all.

At the same time, we must not forget the tremendous support which we received from successive Chairmen of CSIRO and the confidence which they placed in our activities. Likewise, the inspiration which came from overseas activities in similar fields and the magnificent support we received from the many friendly philanthropic bodies who supported us, at a time when capital sums for scientific research in Australia were very hard to come by.

The situation has now changed in a very significant fashion. At the present time a new and highly symbolic instrument in Australian radio astronomy, the Australia Telescope, is nearing completion. This is an ambitious project, designed and supervised by the Division of Radiophysics but constructed for the benefit of all Australian astronomers.

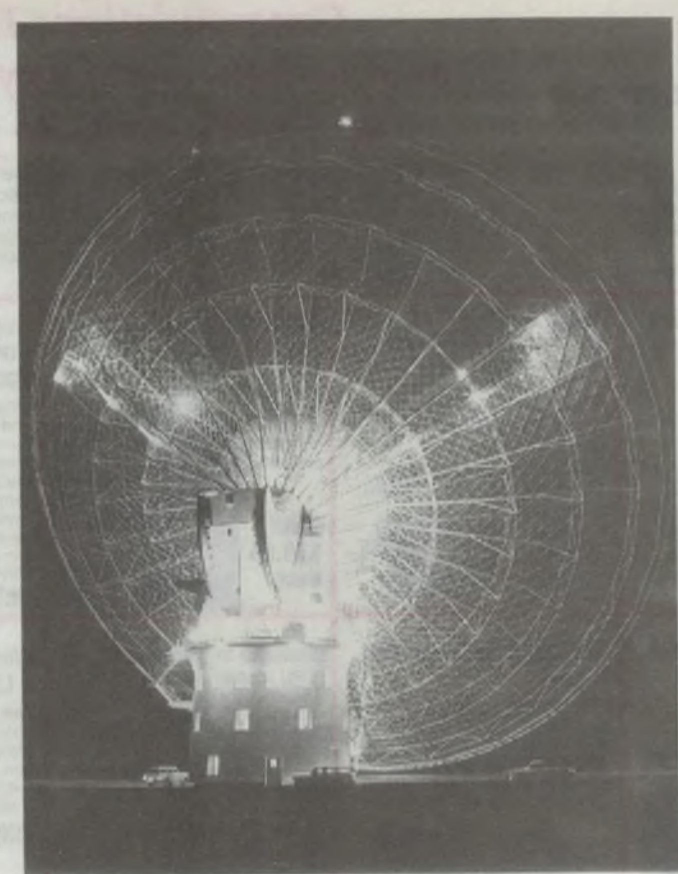

Fig.12 (left): The 64m Parkes radio telescope in course of construction, 1959.

Fig.13 (right): A night view of the completed Parkes telescope.

The Australia Telescope will bring the country up-to-date with current technology and lead it into the next century – not necessarily with a commanding lead, but with an even chance of holding its own with the rest of the world.

Once again, credit is due to the Australian Government for recognising the needs of the situation and providing the very substantial funds which have allowed that instrument to be built.

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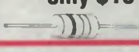

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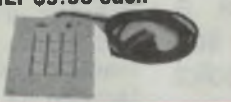

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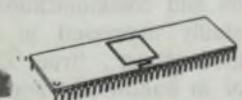

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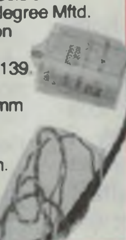

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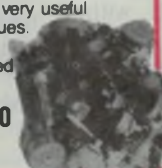

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Z4	IN4148 (IN914) Signal Diodes	100 for $4.00
Z5	IN4001 Power Diodes, 100V 1A	100 for $2.50
Z6	IN5401 Power Diodes 100V 3A	10 for $2.00
Z7	Wire wound Pot's with knob, 100, 220, 470 ohm, 1K ohm	4 for $1.50
Z8	Opto Switch – Infra Red emitter & Photo Transistor	2 for $3.95
Z9	OKI Reed relay, sealed, 24V 2 pole single throw	2 for $1.50
Z10	Mini 12 digit 7 segment Display & Data	5 for $3.00
Z11	3V Piezo Buzzers	$1.50
Z12	115VAC Blower Fans, Ex-Units but tested	$2.95
Z13	Crystals, 8MHz	$1.50
Z14	Crystals 4433.619MHz (Colourburst)	$1.50
Z15	Crystals 32.768MHz (Clock)	$1.00
Z16	Crystals 12.352000MHz (Oscillator)	$3.00
Z17	I.C. Skts. 30 Assorted 8, 16, 18, 22, 24, 28 & 40 way	$2.50
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Z21	Heavy Duty self adhesive rubber feet, 10 x 10mm x 8mm	4 for $0.75
Z22	DC-DC Car converter. 12V in, 6-9V out	$4.50
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Z25	Piezo Tweeter, Mini type, 140 ohm. 40mm dia	$1.75
Z26	Mini speaker, 8 ohm 0.1W, 40mm sq.	$1.25
Z27	Ceramic Microphones, desk type	$1.95
Z28	Dynamic Microphones, Hand held & holder. Low Imped.	$1.95
Z29	Extension Aerials, TV & Radio – 9" to 4ft.	$5.00
Z30	Record Cleaners, or "Dust-Bugs"	$3.00
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Z33	TV Tuners, 6 channel x 100K ohm Mini type	$0.75
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Z35	Tinned Copper Wire .914mm 500gr spools	$15.00
Z36	Tinned Copper Wire 18 swg 500gr spools	$15.00
Z37	Resistor Networks, 16 pin DIL, 5 ea. of 3.3 & 2.2K	$2.00
Z38	Transformer Pri: 240VAC Sec: 12V C/T 200Ma	$3.50
Z39	Computer lead 8' long 9 way "D" Skt to 6p skt.	$2.95
Z40	Disk drive (Sony) 3½" single sided, 400K slight faults	$10.00
Z41	Transformer Pri: 240VAC Sec: 9V 1A	$2.50
Z42	2SK216 'N' channel MOS/FET 200V 0.5A 30W (TO220)	5 for $9.00
Z43	Telephone Double Adaptors	$4.50
Z44	LM309 (7805K) 5V 1A Voltage regulators (TO3)	$0.95
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Z49	AY8149 Si. NPN Transistor(TO3) Sim to 2N3055	20 for $3.00
Z50	68000 8MHz Super CPU	$20.00
Z51	2795 Disk Controller chip	$5.50
Z52	1863 Disk Controller chip	$5.50
Z53	TIL312 Seven segment displays, common anode. Character Ht: 0.24"	5 for $5.00
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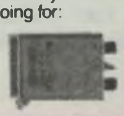

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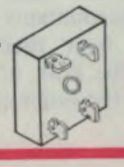

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50th Anniversary Feature:

The NEXT 50 Years – ever onward & upward?

On occasions like 50th birthdays, it's important not to dwell wholly on the past. But trying to look into the future is much harder, because it hasn't happened yet. Bearing in mind that most such predictions turn out to be wrong, here's a courageous and *down-to-earth* attempt to predict what lies ahead for electronics – surely an area even harder to predict than most.

by STEWART FIST

One's friends have long memories – even longer, perhaps than enemies. So it's with much trepidation that I've accepted Jim Rowe's invitation to stick my toe into the luke-warm waters of futurology.

What will the next 50 years of electronics be like? My guess is that a look ahead of 10 years is possible, 20 is stupid, and further than that is impossible and ridiculous. But when I said this to *EA*'s editor, all he said was "Yes, I know – but have a go, anyway!"

There are only two certainties about the 50 year mark, and God in his wisdom made them self-cancelling:

1. Whatever I predict will be wrong; but
2. By then (fortunately) all my friends will be dead.

So here goes. Excellence in technical innovation is a necessary condition for the future, but it doesn't, by itself, guarantee success. What communications technologies we have and use 10 or 50 years from now will not be decided primarily by what the Americans invent, the Japanese build, for a price Australians can afford to pay. The future is decided by the patterns of our work and leisure time, our collective personal interests, the emphasis we place on learning vs entertainment, and many other factors which can rightly only be measured by the psychologist and the sociologist.

And the balance of these societal factors change over the years, so to have any chance of glimpsing the future, we are also faced with the job of analysing these cultural changes.

The concept of working from home rather than in an office, for instance, is more a question of 'Do we want to work alone?' rather than 'Is the technology available?' The technology is available *now*, but apart from a few writers, programmers and consultants there's a most conspicuous absence of a Work-From-Home movement among unions.

There's another myth of technology that needs to be questioned early also, and that's the one that says 'More is necessarily better'. We see this with computers and communications all the time: usually expressed in terms of 'Unequalled power', 'true 32-bit processor' or in bandwidths and measures like MIPS, Megaflops, Whetstones and Dhrystones.

Is a PC running at 10MHz ten times as good as one running at 1MHz? Most of us would probably agree that it is marginally better, but by how much?

What if in the higher-speed model, 90% of the processing cycles are spent dollying up the user-interface? What if they are both only used for word processing? Is a 10,000-cell spreadsheet the state of the art, or an idiot's sand box?

Here is the problem. In order to get the economies of scale, manufacturers are churning out more and more powerful machines for people who have less and less need for power. The business end of the market is no longer selling just to accountants and engineers – they already have their powerful workstations. The bulk of future markets will be with the order clerk, the shipping office and the mail room.

For these people, and perhaps for 95% of all 'information workers' a 1 megabyte machine with one simple integrated program is more than they will ever require. If the makers put half the available power into making the interface easy for anyone to use, then you've got the Macintosh Plus – the base-level machine in Apple's range.

Power users will always need more power. When they have the equivalent of a Cray super-mainframe in their pocket, they will still want to simulate molecular flows by mapping the positions of a thousand billion individual particles in a state of chaos. Computers for power users will constantly advance – until their input flies up their output and they go into a permanent state of oscillation.

At the general business level, a desktop machine like the Macintosh II or the new IBM 386 machines already provides more hardware functionality than most of us are capable of using. Software still has a long way to go, and the IBM stream will spend the next few years catching up with Macintosh in terms of the graphics interface. Computers aren't about number-crunching any more.

But beyond a certain point, the Law of Diminishing Returns begins to operate. We haven't changed the basic design of the bicycle, the pencil or the telephone for 50 years because we haven't needed to – and I predict that it will soon be the same with computers. They are, after all, only tools.

We are still facing perhaps a decade when the computer establishes itself as a 'knowledge navigator' rather than a number cruncher or a word processor, and knowledge navigation implies efficient on-line multi-media services that will probably come about through ISDN telephone networks (for the next 10 years) and later fast packet-switching systems linking directly to your home and office.

Toshiba's new prototype colour videophone, which uses two 64kbit ISDN channels to provide moving images. But do users really want video phones?

Optical disks

Optical disks will be important, in the same way that books are important; there's always some forms of information that you like to keep yourself and not have to ask the library to supply. And disks like books are portable. However, there's no way that these electronic technologies are going to push out newspapers, books and magazines in my lifetime. Print is still the most efficient storage of information that we have – and it's ostentatious to read a laptop database while you are strap-hanging on the bus.

We now have CD-ROM disks that can store 600 megabytes of information – the equivalent of, say, 400 average books. The disks themselves can be produced ex-factory at prices in the $4 to $5 region (not counting the information they contain), which makes this the first medium which is substantially cheaper than paper. They have random access and are capable of holding sound, motion graphics, and even colour video. CD-ROM is a superb information storage medium that I predict will still be around in 50 years.

There – I've done it! My first unequivocal, unqualified prediction.

There are now at least six teams in the world (including one in Canberra) working on the 'Rainbow Disk' which uses material capable of storing a full visual spectrum in each 'spot' of information. You can add (theoretically) about 1 million bits of information to each spot, and there's a lot of spots on a CD disk. No one pretends that you will get the whole million, but even 100,000 would be quite spectacular.

These lines of information would appear like Fraunhofer lines in the reproduced spectrum – so theoretically we could, in the future, see one CD-ROM sized disk capable of holding 40,000,000 books. Let's be even more conservative and say only 10% of this – a mere 4 million books to each disk.

This really is the technocrat's version of what the legal-eagles call *reductio ad absurdum* – taking something to the ridiculous extremes. Who the hell actually *wants* 4 million books worth of information on one disk?

You are going to need a 100 Megaflop computer just to search the index, and by the time the disk is organised and produced a large part of the data will be outdated anyway. It would be far better to concentrate on providing cheap links to on-line databases which can be shared by everyone – then the collection of 4 or 400 million books does make sense.

The point I am trying to make here is that past a certain point, society often gets very little value out of technological improvements. Doubling the capacity of a floppy disk drive from 400K to 800K is a major step forward – doubling the capacity of a CD-ROM disk from 600 megabytes to 1200 megabytes is of little consequence, and jumping from 4 gigabytes to 8 gigabytes is of no consequence at all.

For text, the capacity of the present CD-ROM is probably more than adequate. For music, CD-Audio is good enough although another hour wouldn't hurt. For video it is clearly insufficient, although the 30cm versions will hold a couple of hours of compressed video. A quadrupling of capacity here wouldn't go astray – but that's all.

What we don't need now with the CD standards is a new technological breakthrough. We need a period of consolidation and refinement, so that enough people will actually buy the machines to make it profitable for publishers to make disks.

People aren't very rational when it comes to looking at our available technologies. Often old technologies aren't replaced by new for the best technological or pragmatic reasons, but by emotional or political ones. We regularly throw away the baby with the bathwater, but occasionally we come to our senses.

That's what happened to quadraphonic sound – the ultimate medium for people with four ears. And that's what now seems to be happening with undersea and terrestrial cable systems. Satellites are already old-hat when it comes to point-to-point communications.

Optical fibres

Optical fibre is the breakthrough here, of course. We seem to be moving relentlessly forward to a wired world, with arm-thick bundles of optical cable snaking across the Pacific and spreading out over the continent to link all of our capital cities.

This is prediction number two. Optical fibre cable will marry your house to the world within 20 years, but it won't be used for much more than telephone and television feeds – although some text services will be handy.

Have you still got that image of a

The next 50 years?

A laserdisc video player from Pioneer. Will CD-V help laser discs finally achieve consumer acceptance?

fibre bundle as thick as your arm snaking across the Pacific? Hold it for a second, while we do some calculations. These new halide-glass materials that Corning and others are developing for the next generation of fibres seem certain to be transparent enough to allow repeater spacing to go back from 30 to 500, or even a 1000 kilometres. Maybe eventually to 2000km.

Even taking the minimum figure, we can still link Australia to the world with halide fibre cables that don't require any undersea repeaters.

It is the power requirements of the repeaters every 30km under the sea that are the limitation of current optical fibre technologies. You have to feed them with about 7000 volts at the ends, and that creates secondary problems of insulation, copper weight and cable thickness.

By the time of halide fibres (say, in the late 1990s) we will have practical lasers capable of blinking at 4 gigabits per second – they've already exceeded this in a number of laboratories. Put these two facts together, and you'll find that each cable pair can then carry about 1 million telephone calls, and without the need for a copper power cable down the middle, our arm-thick bunch of fibres would be capable of, say conservatively, 200 million simultaneous telephone calls trans-Pacific.

Again, the solution becomes reduced to absurd limits. We've reached the point of diminishing returns with probably five or six of these fibre pairs. To use even part of this capacity, OTC will have to make it as cheap for me to talk to New York as it is to call my local pizza parlour. Maybe that will happen, but I can't see what we would have to talk about all that time.

Satellites

Satellites will certainly go back to being platforms for broadcasting and for point-to-point mobile links. They are superb at providing communications (including entertainment) for the remote areas of Australia, and to retaining radio and radio-fax links to aircraft, trucks and trains on the move. There's obviously plenty of room for new technologies here, although there is a finite limit to the number of slots available for geostationary satellites.

My guess is that the bandwidth available for up- and down-linking will increase (say double), and the geographical separation of satellites can be reduced down to about one degree. Then, with the takeover of the present TV distribution bands, Aussat should be able to provide twenty to a hundred times the number of currently available satellite-specific services.

However, this is one area where I doubt that we will ever be able to get enough. You only have to think of a population of 30 million all wanting their own personal mobile communications device, and you can already see problems in store.

Fortunately cellular phone technology seems able to supply most of the same services within a city area, without eating up much of the available broadcast bandwidth. Cellular is a great idea because it works on the 'Small is Beautiful' principle. If you want to double the capacity of a cellular system, you simply halve the broadcast range and re-use the same frequencies.

Some new parallel systems in Japan and Europe now only work when you've got line of sight to a standard street pay-phone, which seems to be a good way to bring down the price of portable telephones while reducing the size and retaining most of the features. There will be a lot more development in this technology.

Television

Let's look at TV – the most ubiquitous of all our communications devices. I think it would be fair to say that there's a prevailing opinion among futurologists that three radical changes will take place with TV in the next decade:

1. We will get widescreen high-definition TV (1000+ lines and 1.65:1 aspect ratios) with flat-screens.
2. We will move from the current essentially analog TV system to total digital.
3. We will eventually get 'true' 3D colour television, probably based on hologram technology.

It is worth examining these three concepts to see what lies behind them. Let's start with the Digital vs Analog argument first.

It is almost an article of faith at the present moment that digital is necessarily better than analog in virtually every aspect of information and communications. Again, our view of the world is blinded by our tendency to overlook the familiar.

The best of the full-colour graphic computers around at the present moment is undoubtedly the Macintosh II, which will set you back over $10,000. With four megabytes of RAM, the best available software, and the new 1.44 megabit floppy disks you still can't store and view good colour still images. But a hand-held optical viewer and a box of 35mm colour slides will do it better.

The analog storage capacity and quality of 35mm colour film is *phenomenal* by digital computer standards – hundreds of times better than the best available now on an area, weight or cost basis. Digital just happens to be more flexible, because I can manipulate the image, and cut and paste it into text for desktop publishing.

In short, the advantages of digital systems here is simply that digital is part of a wider standard that includes the storage and manipulation of text characters and numerical calculations. It is not the case that digital is intrinsically better than analoge for the storage and viewing of images. Even linear analog storage systems (like the VCR) have definite advantages at the present moment, and may have for quite a few years yet.

We see videodisc systems now moving to digital storage, but LaserVision video disk has been analog for many years. Why the change?

Again, it appears to be for standardisation reasons rather than quality. CD-ROM disks are part of a much wider digital disk standard, and if we can get our CD systems to handle video as well as audio and text, then we feel that we will be better off with one comprehensive system rather than two different technological channels. There is also the fact that each new application of CD builds on the research-base established by the others.

Digital technology's ability to retain quality for many generations is a major factor, but not an over-riding one when compared to the reduction in resolution that comes about through image compression. Maybe they will solve these problems and maybe they won't. There has to be a finite limit to video compression, and we must be getting pretty close now.

The decision we must make with digital video is either to accept image inferiority resulting from the necessary image compression techniques, or to accept that we must expand the bandwidth – which means a loss of time on disk storage, or loss of available channels in broadcasting. High definition TV (extra lines) and the additional length of line needed to provide the wide-screen effect are all going to add to these bandwidth costs.

The only long-term answer is city-wide cable delivery systems using optical fibre. I've got no doubt that this will come, and sooner rather than later. This year probably marks the watershed; we now have simple and economical ways now of linking optical fibres into standard twisted-pair telephone networks, so there can be a progressive change from copper-pair to optical-fibre in our streets from this point on. Progressive introduction is the only means by which our society can afford the change-over – in terms both of the monetary costs and the disruption to essential business and social services.

However I am not convinced that optical fibre necessarily implies digital television. If we've got such a wide avenue for almost unlimited bandwidth and a relatively interference-free delivery system, why are we bothering with digital anyway? Analog TV techniques are quite capable of co-existing with digital telephones and home security systems in a single fibre link. Many possible improvements of analog error-correction and noise-reduction systems also haven't been explored, because digital seemed to be the way to go.

High Definition TV (HDTV) seems to face no practical obstructions apart from the bandwidth requirements, but it may have economic resistance (from governments and from consumers) especially if it doesn't emerge from some world-wide standard. Potential purchasers need to feel confident of HDTV's long-term viability before they will change: like many other 'improved' technologies, the existing system is already better than adequate.

To attempt a quantification of this problem: in my estimation, the old monochrome TV supplied 60% of the ultimate potential of television for the average home viewer. Colour TV with modern electronics bought the figure up to, say, 80% and at the same time made the sets extremely reliable.

Stereo sound could add another, say, 5% (for some of the audience) which only leaves, in total, a guestimate of 15% 'perceived value' – at the most – for the combined technological marvels of high-definition, wide-screen, quadraphonic hifi sound, stereo 3D and/or hologram 3-D images. I'm discounting smell and touch for the time being!

My point is that we get about 85% of what we already want from the current system. These other items, even if they are possible, are only icing on the cake, and expensive icing at that.

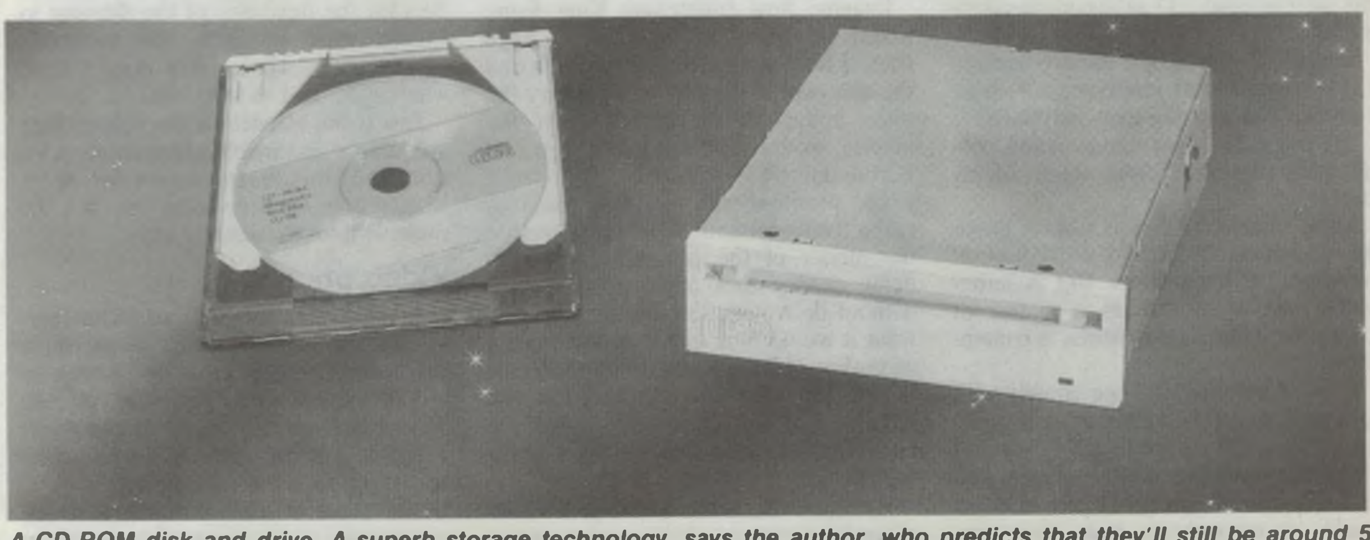
At best, any one of these improvements can only have marginal perceived value – probably wide-screen carries most weight, because a lot of movies need this format. Yet most of these techniques will require a completely new standard for transmission and reception. They are all greedy for bandwidth, which creates a problem both with terrestrial transmission and with satellites, and they can only be enjoyed with totally new libraries of special (three-dimension) productions.

The barrier against introduction is formidible, but obviously the Japanese think that they can do it – which doesn't necessarily mean that the world will follow. The USA wants to lead not follow, and Australia might have other priorities (like balance of payments) for a few more decades.

Wide-screen and high definition TV will probably come in the late 1990s, but don't expect a lemming-like rush to throw away the old equipment of the kind we saw when we changed over from B&W to colour. You may see this in countries like Japan, where conspicuous expenditure on electronics is seen as a national duty, but that's about all.

3-D Television

Three-dimensional TV offers logical, not just technical problems. This is a good case-study in the narrowness of focus of our technology writers and futurologists: virtually everything you



A CD-ROM disk and drive. A superb storage technology, says the author, who predicts that they'll still be around 50 years from now.

The next 50 years?

read on 3-D TV assumes that holograms are the answer.

But let's think about it. First of all, there are three quite different ways of creating the third dimension. The first is used by every film-maker in every film you ever saw, right back to D.W. Griffith and Cecil B. de Mille. It involves using techniques such as camera tracking, camera positioning, lens choice, selective focus, etc., and having actors move in front of distant objects.

Most of our daily view of depth in our world comes from these mental perceptions provided by parallax (the image shift when we move our head), cut-off (one object blocking out part of another), and the image size differences of objects at different distances. This is why current films and television appear so real. No one pretends that one-eyed people only see the world in two dimensions; it is every bit as solid for them as it is for us.

Filmmakers enhance these third dimension clues by selecting camera positions, heights, lenses and movement. This provides our eyes with, say, 90% of all possible third dimension information.

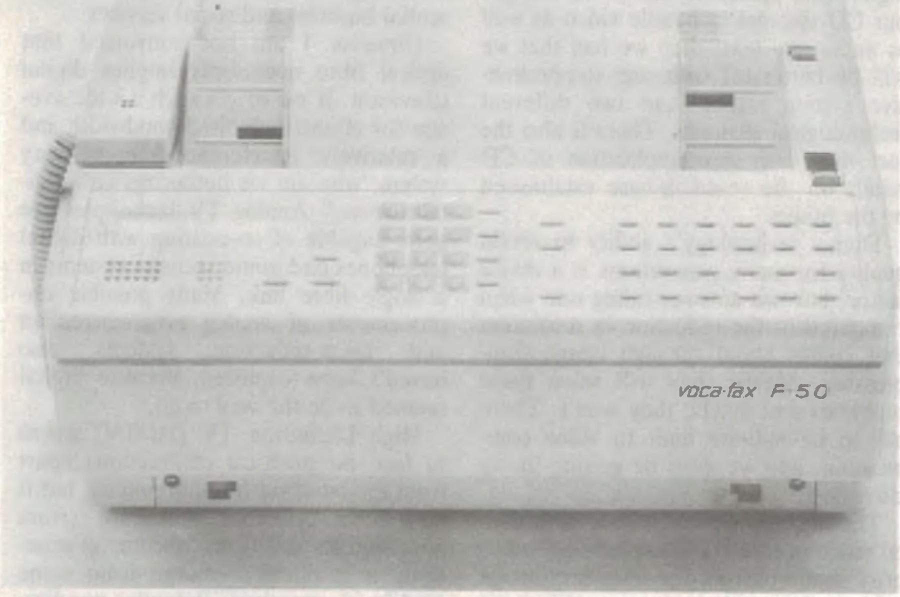
Stereoscopic vision – the type of 3-D effect we get when wearing Polaroid or red/blue glasses and watching 'Creature from the Black Lagoon' at the Cremorne Odeon – relies on feeding slightly dissimilar images to each eye. But the film simulation of stereoscopy is totally unreal.

Stereoscopy normally only adds to our visual 'reality' when objects are within a couple of metres. At distances of more than five or six metres, there's very little dissimilarity between the images and this stereoscopic 3-D information disappears.

Stereo 3-D works in a theatre because it is a distortion of reality, not because it mimics the way the eyes normally see – just like bass-boost makes many people think they are hearing high fidelity sound.

Stereo 3-D television is always possible, of course; we could do it now at the cost of bandwidth. But whether people will want this as a matter of course, on a day-to-day basis, is contentious.

A lot of people don't see equally with both eyes and this technique is disturbing to them. Many more get headaches when their eyes are fed this exaggerated dissimilarity in images. The Odeon would sell more Aspro than ice cream, when the 'creature' is running.



The new Voca-Fax F50 from Voca Communications. Not just a fax machine, but a telephone and personal copier as well – with inbuilt 64-page memory. An optional computer interface allows direct faxing and the F50 to be used as a scanner. The future home communicator?

So there are intrinsic problems here, no matter how sophisticated the delivery system.

The last myth to kill is that of the hologram-type 3D image. This can be of two types – both equally troublesome. The first is the chess-type 3-D that we saw with Hans Solo and Chewbacca in 'Star-Wars'. Remember when they were playing futuristic chess and they had the playing table with little 3-D animal/objects hopping around the board between them? This is one way that hologram TV could work, where we all sit around the table and watch.

Imagine how frightening King Kong would be when he grabbed up Faye Rae, if he was a gigantic 20cm high and she was two! It wouldn't really carry the same impact of the front-seat at the movies, would it? More like a Ken and Barbie doll set.

The problem with all these 'pseudo-realia' (walk-around) simulations, is that the maker of the program can't suddenly change shot angle or shot size, without destroying the illusion. Imagine what it would look like if he cut from a wide-shot of King Kong standing 20 cms tall on the table, to a close-up of the King's ferocious face. It would be laughable – a hairy John the Baptist, on a plate!

We find the same problem for the other hologram possibility – that of the small theatre with the hologram projection into a stage area. Again, the producer can't change sizes and angles without confusing the audience, so at best they can re-create some of the great theatrical stage techniques and thereby lose all the advantages of film and television's dramatic image control.

In fact, if you think about it, the best illusion of 'being there', of being involved in the action, came from the old wide-screen (3 projector) Cinerama. Providing peripheral vision is much more important than stereo or realia-type images. Involving the audience mentally in the action has much more to do with the flexibility of the director to choose what to show the audience; when; from whose view-point; from what angle; and in what size.

This is the essence of the film-making art; drama and involvement come more from what the director *leaves out* of his images than what he leaves in. It's the same with impressionistic art.

Video phones

Another good example of technological overkill is the video telephone which has been promised to us every year or two in the last fifty. This year, at last, (yawn) you can buy them off the shelf, if you've got the cash. But who really needs or wants a picture-phone?

I can think of some professions which would gain from being able to show plans or pictures to each other, and a few occasions (like showing the doctor my new body rash) where I would like to have the facility. But facsimile is better for plans, and the odd medical diagnosis wouldn't over-ride the number of times when I *don't* want people to see me when I'm talking.

Half of the social value of the telephone is that it reduces and restricts the amount of information communicated. For a start, it's a lot easier to lie over the phone than it is to fib face to face – and this is especially important with mobile phones that can be used from the beach. And it's a lot more comfortable to talk, pick your nose, take notes or make faces at the secretary, when the other person can't see you.

One reason for the success of facsimile is that fax limits communications even more than the telephone – it is information pared down to the bare essentials. The common idea that equates more with better in communications systems is often quite wrong. We often prefer to send a fax or a memo rather than telephone because we want to keep personalities out of the interchange – to present hard facts for action, and not get caught up with pleasentaries. Fax is *efficient*.

We should also be well aware that once we have purchased a video phone we are committed to using it, unless we deliberately choose to give offence – so picture phones have negative social implications which could quite possibly over-ride any perceived social value. I don't predict much future for this technology – discounting the group that buy Red Ferraris and smoke Havana cigars.

Summarising...

That is perhaps a good evaluation on which to end this article, before the editor starts tearing out essential copy for space. It emphasises the primary point that more is not necessarily better, and higher, newer or more complex communications technologies aren't necessarily any more effective than the old simple steam-driven standards, because social norms and Parkinson's law takes over.

Telex was a superb technology, and 50 characters per second is probably quite adequate for most informational exchange between business. A 20-page illustrated business report done on a colour Macintosh II with desktop publishing software and a laser printer will rarely contain more factual information than can fit in a 300-word telex – and it will take fifty times longer to read.

This is why, I suggest, a number of reports from the USA (including one from the Bureau of Labor and Statistics) are less than flattering about this decade of rapid office computerisation.

We are all experiencing the Microcomputer Age, and we've passed head-high through the Year of the LAN, while watching the dramatic shift from a blue collar labour force to predominantly 'information workers' slaving away over their IBMs in 'paperless offices'. In older, more cynical days, this used to be known as 'All chiefs but no Indians' – but now it's dignified as the Informational Society.

But in this computerised decade, office productivity has actually declined to the level of the 1960s.

It's even more discouraging for a technophile like me to realise that this decline has probably been A Good Thing. In an ideal world, I think I'd like to see office productivity down by 10% annually. In only a few years that would mean half the memos and half the length of the reports to be circulated and read. And then, given half the chance, we might even solve our balance of payments problem, with the consequential increase in industrial efficiency.

ROD IRVING ELECTRONICS

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

BRAND NEW FANS
Quality, new fans for use in power amps, computers, hotspot cooling etc. Anywhere you need plenty of air!

240V 4⅝"	Cat T12461	**$12.95**
115V 4⅝"	Cat T12463	**$12.95**
240V 3½"	Cat T12465	**$12.95**
115V 3½"	Cat T12467	**$12.95**

10+ fans (mixed) only $11.95 each

FAN GUARDS TO SUIT
4⅝"	Cat. T12471	**$3.95**
3½"	Cat. T12475	**$3.95**

BALL BEARING FANS
Quality, new ball bearing fans suitable for power amps, computers, hotspot cooling etc. Anywhere you need plenty of air!
240V 4⅝" T12464 **$14.95**
10+ fans only $13.95 each

MINIATURE HEATSINK
A great little fellow if you are short of space. Great price too, because we import direct so you save!
Size: 19(L) x 13(W) x 9(H)mm

Cat.No	1-9	10+
H10606	**$0.40**	**$0.35**

MAGNETIC BULK ERASER
The best and by far the quickest way to erase tapes, cassettes and computer disks! Reduces noise levels below recorders own erase head level. On/Off switch located in handle 240V AC operation.
Cat.C14950 .... **$34.95**

MAIL ORDER HOTLINE
008 335757
(TOLL FREE)
LOCAL: 543 7877

PIEZO SIREN
- 4 piezo units in a high impact plastic cabinet
- Input 12V DC - 200mA
- Output 115dB at 1m, dual tone
- Compact size 105 x 85 x 45mm
- Smart design suits interior use

Cat. S15071 .... **$24.95**

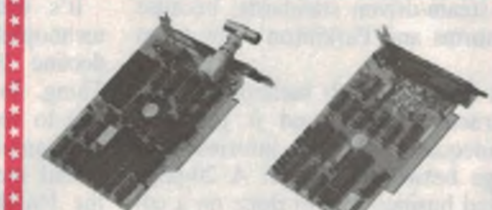
9 PIN TO 25 PIN CONNECTOR ADAPTORS
The perfect solution! Features gold plated pins.
X15668: DB9 Plug to DB25 Socket
X15669: DB9 Socket to DB25 Plug
..... **each $10.95**

U.S. TELEPHONE EXTENSION CABLE
- U.S. plug to U.S. socket
- Length 10 metres

Cat. Y16024 .... **$7.95**

U.S. TELEPHONE EXTENSION CABLE
- U.S. plug to 2 U.S. sockets
- Length 10 metres

Cat. Y16028 .... **$9.95**



R-NET/B INTERFACE NETWORK CARD
- Fully compatible with SMC PC 210
- Bus topology through RG-62 A/U coaxial cable
- Zero-Wait at 20 MHz or higher 80386 machine
- 2·5 Mbps transmission rate

Cat.X18156 .... **$330**

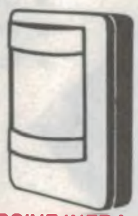
LANS UPS NETWORK CARD
- Fully compatible with Novell' UPS monitor board
- Built-in RS232 port, stereo phone jack and LAN UPS connector
- Supports power monitor, LAN UPS

Cat.X18158 .... **$350**

SAVE

P.A. SPEAKERS
Low dual cone, wide range 200mm (8in.) Ideal for public address, background music, etc. Tremendous Value at these prices! Cat.C12000

1-9	10+
$5.95	**$5.50**



PASSIVE INFRA-RED DETECTOR
(WP-800)

FEATURES:
- Walk test LED indicator
- Wall/corner/ceiling mount
- Micro switch tamper proof protection
- 24 detection beams in 3 different ranges
- N.C. silent S.P.S.T. dry relay contact output
- Alarm auto reset approximately 3 seconds after triggered
- Superior RFI immunity protection
- Very low power consumption
- Adjustable mounting bracket
- Easy installation and adjustment
- Dual element, low noise, high signal to noise ratio pyroelectric
- Detection degree indicator
- D.C. 8-16V power operating

S15079 .... **$89.95**

PORTABLE 16 DRAWER CABINET
- Overall size: 270(L) x 160(W) x 165(H)mm
- Drawer size: 142(L) x 56(W) x 31(H)mm
- Metal case, clear plastic drawers
- Carry strap
- Stackable or wall mountable

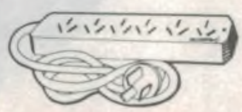
H10085 .... **$19.95**

42mm PIEZO BUZZER
S15073 .... **$7.95**

10 TURN WIRE WOUND POTENTIOMETER
Spectrol Model 534 ¼" shaft.
Equivalent (Bourns 3540S, Beckman 7256)
Dials to suit 16-1-11, 18-1-11, 21-1-11.

R14050	50R	R14100	5K
R14055	100R	R14110	10K
R14060	200R	R14120	20K
R14070	500R	R14130	50K
R14080	1K	R14140	100K
R14090	2K		

1-9	10+
$10.95	**$10.50**



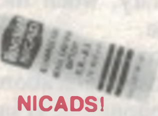
SURGE BUSTER!
6 PROTECTED POWER OUTLETS
Protect your valuable electronic equipment from damaging power surges. Ideal for protecting personal computers, video equipment, colour TVs, amplifiers, tuners, graphic equalisers, CD players etc.

SPECIFICATIONS:
Electrical rating: 240V AC, 50Hz, 10A
Complies with Australian Standards Approval number N10084
3 x Metal Oxide Varistors (MOV)
Surge/Spike Rating (each MOV): 4,500 amps (8x 20us)
Energy Absorb. Factor each MOV: 75 joules (10 x 1000us)
Maximum Clamping Voltage: each MOV: 710 volts at 50 amps
Response time: Less than 25 Nanoseconds.

X10086 .... **$69.95**

ECONOMY 19" RACK CASE
Save with this quality rack mount case complete with vents, handles and assembly screws. Tremendous value!
Dimensions: 480 x 134 x 250mm
Cat. H10415 .... **$44.95**

TDK LINE FILTERS
240 V 3A
Cat. **$12.50**



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

Size	Desc.	1-9	10+	100+
AA	450 mA H.	$2.95	$2.75	$2.50
C	1.2 A H.	$9.95	$9.50	$8.95
D	1.2 A H.	$9.95	$9.50	$8.95

POWER ADAPTORS 1 AMP POWER PACK
- 240V AC to 6/7.5/9/12V DC
- Ideal for workshop
- DC connections via unique multi plug adaptor system
- Sizes 2.5, 3.5mm phone and 2.1, 2.5mm DC plug
- Cord 1.6 metre long

Cat. M19010 ...... **$36.95**

MODEM TRANSFORMER
PCB pins, spacing 25mm equipment to line, 15mm between equipment pins, 25mm between line pins

CAT.No	1-9	10+
M10230	**$14.95**	**$13.95**

4A REGULATED POWER PACK
- 240V AC input to 13·8V DC regulated 1A outlet
- Ideal for CB, ham radio, and other high power applications
- Fully overload and short circuit protected
- Will handle up to 6A surge current
- Ripple less than 10mV peak-peak
- Large heatsink and vent system for cooling
- Outputs: screw terminals or 4mm banana sockets
- Illuminated on/off switch
- Fuse protected
- Approved by the Department of Energy

M19032 .... **$139**

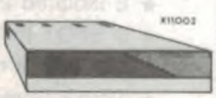
DIECAST BOXES
Diecast boxes are excellent for RF shielding, and strength. Screws are provided with each box.

H11451	100 x 50 x 25mm	$ 5.95
H11452	110 x 60 x 30mm	$ 6.50
H11453	120 x 65 x 40mm	$ 6.95
H11461	120 x 94 x 53mm	$11.50
H11462	188 x 120 x 78mm	$13.50
H11464	188 x 188 x 64mm	$29.50

SLOPING FRONT INSTRUMENT CASE
Plastic with metal front panel, available in two sizes
H10450 190 x 120mm **$12.95**
H10455 265 x 185mm **$21.95**
(measurements are approximate only)

K&W METAL INSTRUMENT CASES
Used in many projects, these cases have hammertone finish and are both versatile and economical.

H10478	125 x 40 x 65mm	$ 5.95
H10479	150 x 55 x 95mm	$ 6.95
H10480	100 x 92 x 130mm	$ 8.95
H10481	150 x 55 x 100mm	$ 7.95
H10482	200 x 80 x 130mm	$ 9.95
H10485	255 x 92 x 155mm	$14.95
H10487	255 x 165 x 155mm	$16.95
H10489	305 x 105 x 200mm	$16.95



DUAL 8" SLIMLINE DRIVE CASE
X11025 Bare Case $109
X11026 Case & Power Supp. $275

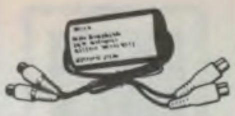
SINGLE 8" SLIMLINE DRIVE CASE
X11020 Bare Case $109
X11022 Case & Power Supp. $179

5¼" SLIMLINE DRIVE CASE
X11001 Bare Case $49
X11011 Case & Power Supp. $109

2 x 5¼" SLIMLINE DRIVES CASE
X11002 Bare Case $69
X11012 Case & Power Supp. $149

3½" DRIVE CASE
X11042 Bare Case $59
X11044 Case & Power Supp. $129

DUAL 3½" DRIVE CASE
X11046 Bare Case $79
X11048 Case & Power Supp. $139



RCA TO RCA ISOLATION TRANSFORMER

- 15A high quality noise suppressor isolation transformer
- Designed to eliminate noise in the audio line
- Does not affect the audio signal
- Simply fits inline between car stereo and the separate power amplifier

M10038 .... **$15.95**

RELAYS

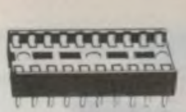
	1-9	10+	100+
S.P.D.T. 3A connectors S14060	**$1.50**	**$1.30**	**$1.10**
D.P.D.T. 3A connectors S14061	**$1.95**	**$1.75**	**$1.30**
S.P.D.T. 12V Coil 10A 240V S14114	**$7.95**	**$7.50**	**$6.95**

RECHARGEABLE 12V 1.2AH GELL BATTERY

Leakproof, long service life batteries ideal for security systems, emergency lighting or as a computer backup power supply, etc.

Cat. S15029 .... **Normally $19.95**

1-9 **$13.95** 10+ **$12.95**



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	$0.15
P10560	14 pin	$0.25	$0.20
P10565	16 pin	$0.35	$0.20
P10567	18 pin	$0.40	$0.30
P10568	20 pin	$0.40	$0.30
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

SEMICONDUCTORS!

ALWAYS CHECK OUR PRICES BEFORE YOU BUY!

	1-9	10+
4164-12	$5.40	$5.00
41256-12	$18.50	$17.50
2764	$5.95	$5.50
27256	$10.95	$10.50
27512	$23.95	$22.95
62256	$35.00	$32.00

NEW LM12CLK

150W OP AMP **$39.95**

SP0256 SPEECH CHIP

$21.95

8087 CHIPS

GENUINE INTEL CHIPS!

8087-3 (4.77MHz)	$245
8087-2 (8MHz)	$350
8087-1 (10MHz)	$475
80287-6 (6MHz)	$375
80287-8 (8MHz)	$555
80287-10 (10MHz)	$690
80387-16 (16MHz)	$999
80387-20 (20MHz)	$1460
80387-25 (25MHz)	$1860

HUGE RANGE AT GREAT PRICES

ROD IRVING ELECTRONICS

GENERAL PURPOSE TRANSISTORS

PN100: a NPN general purpose medium power amp and switch with continuous collector current up to 500mA

PN200: a PNP general purpose amp at collector currents to 1 Amp.

Both are TO-82 plastic package

PN100 REPLACES:
PN2221, PN2222, PN2222A, PN3585, PN3568, PN3569, PN3643, PN5133, 2N2219A, 2N2222A, 2N3414, 2N3415, 2N3416, 2N3417, 2N3700, 2N3704, 2N3904, 2N4123, 2N4124, 2N4401, 2N5088, 2N5210

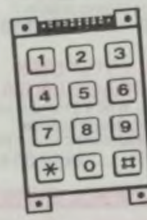
PN200 REPLACES:
PN2907, PN2907A, PN3638, PN3638A, PN3640, PN3644, PN4121, PN4143, PN4249, PN4249, PN4250, PN4355, PN4916, PN4917, PN5910, 2N2905A, 2N3467, 2N3702, 2N3906, 2N4125, 2N4126, 2N4291, 2N4402, 2N4403, 2N5086, 2N5087, 2N5447

PN100 Cat. T90001
PN200 Cat. T90002

1-9	10+	100+
$0.20	**$0.18**	**$0.15**

SPECTROL 64Y MULTI TURN TRIMPOTS

Cat.No	Description	1-9	10+
R14700	10R	$3.50	$3.20
R14710	20R	$3.50	$3.20
R14720	50R	$3.50	$3.20
R14730	100R	$3.50	$3.20
R14740	200R	$3.50	$3.20
R14750	500R	$3.50	$3.20
R14760	1K	$3.50	$3.20
R14770	2K	$3.50	$3.20
R14780	5K	$3.50	$3.20
R14790	10K	$3.50	$3.20
R14800	20K	$3.50	$3.20
R14810	50K	$3.50	$3.20
R14820	100K	$3.50	$3.20
R14830	200K	$3.50	$3.20
R14840	500K	$3.50	$3.20
R14850	1M	$3.50	$3.20



NUMERIC KEYPAD

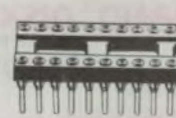
Unencoded keypad, 10 digit keys plus two utility keys. Light grey in colour

OUTPUT ARRANGEMENT:

Output Pin Nº	Symbol
1	N.A.
2	Shield plate
3	Column 2
4	Row 4
5	Column 3
6	Row 1
7	Column 1
8	Row 2
9	Row 3
10	N.A.

Cat C19030

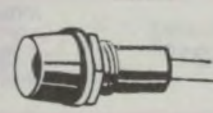
1-9	10+	100+
$2.95	**$2.50**	**$1.95**



GOLD INSERT LOW PROFILE IC SOCKETS

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

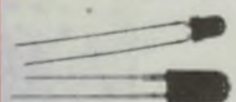
Cat.No.	Description	1-9	10+
P10620	8 pin	$1.20	$1.10
P10624	14 pin	$1.60	$1.50
P10626	16 pin	$1.90	$1.80
P10628	18 pin	$2.00	$1.80
P10630	20 pin	$2.20	$2.00
P10632	22 pin	$2.40	$2.20
P10634	24 pin	$2.60	$2.40
P10640	28 pin	$2.90	$2.60
P10644	40 pin	$3.00	$2.70



CHROME LED BEZELS

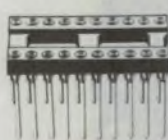
9mm hole, available 3 colours

Cat.No.	Description	Price
S14030	Red	**$1.20**
S14032	Green	**$1.45**
S14034	Yellow	**$1.45**



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**



WIRE WRAP IC SOCKETS

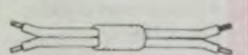
These quality 3 level wire wrap sockets are tin-plated phosphor bronze.

Cat.No.	Description	1-9	10+
P10579	8 pin	$1.50	$1.40
P10580	14 pin	$1.85	$1.70
P10585	16 pin	$1.95	$1.80
P10587	18 pin	$1.95	$1.80
P10590	20 pin	$2.95	$2.70
P10592	22 pin	$2.95	$2.70
P10594	24 pin	$3.95	$3.50
P10596	28 pin	$3.95	$3.50
P10598	40 pin	$4.95	$4.50

PANEL METERS GALORE!

We have a great range of panel meters at great prices!

Cat.No.	Description	Price
Q10500	MU45 0-1mA	12.50
Q10502	MU45 0-50uA	12.50
Q10504	MU45 0-100uA	12.50
Q10510	MU45 0-5A	12.50
Q10518	MU45 0-1A	12.50
Q10520	MU45 0-1A	12.50
Q10525	MU45 0-20V	12.50
Q10530	MU52E 0-1A	14.50
Q10533	MU52E 0-5A	14.50
Q10535	MU45 VU PMetre	14.95
Q10538	MU65 0-50uA	16.95
Q10540	MU65 0-1mA	16.95
Q10550	MU65 0-100uA	16.95
Q10560	MU65 0-20V	16.95



CAR BATTERY ISOLATOR

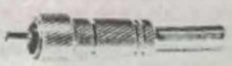
Designed for car burglar alarm back-up batteries, this isloator allows the back-up battery to be charged from the car battery while preventing the back-up battery from draining back to the car battery.

A12095 .... **$3.20**

CAR ANTENNA BOOSTER

- In-line instalation
- 12V boosts 100%

Cat.A12073 .... **$7.95**



RCA GOLD PLATED PLUGS AND SOCKETS

For those who need the ultimate in connection. Essential for compact disc players to get that fantastic sound quality.

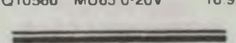
Plug (P10151) **$2.95**
Socket (P10150) **$2.25**

RCA GOLD PLATED CHASIS SOCKET

For the ultimate connection!

Cat. P10229 ...... Normally $1.75

1-9	10+	100+
$1.00	**$0.90**	**$0.85**



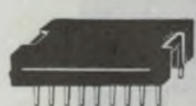
FERRITE AERIAL ROD

200mm x 9mm

Cat. L11401 .... **$2.75**

TEXTOOL SOCKETS

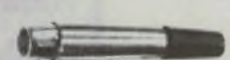
P17016 16 pin	**$14.95**
P17024 24 pin	**$18.50**
P17028 28 pin	**$24.95**
P17040 40 pin	**$29.50**



INSULATION DISPLACEMENT TYPE HEADER PLUGS

Gold plated ribbon cable plug that plugs directly into PCB mounting IC sockets. All include press-fit cap that fits into bottom half of plug over IDC cable.

Cat.No.	Description	1-9	10+
P12114	14 pin	$1.50	$1.40
P12116	16 pin	$1.60	$1.50
P12124	24 pin	$2.95	$2.75
P12140	40 pin	$5.95	$5.75



CANNON TYPE CONNECTORS AT SPECIAL PRICES!!

Cat. No.	Description	Price
P10960	3 pin line male Was $3.90	**NOW $2.90**
P10962	3 pin chasis male Was $3.00	**NOW $2.40**
P10964	3 pin line female Was $4.50	**NOW $3.25**
P10966	3 pin chasis female Was $4.95	**NOW $3.45**

GET MORE FOR YOUR DOLLAR WITH ROD IRVING ELECTRONICS!

Regardless of where you live in Australia, you can take advantage of Rod Irving Electronics' discount prices either through our Sydney and Melbourne stores or our Mail Order Service. Simply phone your orders through on (008) 33 5757 for the cost of only a local call. (Inquiries and local orders phone (03) 543 7877)

ROD IRVING ELECTRONICS

ROD IRVING ELECTRONICS

"NO BRAND" DISKS!

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 white paper jacket, and index labels. (5¼" disks includes write protects)

5¼" 2S/2D "NO BRAND" DISKS

10+DISKS	100+DISKS	1,000+DISKS
$6.50ea	$6.25ea	$6.00ea

(ALL PRICES PER 10 DISKS)

5¼" HIGH DENSITY DISKS

(DOUBLE SIDED)

10+DISKS	100+DISKS	1,000+DISKS
$21ea	$20ea	$19ea

(ALL PRICES PER 10 DISKS)

3½" 2S/2D "NO BRAND" DISKS

Suitable for IBM, PS/2, Macintosh, Atari, etc.

$21

(ALL PRICES PER 10 DISKS)

MICRODOT DISKS!

DESCRIPTION	1-9 BOXES	10+ BOXES
3½" 2S/2D	.......$23.95	$22.95
5¼" 2S/2D	.......$11.95	$10.95
5¼" 2S/HD	......$21.00	$20.00

VERBATIM DISKS!

(ALL PRICES PER BOX OF 10 DISKS)

DESCRIPTION	1-9 BOXES	10+BOXES
3½" 1S/2D	...$39.95	$37.95
3½" 2S/2D	...$46.95	$43.95
3½" 2S/HD	..$99.00	$89.00
5¼" 1S/2D	...$22.00	$21.00
5¼" 2S/2D	...$26.00	$24.00
5¼" 2S/4D	...$75.00	$70.00
5¼" 2S/HD	..$41.00	$39.00

5¼" DISK STORAGE

- 100 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16020 .... only $15.95

50 x 5¼" DISK STORAGE

- 50 x 5¼" disk capacity
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16025 ..... only $14.95

120 x 3½" DISK STORAGE UNIT

- Holds up to 120 x 3½" diskettes.
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16039 ..... only $21.95

80 x 3½" DISK STORAGE UNIT

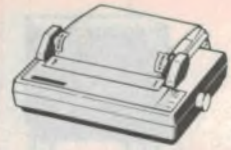
- Holds up to 80 x 3½" diskettes
- Smoked plastic hinged lid
- Lockable (2 keys supplied)

C16038 ..... only $19.95

40 x 3½" DISK STORAGE UNITS

- Holds up to 40 x 3½" diskettes
- Lockable (2 keys supplied)
- High impact plastic lid and base

C16035 ..... only $14.95



EPSON LX-800 PRINTER

- NLQ Mode
- 180 C.P.S. & 25 C.P.S.
- Tractor or friction feed
- Proportional printing
- Convenient push button control panel
- Standard Parallel interface

C22054 .... $495

PANASONIC KX-P1081 DOT MATRIX PRINTER

- 120 C.P.S.
- Pica or Elite character set
- Print Modes: NLQ, Dot Graphics, Draft, Proportional Font
- Reliable and Compact
- Proportional Printing
- Logic Seeking
- 1K Printer Buffer

C22050 ...... ONLY $379

SAMSUNG 20MHz COMPOSITE MONITOR

X14516 AMBER $109

GOLDSTAR 12" TTL MONITOR

X14502 AMBER $119

RITRON CGA COLOUR MONITOR

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 .... only $445

RITRON EGA COLOUR MONITOR

Quality monitors without the exorborant price tag!

Display Tube: 14 inch 90° deflection dot type black matrix Standard persistence phosphor

Active Display Area: 240 x 180mm

Resolution:
64 Colour: 720 dots(H) x 350 lines
16 Colour: 640 dots(H) x 200 lines

X14527 .... only $645

QUICK MOUSE

MICROSOFT* COMPATIBLE!

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

Cat.X19952 .... $94.95

ENCLOSED PRINTER STAND

- Keeps your paper and print-outs neat and orderly
- Transparent cover makes it easy to check on paper supply
- Paper can be fed from the centre or the rear according to the design of the printer
- Removable drawer which allows paper to be changed without moving the printer
- Retractable rear basket makes print-out collection fast and convenient
- Suitable for most printers

C21055 .... $59.95

COMPUTER PAPER

Quality paper at a low price!
2,000 sheets of 60 gsm bond paper.

C21003 11 x 9½" $39.95
C21005 15 x 11" $67.95

IBM* PC*/AT* EXTENSION BOARD

This allows the user to raise add on cards above the motherboard for ease of repair and testing

- + - 5 Volt fuses as power protection
- IBM* PC* AT* edge connector
- IDC connector for expansion to other interfaces via ribbon cable

H19120 .... $99.00

IBM* PC*/XT* EXTENSION CARD

This card will fit in the standard IBM* PC*/XT* expansion slot and allows you to repair and test IBM* PC*/XT* add on cards. It extends the add-on cards above the mother board for easy access. Standard IBM* PC*/XT* bus edge connector

H19115 .... $69.00

RITRON MULTISYNC VGA COLOUR MONITOR

Quality Auto VGA, EGA, CGA monitor without the high price tag!

Display Tube: 14 inch 90° deflection P22 Non-glare, tint 0.31mm Dot pitch.

Active Display Area: 245 x 185mm

Resolution: 800 dots(H) x 600 lines(V)

Display Colour: TTL input
TTL input: 8/16/64 colours
Analog input: unlimited colours

X14528 .... only $945

MONITOR MOVER ARM

Position your monitor exactly where you want it! Place your monitor in an ideal working position, or out of your way when you're not using it. Maximise desk space!

- Solid steel structure
- Height adjustment by knob (3cm - 27cm)
- Span 33cm
- Tray 30cm (tilting +/- 15°)
- Desk clamp range 3cm - 7.5cm
- Maximum load 50kg

C21079 .... $159

20 M/BYTE HARD DISK
Drive with controller card. IBM* compatible. 12 month warranty
X20010 ...... **ONLY $449**

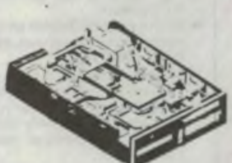
40 M/BYTE VOICE COIL HARD DISK
IBM* compatible. 28 msec access, 12 month warranty
Without controller .. **$895**

80 M/BYTE VOICE COIL HARD DISK
IBM* compatible. 25 msec access, 12 month warranty
Without controller **$1,595**

330 M/BYTE VOICE COIL HARD DISK
IBM* compatible. 18 msec access, ESDI, 12 month warranty
Without controller **$3,200**

EXTERNAL PS/2* COMPATIBLE 5¼" DISK DRIVES
Capacity: 360K/1.2 MB formatted
Track/Disk: 80/160
Track Density: 48/96 TPI
Number of Cylinders: 80
Average Access Time: 91 (94) msec
Settling Time: 15 msec
MTBF: greater 10,000 hours
MTTR: 30 min. or less
- External 37 pin connector cable
- Internal 40 pin adaptor cable for PS/2 drives
- Bracket for all PS/2 models
- 40 pin card edge
- Installation Guide

Cat.C11907 **$495**



QUALITY JAPANESE DRIVES!!

5¼" 360K DRIVE
- 500K unformatted.
- IBM* XT* compatible

Cat.C11901 .... **$239**

5¼" 720K DRIVE
- 1 M/Byte unformatted
- IBM* AT* compatible

Cat.C11906 .... **$269**

3½" 1.44 M/BYTE DRIVE
- Switchable 1.44 M/Byte formatted or 720K formatted
- Double sided, double density
- 5¼" mounted

Cat. C11911 .... **$225**

CONTROLLER CARD TO SUIT
X18009 .... $139

DATA CASSETTES
Save a small fortune with these quality 20 minute tapes. We import direct so we can pass on the savings.
Cat. D11141

1-9	10+	25+
$1.00	$0.90	$0.80

IBM* XT* COMPATIBLE COMPUTERS FROM $995
Check these features and our prices. We're sure you'll agree they're exceptional value for money!
- Final assembling and testing in Australia!
- Fast TURBO Motherboard
- AT* style keyboard
- Tested by us for 24 hours prior to delivery!
- 8 Slot motherboard
- 12 months warranty!
- 150W power supply

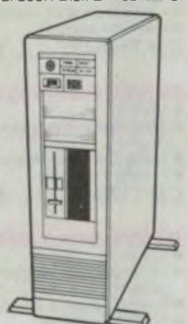
*$995 WORKSTATION COMPATIBLE COMPUTER
256K RAM, Single Drive, Graphics and Disk Controller Card **$995**

640K RAM TURBO COMPATIBLE COMPUTER
2 x 360K Disk Drives, Multifunction Card, Colour Graphics, Disk Controller, 1 Serial, Parallel Port. (Includes Timer Disk) **$1,195**

WITH 20 M/BYTE HARD DISK:
& single 360K Disk Drive **$1,495**
& dual 360K Disk Drives **$1,695**

WITH 40 M/BYTE HARD DISK:
& single 360K Disk Drive **$1,695**
& dual 360K Disk Drives **$1,895**

WITH 80 M/BYTE HARD DISK:
& single 360K Disk Drive ...... **CALL**
& dual 360K Disk Drives ...... **CALL**



386 TOWER PC
The 386 Tower PC is a high performance system that's IBM*AT* compatible. However, the 386 Tower PC gives you 2-5 times the performance.

FEATURES:
- Intel 80386-16MHz microprocessor
- Switchable 16/20 MHz
- 2 M/Byte fitted. Total memory expandable up to 16 M/Bytes
- Up to 2 M/Byte or 8 M/Byte RAM modules on system board or on RAM card
- Option for 80287 & 80387 co-processor socket
- Operates in page mode with interleave memory subsystem
- Shadow RAM supported to allow system BIOS to be executed on system memory instead of slower EPROM
- Four 16-bit I/O slot. Three 8-bit I/O slot, and one 32-bit memory slot
- 8042 keyboard controller interface for AT* compatible keyboard
- Seven direct memory access (DMA) channels
- Chips and Technology chip set
- AMI 386 BIOS/Phoenix 386 BIOS/ AWARD 386 BIOS (AMI fitted)
- 50 M/Byte hard disk, 42 M/Byte formatted. Fast access
- EGA card

$5,995

BABY AT* COMPATIBLE COMPUTER! 2 M/BYTE $2,695
- Final assembling and testing in Australia!
- 4 M/Byte Main Board, 2 M/Byte installed
- Switchable 8/10/12 MHz
- 1.2 M/Byte Floppy Disk Drive
- 80286 CPU
- Colour Graphics Display Card
- 8 Slots
- Floppy & Hard Disk Controller
- Printer Card and RS232
- Keyboard
- 200W Power Supply
- Manual
- 6 Months Warranty
- Size: 360(W) x 175(H) x 405(D)mm

With 20 M/Byte Hard Disk $2,695
With 40 M/Byte Hard Disk $2,895
With 80 M/Byte Hard Disk CALL

IBM* COMPATIBLE CARDS

VGA Card 256K RAM	only **$655**
VGA Card 512K RAM	only **$825**
EGA Card	only **$330**
Intelligent 6 port I/O Card	**$330**
EPROM Programming Card	**$345**
Extended 3.5 M/Byte (AT)	**$299**
Colour Graphics	**$99**
Floppy Disk Controllers	
360 K	**$52**
360K/1.2/1.44MB	**$139**
4 Way 1.44MB	**$159**
Printer Card	**$29**
Multi I/O Card	**$145**
Mono Graphics Printer/TTL	**$109**
Games Card	**$29**
RS232 Card	**$49**
RS232 & Clock Card	**$49**
Hard Disk Controller Card	**$195**
XT 8 MHz Turbo Motherboard excluding RAM	**$169**
XT 10 MHz Turbo Motherboard excluding RAM	**$199**
Serial/Parallel/Games	**$115**

TELECOMMUNICATION PLUG TO 2 SOCKETS.
Ideal for modem connections.
Cat.Y16014 .... **$12.95**

386 25MHz MAINBOARD
- Processor 80386-25
- Cache controller 82385-20
- Speed: 25 MHz or 20MHz
- Memory: 32KB Cache memory (35ns)
- 2 M/Byte RAM fitted (70ns)
- 2/8 MB plus 32 bit memory card
- Expansion slots: 1 x 32 bit, 5 x 16 bit, 2 x 8 bit
- Intel* Combo Chip set: 82230, 82231
- BIOS: AMI
- Landmark Test: 43.5 MHz
- LED display for speed indication
- Ability to run OS/2, MS/DOS, XENIX
- Real time clock/calendar with battery back up
- Baby AT* size board

X18105 .... **$4,395**

150W SWITCH MODE POWER SUPPLY FOR IBM* PC*/XT* & COMPATIBLES
DC OUTPUT: +5/13A, -5V/0.5A +12V/4.5A -12V/0.5A
Cat. X11096 .... **$129**

200W SWITCH MODE POWER SUPPLY FOR IBM* AT* & COMPATIBLE
DC OUTPUT: +5/16A, -5V/0.5A +12V/5A -12V/0.5A
Cat. X11097 .... **$199**

180W SWITCH MODE POWER SUPPLY FOR BABY AT* COMPATIBLES
Cat. X11098 .... **$169**

IBM* XT* COMPATIBLE CASE WITH AT* STYLING
Now you can have AT* styling in a XT* size case. Features security key switch, 8 slots, and mounting accessories.
Size: 490(W) x 145(H) x 400(D)
Cat. X11091 .... **$99**

TOWER COMPUTER CASING
Features security key switch, and mounting accessories etc.
Size: 165(W) x 600(H) x 500(D)
Cat.X11105 .... **$295**

BABY AT* STYLE COMPUTER CASING
Compact foot space. Features security key switch, 8 slots, and mounting accessories.
Size: 360(W) x 175(H) x 405(D)
Cat.X11093 .. **ONLY $99**

IBM* XT* COMPATIBLE CASE
XT* size and styling. Features security key switch, 8 slots, and mounting accessories.
Size: 490(W) x 390(D) x 140(H)
Cat. X11090 ... **only $69**

E-NET INTERFACE NETWORK CARD
- Fully compatible with Novell NE-1000 Ethernet card
- Built-in 15 pin D type connector
- 10 Mbps transmission rate
- Meets the IEEE 802.3 standard

Cat.X18160 .... **$489**

R-NET/S INTERFACE NETWORK CARD
- Fully compatible with SMC, Novell Arenet card
- Star-burst topology through RG-62 A/U coaxial cable
- Zero wait at 20MHz or higher 80386 machine
- 2.5 Mbps transmission rate

Cat.X18162 .... **$312**

ROD IRVING ELECTRONICS
All sales tax exempt orders and wholesale inquiries to:
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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

ROD IRVING ELECTRONICS

KITS! KITS! KITS! KITS! KITS!

PC DRIVEN FUNCTION GENERATOR
Here's a simple and low cost little unit which lets you use your PC 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!
Cat.K88111 .... **$49.95**

150W MOSFET POWER AMPLIFIER
Here's a high power, general purpose 150W Mosfet Power Amp Module! Suitable for guitar and P.A. applications and employing rugged, reliable Mosfets in the output stage. (ETI 499) (ETI March '82)
Cat.K44990 .... **$97.50**
(Heatsink not included)
plus transformer **$49.50**

SOLDERING IRON TEMPERATURE CONTROL KIT
An important factor in good soldering technique is the correct choice of soldering temperature. If you have put off buying a temperature controlled soldering iron because they are so expensive, your problems are solved with this low cost soldering iron temperature controller kit. It provides fully regulated, adjustable temperature control over a reasonably wide range and will work with just about any conventional 240V soldering iron rated from 20W to 75W. (ETI 1532, ETI Sept. '86)
Cat.K55320 .... **$24.95**

ELECTRONIC WATT METER
This unit will measure the power consumption of any mains appliance with a rating up to 3 kilowatts. It makes use of a special op amp called an "output transconductance amp" or OTA, for short. (EA Sept. '83) 83WM8
Cat.K83082 .... **$89.95**

NAIL FINDER
Essential for electricians and handymen. The Nail Finder will help locate timber studs behind Gyprock or plasterboard wall surfaces, as well as locating pipes and wiring behind walls. (EA Oct. '83)
Cat.K83100 .... **$11.95**

150W MOSFET POWER AMPLIFIER
Here's a high power, general purpose 150W Mosfet Power Amp Module! Suitable for guitar and P.A. applications and employing rugged, reliable Mosfets in the output stage. (ETI 499) (ETI March '82)
Cat.K44990 .... **$97.50**
(Heatsink not included)
plus transformer **$49.50**

SOUND PRESSURE METER
Noise is one of the many pressures of todays often stressful lifestyle. To be able to comabt noise in its many forms, you must be able to measure it. This low cost Sound Pressure Meter will measure sound levels of less than 30dB to more than 120dB, either fast or slow response to the "A" weighting curve. (EA, May '81, 81sp5)
Cat.K81053 .... **$39.50**

CRYSTAL CONTROLLED TV PATTERN GENERATOR
Anyone wishing to obtain the maximum performance from a colour TV reciever needs a pattern generator. Why not build this superb unit which provides five separate patterns; dot, crosshatch, checker board, grey scale and white raster? **Note:** The RIE kit includes a large ABS type case! (80pg6, EA June 80)
Cat.K80033 .... **$99.95**

AUDIO TEST UNIT KIT
Just about everyone these days who has a stereo system also has a good cassette deck, but not many people are able to get the best performance from it. Our Audio Test Unit allows you to set your cassette recorder's bias for optimum frequency response for a given tape or alternatively, it allows you to find out which tape is best for your recorder. (81AO10) (EA Oct '81)
Cat. K81101 .... **$59.50**

SLIDE CROSS-FADER
Want to put on really professional slide show? This slide cross-fader can provide smooth dissolves from one projector to another, initiate slide changing automatically from an in-built varialbe timer, and synchronise slide changes to pre-recorded commentary or music on a tape recorder. All this at a cost far less than comparable commercial units. (EA Nov '81) 81SS11
Cat. K81110 .... **$99.00**

MAIL ORDER 008 33 5757
PLACE YOUR ORDER FROM ANYWHERE IN AUSTRALIA FOR THE COST OF A LOCAL CALL. (STRICTLY ORDERS ONLY)

STANMORE SHOP!
74 PARRAMATTA RD, STANMORE
PHONE (02) 519 3134

VOCAL CANCELLER
If you have ever imagined yourself as lead vocalist/musician with a famous band, here is your chance to "audition"! You can cancel out the lead vocal on almost any stereo record and substitute your own voice or musical instrument. (EA April '82, 82vc3)
Cat.K82042 .... **$22.50**

100W SUB-WOOFER AMPLIFIER
Capable of up to 120 watts RMS into 4 ohm loads and up to 80 watts RMS into 8 ohm loads, this power amplifier module has been specifically designed for use as a sub-woofer driver amplifier in a tri-amped hi-fi system. It uses four power Mosfets for rugged, reliable operation. (EA July '82) (82PA7)
Cat.K82075 .... **$97.50**

ELECTRIC FENCE
Mains or battery powered, this electric fence controller is both inexpensive and versatile. Based on an automative ignition coil, it should prove an adequate deterrent to all manner of livestock. Additionally, its operation comforms to the relevant clauses of Australian Standard 3129. (EA Sept 82) 82EF9
Cat.K82092 .... **$19.95**

PHONE MINDER
Dubbed the Phone Minder, this handy gadget functions as both a bell extender and paging unit, or it can perform either function separately. (EA Feb '84) 84TP2
Cat.K84021 .... **$27.50**

VIDEO FADER CIRCUIT
Add a touch of professionalism to your video movies with this simple Video Fader Circuit. It enables you to fade a scene to black (and back again) without loss of picture lock (sync) or colour. (EA Jan '86, 85ft10)
Cat.K86010 .... **$24.95**

CD PLAYER ATTENUATOR
If you have just purchased a compact disc player your amplifier could be in trouble! CD players seem to have standardised on a 2V output level where as most Hi-Fi amps have a 500mV sensitivity for full rated output.
In order to overcome this you may need a CD Antenuator. It does not distort the signal in any way. It is inexpensive and simple to construct, making it an ideal beginners project. (EA '86)
Cat.K86011 .... **$7.95**

FAST NICAD CHARGER
This project is specifically designed for modellers and photographers who make heavy demands on Nicad betteries quite routinely. Theres nothing more frustrating than having your remote control model run out of juice as it runs/flies out of sight, or your flash run out of flash at an inappropiate moment. If you use Nicads and need a quick charge then this project is a must for you. (ETI 274, July '80)
Cat.K45630 .... **$79.95**

SPEAKER PROTECTION UNIT
An expensive speaker system can be readily destroyed by a 20 watt amplifier. Carelessness with a high power amplifier can melt voice coils like cheese on toast. However, with this Speaker Protection Unit you can avoid risking the misery and expense. (ETI455.)
Cat.K44550 .... **$44.95**

PC BOARD HOLDER
Better than an extra pair of hands! A must for all PCB work.
Cat. T12444 .... **$9.95**

ROYEL 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. (Note: This mode cannot be used continuously.) A range of 6 long-life tips are available.

ROYEL DR-30 (21 WATT)
- 3mm tip
- 240V operation, no transformer required
- Safety Standards Approved
- 6 months warranty

Cat T12640 .... **$39.50**

ROYEL DR-50 (30 WATT)
- 5mm tip
- 240V operation, no transformer required
- Safety Standards Approved
- 6 months warranty

Cat T12645 .... **$44.50**

ROYEL DR-60 (40 WATT)
- 6.5mm tip
- 240V operation, no transformer required
- Safety Standards Approved
- 6 months warranty

Cat T12650 .... **$49.50**

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). Features include:
- Chip drawer has conductive foam pad
- Mains powered
- High UV intensity at chip surface ensures EPROMs are thoroughly erased
- Engineered to prevent UV exposure
- Dimensions 217 x 80 x 68mm

WITHOUT TIMER
Cat. X14950 .... **Normally $97**
Special, $79

WITH BUILT-IN TIMER
Cat. X14955 .... **Normally $139**
Special, $99

PORTASOL PROFESSIONAL
- Four tools in one: Blow Torch, Hot Blow, 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 built-in flint for igniting Portasol tip
- Includes snap case for storage

Cat. 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

HAKKO 926 SOLDERING STATION
Quality, Safety and Performance!

FEATURES:
- Super quick heat up coupled with faster thermal recovery permits high quality soldering at lower tip temperature
- Built in ceramic heater sensor maintains temperatures within 0.5°C of the setting
- Soldering iron grip is heat insulated for operator comfort
- The soldering iron is low voltage 24V, and is completely isolated from the A.C. line by an insulated transformer
- A full wave zero crossing switch system is utilized to turn heater element ON and OFF
- The soldering tip is connected to earth ground

SPECIFICATIONS
Power Consumption AC100, 110, 120, 240V-60W. Output 24V
Temperature 200°C to 480°C
Insulation Resistance 50Mohm (480°C)
Leak Voltage under 0.6mV (between tip and ground)
Weight 1.5Kg without cord and iron stand
T12580 .... **$195**

MINIATURE HOBBY VICE
- Lever operated suction grip base for instant mounting and portability
- Mounts on smooth non-porous surfaces.
- Ideal for holding components, and other small/light objects.

Cat.T12458 . **only $6.45**

HUNG CHANG (RITRON) 20 MHz DUAL TRACE OSCILLOSCOPE

- Wide bandwidth and high sensitivity
- Internal graticule rectangular bright CRT
- Built in component tester
- Front panel trace rotater
- TV video sync filter
- Z axis (Intensity modulation)
- High sensitivity X-Y mode
- Very low power consumption
- Regulated power supply circuit

COMPONENT TESTER is the special circuit with which a single component or components in circuit can be easily tested. The display shows faults of components, size of a component value, and characteristics of components. This feature is ideal to trouble shoot solid state circuits and components with no circuit power. Testing signal (AC Max 2 mA) is supplied from the COMPONENT TEST IN terminal and the result of the test is fed back to the scope through the same test lead wire at the same time.

CRT
CRT: 6" (150mm) Flat-faced high brightness CRT with Internal Graticule
Effective display area: 8 x 10 div (1 div = 10 mm)
Acceleration potential: 2KV

VERTICAL
Operating Modes: CH-A, CH-B, DUAL, ADD (CH-B can be inverted.)
Dual modes: Alter: 0.2ufs - 0.5ms/div. Chop: 1ms - 0.5s/div.
CHOP frequency 200KHz approximately
Deflection factor: 5mV/div 20V/div +/− 3%, 12 ranges in 1-2-5 step with fine control
Bandwidth: DC, DC - 20MHz (−3dB). AC, 10Hz - 20MHz −3dB)
Rise Time: Less than 17ns
Overshoot: Less than 3%
Input Impedance: 1M ohm +/− 5%, 20pF +/− 3pF
Maximum Input Voltage: 600Vp-p or 300V (DC + AC Peak)
Channel Isolation: Better than 60 dB at 1KHz

HORIZONTAL
Sweep Modes: NORMAL, and AUTO
Time Base: 0.2ufs - 0.5s/div +/− 3% 20 ranges in 1-2-5 step with fine control
Sweep Magnifier: 5 times (5X MAG)
Linearity: 3%

TRIGGERING
Sensitivity: INTERNAL: 1 div or better for 20Hz - 20MHz (Triggerable to more than 30MHz). EXTERNAL: 1Vp-p or better for DC - 20MHz (Triggerable to more than 30MHz)
Source: INT, CH-A, CH-B, LINE and EXT
Slope: Positive and Negative, continuosly variable with level control PULL AUTO for free-run
Coupling: AC, HF-REJ and TV. TV SYNC Vertical and Horizontal Sync Separator Circuitry allows any portion of complex TV video waveform to be synchronized and expanded for viewing TV-H (Line) and TV-V (Frame) are switched automatically by SWEEP TIME/DIV switch TV-V:0.5s/div to 0.1ms/div. TV-H:50ufs/div to 0.2ufs/div

X-Y OPERATIONS
X-Y Operations: CH-A: Y axis. CH-B: X axis Highest Sensitivity: 5mV/div

COMPONENT TESTER
Component Tester: Max AC 9V at the terminal with no load. Maximum current 2mA when the terminal is shorted. (Internal resistance is 4.7K ohm)

OTHER SPECIFICATIONS
Intensity Modulation: TTL LEVEL (3Vp-p); Positive ...... brighter
BANDWIDTH: DC-1MHz Maximum Input Voltage: 50V (DC + AC Peak)
Calibration Voltage: 0.5Vp-p +/− 5%, 1KHz +/− 5% Square wave.
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Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
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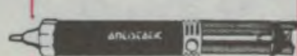

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ROD IRVING ELECTRONICS

50th Anniversary Feature:

Fifty Years of 'Hobby' Projects

No review of our magazine's development over the last five decades would be complete without a look over the construction projects that we have published. Here's an attempt to capture the on-going 'build it yourself' spirit that *Electronics Australia* has always tried to foster in its readers, right up to the present day.

by JIM ROWE

As you can see from the souvenir reprint which accompanies this issue, so-called 'hobby projects' were already very much a part of the magazine when it effectively became a monthly in April 1939, with the first issue of *Radio & Hobbies*. The tradition of providing build-it-yourself designs had begun way back in the 1920's, with its predecessor *Wireless Weekly*, and long before 1939 the strong response from readers had made it almost mandatory for the magazine to provide a constant stream of project designs.

Right from the start, these designs were not strictly intended just for hobbyists. In fact they were frequently used by professionals, either as the basis for their own commercial designs or to build up equipment more cheaply than buying it. The latter was often the case with designs for test equipment, for example.

Of course in the early days of radio, there wasn't a great deal of difference between 'professionals' and 'amateurs'. Quite often the former were merely people from the enthusiast ranks, who had been fortunate enough to get employment which put their knowledge to use in earning a living – and gaining them greater experience, in some cases, than those who remained hobbyists.

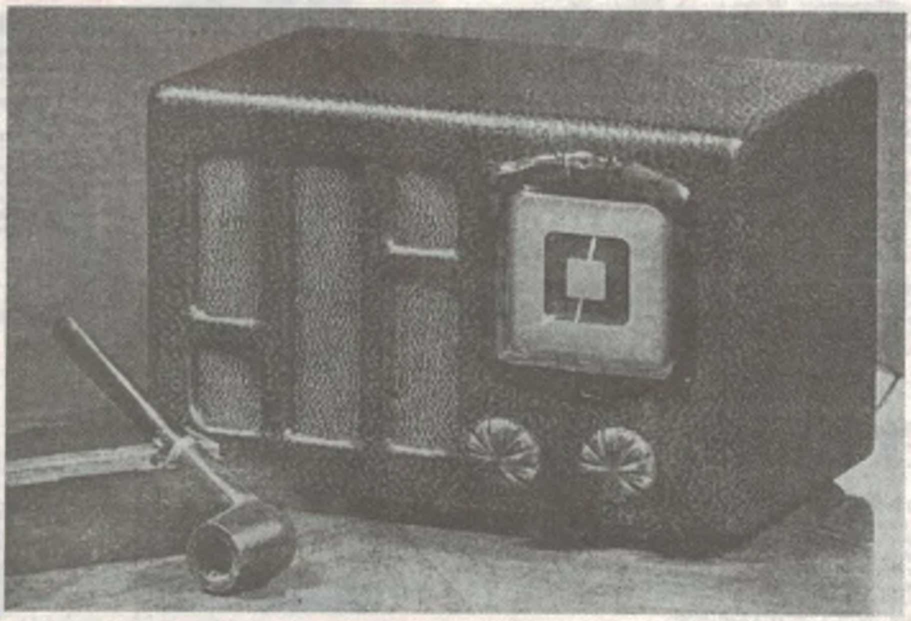
No doubt one reason why our readers, both professional and amateur, have always been keen on designs for construction projects is the strong spirit of independence which runs through the Australian character. After all, why buy an expensive piece of equipment, if you can build one up yourself – and save considerable money in the process!

Another reason for the strong emphasis on designs for construction is surely that *actually building* pieces of electronic gear, and getting them going, has always been – and as far as I'm concerned will always be – the best possible way to learn electronics. This has been recognised intuitively by our readers for a long time; in fact I suspect they had discovered the value of practical 'hands-on' experience long before it was discovered by educational theorists.

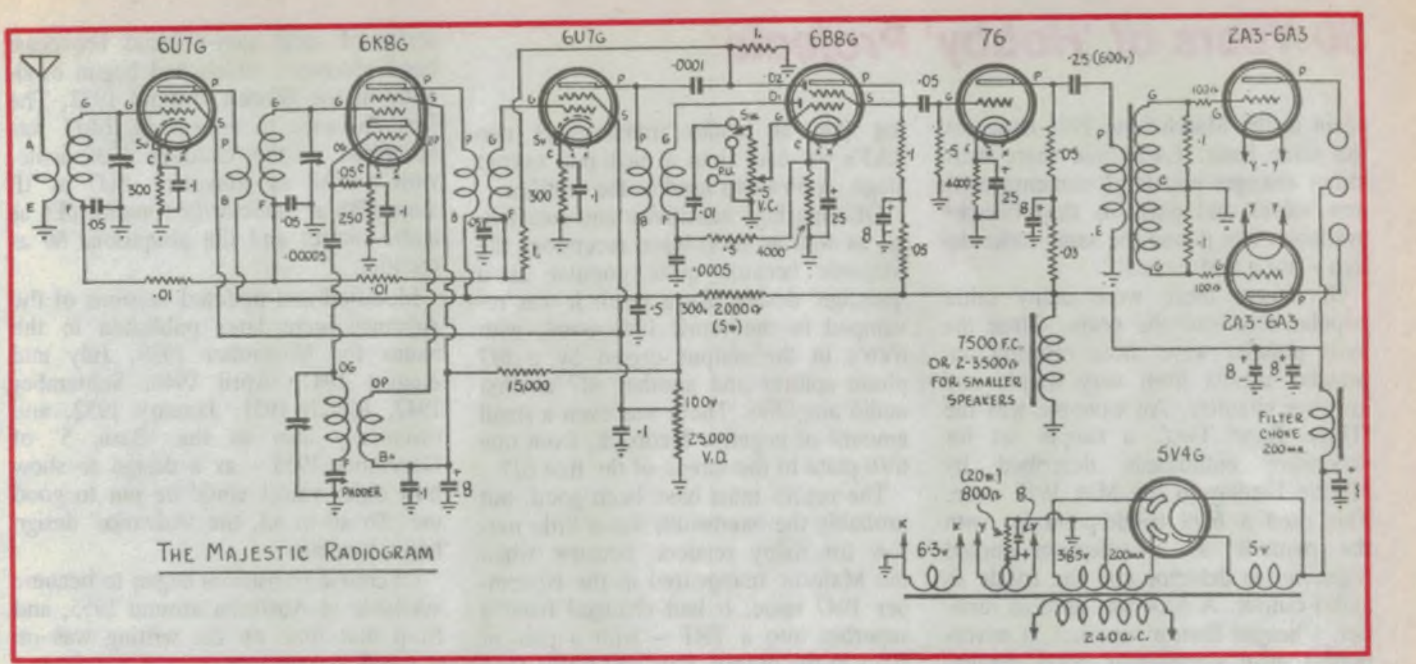
One way and another, then, construction projects have been always been the 'core' content of the magazine, and have no doubt been a key ingredient in its appeal for most readers. And this tradition is certainly very much alive today – it would be a very brave (or extremely foolish) editor who decided to try leaving them out.

One of the things that struck me as I was looking back over past issues, in preparation for this article, was the way that the construction projects have reflected the development of electronics technology. Hardly a profound discovery, I agree – but worth noting all the same.

As each new development took place, it was generally reflected quite rapidly in our construction project designs. And of course the payoff for readers was that they were able to gain experience with new components and circuit tech-



John Moyle's original 'Little General' mantel radio, of April 1940. It was immensely popular, and was updated many times over the years.



The circuit schematic for the 8-valve 'Majestic' radiogram of October 1940, also by John Moyle.

niques, pretty well as soon as they became available to anyone in the country. I'm no doubt a little biased, but to me this seems quite an achievement, and one for which all who have worked on designing our projects over the years may feel justifiably proud.

It would be impossible, in any single article, to even mention all of the projects that have been described over even the last 50 years – let alone do any of them justice. So I'm not going to try. My aim here is a 'broad brush' approach, to try and pick out sufficient of the long-remembered and popular 'milestone' designs which have appeared during that time, to capture the broad scope of our construction projects as they have developed with the technology.

So if there's a pet project you remember, and I don't even give it a mention, please forgive me.

To make things just a little more manageable, I've divided the projects up into a number of broad areas of interest: radio receivers, audio and hifi, sound recording, television, test instruments, computers, amateur radio, car projects and miscellaneous. Let's begin, then, by looking at designs for radio receivers.

Radio receivers

Needless to say, long before April 1939 radio receivers made up the bulk of construction projects, and this was to continue for some years. Back in the *Wireless Weekly* days there had been a continuous stream of receiver designs – little ones, big ones, battery sets and AC-powered sets, broadcast-band only and dual-wave sets, you name it – and inevitably this tradition carried over into the monthly.

Quite apart from the insatiable reader interest, this was no doubt because of the continuity in editorial staff, with 'Braith Hull (until late 1939) and John Moyle. Mr Moyle had joined the *Weekly* in the mid 1930's and was to remain until early 1960, most of the time as Editor.

Probably one of the most popular receiver projects of all in the early days was 'Little Jim', a simple battery/AC one-valve set which John Moyle had first described in the May 27, 1938 issue of the *Weekly*. The idea of the original design was to produce a simple and cheap headphone set, for cricket enthusiasts to listen to the Tests in bed without disturbing their 'better half'(!). It used a 6A6 twin triode valve with one half as a Reinartz regenerative detector, and the other half as an audio amp to drive the 'phones. The valve heater was powered by 6.3V from a small transformer, but a 45V 'B' battery was used for the plate supply to simplify things.

The design had been so popular (no doubt because of its very low price) that it was repeated without any changes, in the first issue of *R&H*. And it was subsequently to appear again in the February 1941 issue, but this time using a 6J8 triode-pentode instead of the original twin triode, which had then become unobtainable.

As if that wasn't enough, an all battery-operated version of the design called 'Little Jim's Mate' appeared in the May 1939 issue, for the benefit of those without AC power. This used a type 19 battery twin triode, with its 2V filament running from 1.5V – which still gave adequate emission and also had the effect of extending battery life.

This pattern of popular designs being updated and essentially republished was to be repeated over and over again, especially with radio receivers and for what might be termed the 'radio decades': the 1940's and 1950's.

In the August 1939 issue, for example, John Moyle described a very compact AC 'mantel' type radio, dubbed the '4/39'. It used 4 valves in a fairly basic superhet circuit, with a 6K8 as converter, 6F7 as IF amplifier and also first audio stage, and a rather strange valve called an EBL1 (which was an output tetrode with twin diodes) as detector and audio output. The rectifier was a trusty 80.

Being quite cheap to make, and a good performer, the design had been built by hundreds of keen constructors. But in the April 1940 issue, John Moyle himself revamped it as the 'Little General', replacing the odd-ball EBL1 valve with a 6V6 in the output, and the 6F7 with a 6G8 as IF amplifier and detector. And in this form, the set turned out to be *immensely* popular – it virtually set the pattern for mantel radios, for the next decade at least.

The basic 'Little General' design was re-presented in June 1940, October 1940, December 1941, January 1946, August 1947, July 1951, September 1952, in the June-September 1956 issues as a learn-while-you-build exercise, and

50 Years of 'Hobby' Projects

again in the March-June 1961 issues on the same basis. Each time there were minor changes and improvements, with new valves and parts as they became available. But it was the same basic design – not a bad record!

Of course there were many other popular sets over the years. Often the most popular were those offering impressive results from very simple and low-cost circuitry. An example was the 'Three Band Two', a simple set for shortwave enthusiasts described by Maurie Findlay in the May 1957 issue. This used a 6U8 triode-pentode, with the pentode as an electron-coupled regenerative detector and the triode as audio output. A 6X4 was used as rectifier. Cheaper than a superhet, it nevertheless gave surprisingly good results, and was very popular. As a result it was repeated virtually unchanged in the October 1966 issue.

Another example was the 'Super 3' of May 1952, which achieved performance almost as good as that of the 'Little General', using only a 6AN7 converter with an ECC33 twin triode as regenerative IF amplifier/detector and audio output. A 6X4 was again used as the rectifier.

There was also John Moyle's 'Pentagrid Three' of December 1939, a low-cost battery superhet for country listeners using the then-new 1.4V valves 1A7 (converter), 1N5 (IF amp) and 1D8 (detector, audio amp and audio output). Not to mention his famous 'R&H Portable' of June 1939, using four of the same new 1.4V valves, and his 'Tiny Tim' mantel of September 1939, using a 6C8 twin triode as Reinartz regenerative detector and audio amplifier, a 6F6 as audio output and again a trusty 80 as rectifier (what else?)

Of course as well as little sets, there were always big sets as well, for those who could afford them. These dated also from the old *Weekly* days, when Hull and Moyle had set the pace with designs such as the 'Stereoscopic 8' of November 18, 1938 and the 'Stereoscopic 9' of December 16 in the same year. (More about that word 'stereoscopic' later...)

A good example was the 'Majestic Radiogram', an 8-valve design described in the October 1940 issue by John Moyle, and headed 'The Finest Receiver You Can Build'. It was a superhet with a 6U7 RF stage, 6K8 converter, another 6U7 as IF amp, a 6B8 as detector and audio amp, and a 76 driving (via an audio transformer) two 2A3's (or 6A3's) in a push-pull output stage. A 5V4 was used as the rectifier.

Offering high sensitivity and selectivity, as well as short-wave reception, the Majestic became quite popular as a 'prestige' design. As a result it was revamped in the April 1941 issue, with 6V6's in the output driven by a 6J7 phase splitter and another 6J7 as first audio amplifier. There was even a small amount of negative feedback, from one 6V6 plate to the screen of the first 6J7.

The results must have been good, but probably the bandwidth was a little narrow for many readers, because when the Majestic reappeared in the November 1947 issue, it had changed from a superhet into a TRF – with a pair of 807's in the output, bass and treble tone controls and the power supply on a separate chassis. This design was then revamped yet again for the August 1951 issue, with 6V6's back in the output stage and the addition of a whistle filter and a preamp for magnetic pickup cartridges.

Other popular valve sets in the larger category were the 6-valve 'Standard' series, which had originally begun in *Wireless Weekly* during 1933. The first to appear in *R&H* was in the Christmas 1940 (January 1941) issue, and was a superhet with 6J8 converter, 6U7 IF amp, 6B8 as detector/audio amp and a pair of 6V6's in a 'paraphase' push-pull output stage – plus a 5Y4 as rectifier. This design was later to be revamped in the December 1942 and May-June 1946 issues.

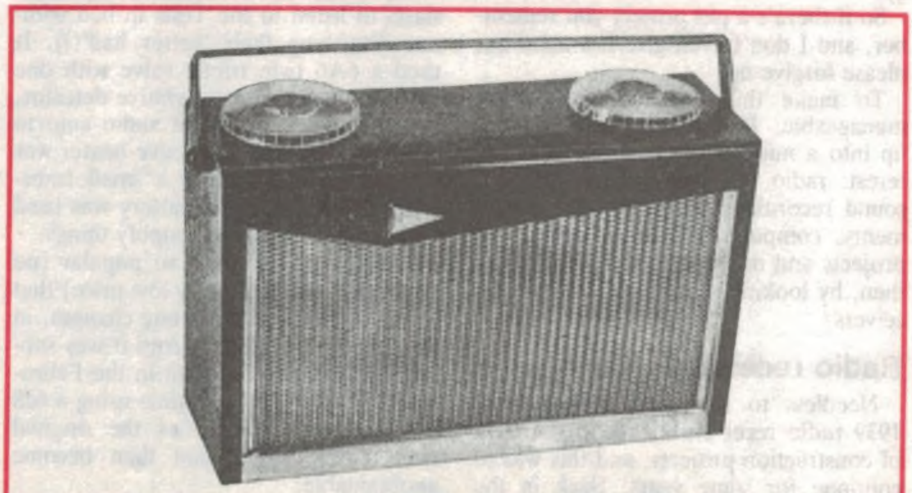
There was also the 5-valve 'Advance' series of solid easy-to-build broadcast band receivers, which had begun originally in the *Weekly* around 1932. The first Advance to appear in *R&H* was described in the October 1939 issue, with a 6A8 as converter, 6U7 as IF amp, 6B6 as detector/first audio, 6F6 as audio output and the ubiquitous 80 as rectifier.

Modified and updated versions of the Advance were later published in the issues for November 1939, July and August 1941, April 1946, September 1947, March 1951, January 1952, and essentially also as the 'Basic 5' of December 1955 – as a design to show how older valves could be put to good use. So all in all, the 'Advance' design had a long life.

Of course transistors began to become available in Australia around 1955, and from that time on the writing was on the wall for valve sets.

The first simple transistor radios to appear in the magazine were described by Neville Williams, as a learning series in the issues for May-August 1955. They used the OC70-71-72 series of PNP germanium devices, which had recently been released by Philips and Mullard.

Quite a few small one, two and three-transistor sets followed during the next few years, but the first real 'milestone' transistor set was probably the 'Transporta Six', described in the August 1958 by Maurice Findlay. This was the first transistor superhet portable described for home construction, and had largely been developed in STC's applications laboratory. It was a simple superhet, which used imported Texas Instruments 2N252 and 2N308 transistors respectively in the converter and IF amp stages, a GD4 diode as detector, lo-



The 'Transporta 6' of August 1958, our first transistorised superhet receiver project. It was described by Maurice Findlay.

cally-made TS1 and TS2 transistors in the first two audio stages, and a pair of 2N185's in a transformer-coupled class B output stage. The RF and audio sections were mounted on two of the new 'printed circuit boards' (PCBs), which were housed along with the 5-inch speaker in a small leatherette-covered wooden box measuring about 280 x 150 x 75mm.

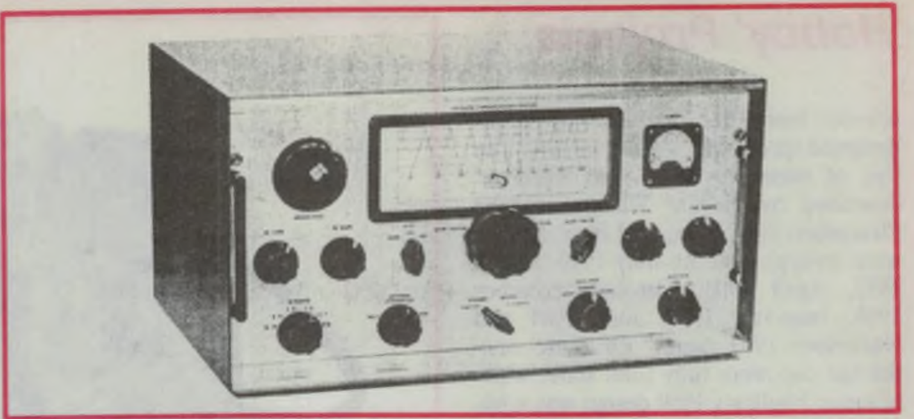
The 'Transporta Six' worked well, despite the limitations of those early germanium transistors – looking back, they were really pretty terrible! It was followed in February 1959 by the 'Transporta 7', described by Neville Williams but essentially very similar to the first except that a 2N309 transistor had been added as a second IF amplifier.

Another 'Transporta 7' appeared in November 1960, this time with an RF stage instead of the second IF amp. Described by Alan Nutt, the front end of this version used the 2N370-372-373 series of RCA transistors, with a second GD4 diode added to improve the action of the AGC circuitry. And the same basic design was revamped by myself in the December 1963 issue, with only minor changes to the circuit (blush!) but all on a single large PCB and housed in a neat plastic case – both of which had been organised by Ron Bell of RCS Radio, if I remember correctly.

The only noticeable limitation of those early Transporta sets was a tendency to 'pull' in frequency on strong signals, due to the use of a self-oscillating mixer stage. This was overcome in the 'Transistor 8', described by John Barker in the July 1960 issue. In most respects this was very similar to the RF Transporta 7, but used a separate local oscillator using a 2N371 transistor. Unlike the Transporta sets, all of the 'front end' was built on a conventional metal chassis rather than a PCB, and I seem to recall that it gave John Barker no little trouble before he 'tamed' its initial instabilities.

Certainly when I came to produce a three-band version of the same design myself, described in the August 1961 issue, I had no end of trouble in getting it stable on all three bands. The final design worked well enough, but if ever I needed convincing that transistors really needed the lower impedances achievable with PC boards, that project did the trick!

As it happens, the '3-Band Transistor 8' was essentially the last conventional broadcast-type receiver we were to describe. After that, commercially marketed sets became so cheap, and so good, that there really wasn't much point in describing them – apart from small 'learn about radios by building one' designs, which have continued to the present day. Typical examples have been the 'Three Transistor All-Wave Set' of October 1978, and the 'Regenerative Radio with Varicap Tuning' of January 1988.



Ian Pogson's original 'Deltahet' communications receiver, described in September-October 1964. It used 17 valves.

Of course right from the beginning there had been another stream of receiver designs, intended more for the dedicated short-wave enthusiast and the radio amateur than the general listener.

These were the communications-type receivers, and they began very modestly with the 'Communications Four' described in the July 1940 issue – a very modest 4-valve design, with a 6J7 regenerative detector, followed by a 6C5 audio stage driving a 6V6 in the output and with a 5Y3 as rectifier. About the only sophistication was a second 'bandspread' tuning capacitor and dial, and a headphone socket.

Rather more elaborate was the '1946 Amateur Junior' receiver, described by Neville Williams in the April 1946 issue and intended for the newcomer to amateur radio or shortwave listening. It was still a fairly standard 5-valve superhet circuit using octal valves, but with plug-in coils, bandspread tuning and an IF of 1900kHz rather than the usual 455kHz used for broadcast-type sets. A BFO was added a few months later (August 1946), to cater for Morse reception.

Even more elaborate was Neville's 'Communications Nine', of February 1947. This had a miniature 956 'acorn' valve as an RF stage, switched coils, an S-meter, a noise limiter and variable AGC. At the time, it was the most pretentious receiver yet described.

John Moyle topped this design in the July 1948 issue with his '2JU Eleven De-Luxe', which used an EF50 valve in the RF stage, a 6C5 to drive the S-meter and a 6SN7 as combined BFO/-bandset oscillator. Otherwise it used much the same octal valve line-up as the earlier sets.

Communications receivers then generally started to become rather more specialised, as shown by John Moyle's 11-valve 'All Wave Special De-Luxe' of April 1949. This used a special pre-assembled and aligned front-end assembly, produced by Melbourne-based Aegis, and a crystal IF filter from the same firm.

But the next big 'milestone' in our communications receivers came in the issues for May-August 1963, when Ian Pogson described his famous 'Deltahet' front end, using the Wadley-loop principle – which had been invented by a Dr Wadley of South Africa in the 1950's, but before the Deltahet used only in professional (and very expensive) receivers from firms such as Racal.

A major benefit of the Waddley-loop concept was that it split the HF band into 30 bands 1MHz wide, and effectively switched between any of these bands electronically – to give the tuning stability of individual crystal converters. At the same time, the front end itself used only a single 1MHz, using selection of its harmonics for the double up/-down conversion system.

Ian followed up the original front-end design with a full Deltahet receiver, described in the September-October 1964 issues and using 17 valves. Despite its size and complexity it was very successful, with hundreds being made by constructors all over the world.

Later on, in the January-May 1971 issues, Ian was to describe a fully solid state version: the 'Deltahet Mk2'. It used some 40 transistors (discrete silicon), and a similar number of diodes, and remains the most complex high-performance receiver ever described by the magazine – possibly any magazine.

Before leaving radio receivers, I should perhaps note that among the various other kinds of receiver I haven't covered here, there was a series of sets designed specifically for use in cars. The first of these was the 'Auto Receiver' described by Neville Williams in the December 1945 issue, and later designs were to appear in the May 1949, March 1952, April 1953, October-December 1956, June-July 1959, June 1961 and November 1963 issues. Of these only the last two were fully solid state, while Maurice Findlay's 1959 design was a hybrid design with valves in the front end and transistors for the audio driver and output stages.

After 1963, there were no further car radio designs – as with broadcast radios, home construction became impractical because commercially marketed units were so attractive in terms of both price and performance.

Audio & hifi

Even in the old *Wireless Weekly* days, there had been considerable interest in obtaining improved sound reproduction – from both radio signals and records. This had been the rationale behind John Moyle's series of 'Stereoscopic' receiver and amplifier designs, for example, beginning with the 'Simple Stereoscopic Amplifier' in the August 26, 1938 issue. This was a very basic 3-valve circuit, with a 6U7 driving a 2A3 (or 6A3) triode output stage, and with an 83V as rectifier. It produced 'up to 3.5 watts output'.

Incidentally you may be puzzled as to why the term 'stereoscopic' was being used way back then in the 'mono' days, decades before true stereo came in. So was I, until I read through a couple of the articles!

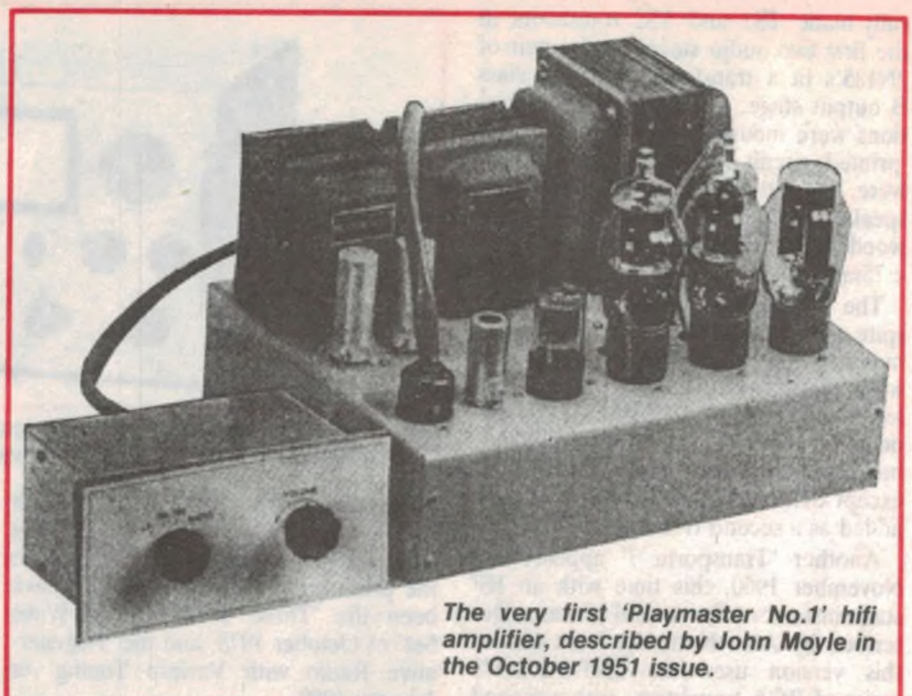
Apparently it was discovered, by John Moyle among others, that if you used two speakers spaced apart, and employed simple filtering so that one handled the bass, and the other the middle and treble frequencies, this would give a 'spreading out' effect – especially with orchestral music. The filtering used was very basic, nothing more than manipulation of the speaker baffling plus two 25uF capacitors in series with the speaker handling the mid/treble material.

The first nominal 'high quality' amplifier design to appear in the monthly *R&H* was a 13.5 watt circuit given in the October 1939 issue, and essentially reprinted from the AWV publication *Radiotronics*. The circuit diagram had even been drawn by W.N. Williams (shortly to join the *EA* staff), and checked by Fritz Langford-Smith of *Radiotron Designers' Handbook* fame. It had a total of 5 valves, with a 6J7 voltage amp and a 6V6 as phase splitter, driving a pair of trusty 2A3 triodes in push-pull with fixed bias for class AB operation. A 5U4 was used for the rectifier. There was no negative feedback, but the response was within 2dB from about 30Hz to well above 10kHz and the total harmonic distortion (THD) less than 5% over most of the range.

In March 1941 an improved design appeared, this time with full construction details. It again had an output of about 13W, but this time the phase splitter used another 6J7 and the output stage used a pair of 6V6's to replace the by-then hard to obtain 2A3's. This time the output valves had cathode biasing, and there was a modest degree of negative feedback from one output plate to the screen of the first 6J7. This gave a noticeably flatter response, and presumably lower THD.

The first design to actually carry the label 'high fidelity' appeared in the October 1945 issue. As before this used a pair of 6J7 valves driving a pair of 6V6's, but this time the 6V6's were in *parallel* rather than push-pull, and had rather more negative feedback applied – from the output plates back to both the screen and cathode of the second 6J7. This gave a rather flatter response again, and made the amplifier less sensitive to the changes in speaker/output transformer impedance at both high and low frequencies. There were also separate bass and treble tone controls, offering limited amounts of both boost and cut.

But the first of what was to become a long line of *true* high fidelity amplifiers, each achieving a performance equal to the best that could be obtained using the latest technology at the time, was to be introduced by John Moyle in an article which appeared in the October 1951 issue, entitled 'A New Deal in Amplifiers'. It was called the 'Playmaster No.1', and it came with a separate and matching 'Playmaster Control Head No.1'.



The very first 'Playmaster No.1' hifi amplifier, described by John Moyle in the October 1951 issue.

The Playmaster No.1 was a relatively familiar-looking 5-valve circuit in the broad sense, with a 6AU6 voltage amp, a 6J5 triode as phase splitter and a pair of 807 beam tetrodes in the push-pull output stage (remember the 807, with its plate connected to the top cap? It was one top cap you definitely *didn't* touch to see if was alive!). A 5U4 was the rectifier, feeding the 807's with over 400 volts.

But there was now quite a significant amount (roughly 16dB) of negative feedback, from the speaker voice-coil right back to the cathode of the 6AU6 input stage – i.e., around the entire power amplifier. It was enough to bring the overall voltage gain back to 30, and gave significantly better frequency response, lower output impedance and THD performance than had been achieved to date. Moyle didn't have the equipment to measure THD accurately, but he estimateed it as well below 1% for full output of 18W.

The matching Playmaster No.1 'Control Head' had a single ECC33 dual triode, with switched passive equalisation to suit the various recording characteristics in use.

Overall, the combination of power amplifier and control unit achieved very close to the best performance possible at the time, and they became an instant 'reference' for hi-fi enthusiasts. They also set the pattern for all further Playmaster designs described in the magazine: many different kinds of amplifiers would be described in the following years, but only those worthy of the title by virtue of their performance would be dubbed a 'Playmaster'.

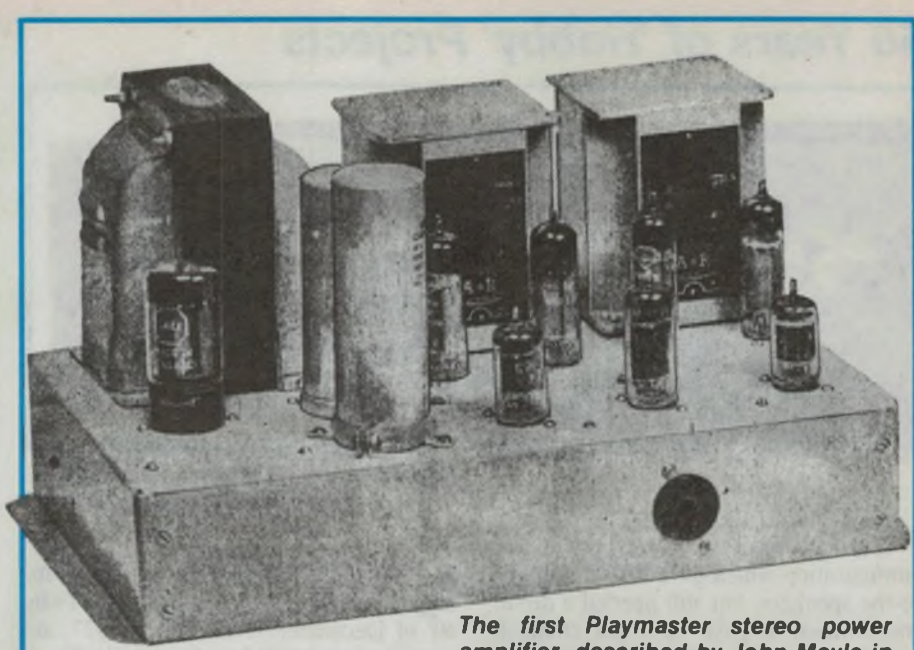
In the very next month, John Moyle himself followed up with the 'Playmaster No.2' power amplifier, a smaller one using 6V6 valves in the output, and rated at 10W. It had the same amount of negative feedback, and achieved the same high standard of reproduction when used with the Control Head No.1.

Then in the December 1951 issue, he followed this up with two further Playmaster items – a more elaborate 'Control Unit No.2', and a 'Baby Playmaster No.4'. The new control unit was essentially the original unit, but with switched passive bass and treble tone controls added, plus switching for radio input.

On the other hand the Baby Playmaster was a simpler 3-valve integrated design, with an ECC35 high-gain twin triode driving a 6M5 in the output and with a 5Y3 as rectifier. But there was still a generous amount of overall negative feedback, and at the rated output of 4W it gave very similar performance to its larger brothers. (Remember that the speakers in use at the time were quite sensitive – 4W could produce quite impressive volume!)

What happened to Playmaster No.3? Somehow it must have been delayed slightly, because it appeared next month in the January 1952 issue. It was also rated at 4W, but used a 6AU6 driving a 6V6 with a little less negative feedback, and was designed as a basic power-amp to go with either of the standard Control Units.

For those who didn't quite trust any other output valves other than triodes, Moyle came out in the June 1952 issue with the Playmaster No.5 power amp. This had a pair of trusty 2A3's in the push-pull output stage, with a 6SN7 twin triode as long-tailed pair phase splitter. Again there was plenty of overall negative feedback – just 20dB – giving less than 0.25% THD at the full rated output of 10W. With the combination of triodes in the output and this



The first Playmaster stereo power amplifier, described by John Moyle in the January 1959 issue.

much negative feedback the output impedance was also extremely low, giving good speaker damping.

This design was extremely popular, and probably the purists' favourite until 1955, when the 'ultra-linear' connection came into vogue. This used special taps on the primary of the push-pull output transformer, for the screen grids of either beam tetrodes or pentodes, giving partial-triode operation of these valves and consequently lower distortion and output impedance (but still with higher efficiency).

From that point on, virtually all of the valve Playmasters used the ultra-linear configuration. John Moyle himself described an experimental 7W ultra-linear amplifier using 6BW6's in January 1955, followed by a 17W 'Playmaster No.8' design in the following month using EL37's. Then a couple of months later in the May issue there appeared 'Playmaster No.9', using EL84's in the output and producing around 12W nominal output.

Without a doubt 1955 was the year of the ultra-linears, and the year in which the valve Playmasters achieved pretty well the highest performance they were to reach.

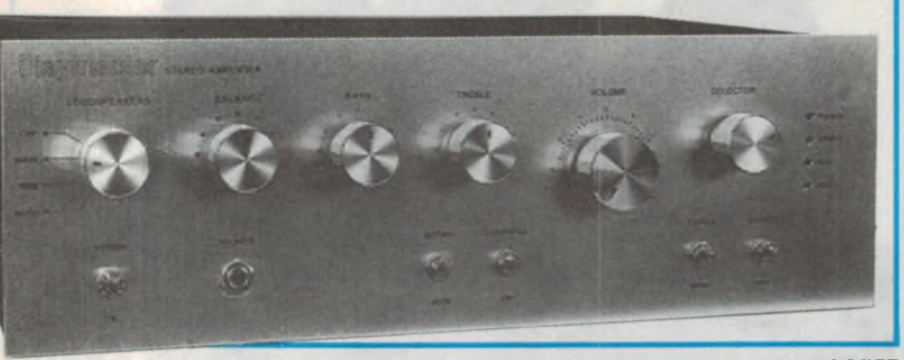
The first Stereo Playmaster appeared in January 1959, with 10W output per channel. Described again by John Moyle, it used pairs of EL84's in the output stages and was basically a stereo version of the May 1955 design. He followed up in May 1959 with a twin 17W model, again virtually a stereo version of the No.8. Various smaller designs after that were to finish out the valve era.

By the end of 1960, transistor amplifiers had reached a modest level of performance, and I myself described a very low-powered 'Transistor Stereo Amplifier' in the December issue. It used 2N217S transistors in class AB, with transformer coupling.

But the first transistor stereo amplifier that one would claim as even vaguely 'high fidelity' appeared in the April-May 1963 issues, described again by yours truly. Called the 'Unit Playmaster 105', it used pairs of 2N2147 transistors in the output stages, in a 'totem pole'

Probably the most successful stereo amplifier we ever described: Leo Simpson's solid state 'Playmaster Twin-25' of April-May 1976.

50 Years of 'Hobby' Projects



Leo Simpson's 'Playmaster MOSFET Amplifier' of December 1980.

configuration which gave direct coupling to the speakers, but still needed a driver transformer. It gave 12W per channel, with less than 1% THD and quite good noise and distortion figures (although still not as good as the last valve designs).

Things really didn't improve dramatically until 1965, when silicon transistors became available. In December of that year, I was able to describe our first all-transistor 'Playmaster 112 Control Unit'. For the first time it gave a performance equal to that of the value control units, and would drive any of the earlier valve power amplifiers. But the matching 'Playmaster 113' power amplifier of March 1966 still used the same output stages as the 1963 design.

Surprisingly, perhaps, it was to take another two years before we were able to describe the first complete amplifier using silicon transistors throughout. This was Anthony Leo's 'Playmaster 155' of April 1967, a unified design which delivered 10W per channel from pairs of 40250 transistors.

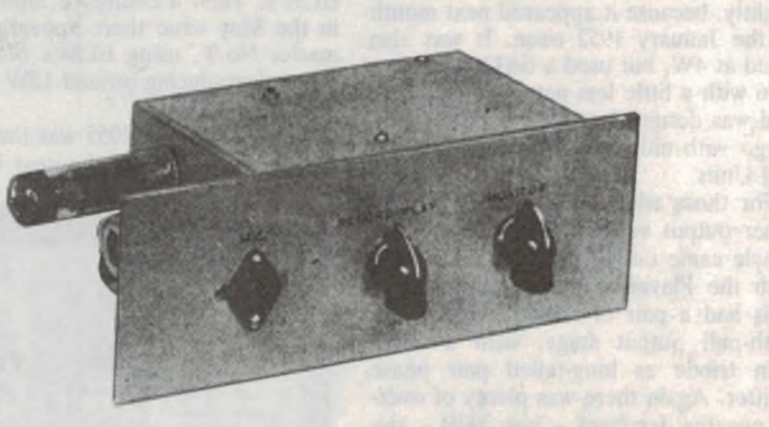
And it was even longer before a high-powered silicon power amplifier appeared – the 'Playmaster 128', again described by Anthony Leo, in the January 1970 issue. This used pairs of 2N3055 transistors in the output, with direct coupling, and produced 45W per channel into 8 ohms, with THD generally below 0.1%. As such, it was probably the first of the truly 'hifi' transistor amps.

Since then, of course, we have described many high quality amplifiers. And some of them have been phenomenally successful, in terms of reader popularity. Examples were the 'Playmaster 136' of December 1972-January 1973, designed by Neville Williams; the 'Playmaster Twin-25' of April-May 1976, designed by Leo Simpson, which as a kit sold in the tens of thousands; its bigger 'brother' the 'Playmaster Twin 40' of December 1976-January 1977, almost as successful; Leo Simpson's 'Playmaster MOSFET Stereo Amplifier' of December 1980-February 1981; and his 'Playmaster Series 200 Amplifier' of January-May 1985.

Apart from the Playmaster family of designs, there have of course been many other amplifier designs described over the years. But I think these show the development of audio amplifier technology quite well, and also illustrate the way that we've always tried to keep our designs up to date as that technology developed.

Sound recording

After the second World War, there was a great deal of interest among audio enthusiasts in the idea of making home recordings. Commercial disc recordings had been made in Australia since the 1930's, but the equipment required had always been too expensive and complex for home use.



Ray Howe's 'R&H Tape Adaptor No.2' of July 1953, which allowed an existing amplifier to be used for tape recording.

Local interest was largely triggered by the release of a low cost disc recording deck, made by Melbourne firm Byer Industries and developed by the firm's founder Max Byer. Called the 'BRS Junior Recorder', it had a worm drive and quadrant gear system underneath to drive the arm across the acetate-covered aluminium recording blank. The first deck only allowed recording at 78rpm, but a second version allowed 33.3rpm 'microgroove' recording as well.

R&H editor John Moyle was a friend of Max Byer, who sent him a sample of the first model in early 1947, and later a sample of the improved two-speed model. It seems to have been these decks which sparked off a series of disc recording projects in the magazine.

Initially, the cutter head of the recorder was simply driven from the output of a standard hifi amplifier. But various other facilities were needed for best results, and in September 1947 Neville Williams described a 'Recording Amplifier' designed especially for the job. It had an output level meter, adjustable treble boost and used an 807 valve in the output to provide adequate cutter drive.

Derek Williamson described a slightly modified version of the same design in May 1950, and described an equaliser to compensate for resonance in the cutter head, which tended produce an annoying peak. Then in April 1951, John Moyle described the 'Junior Recorder', and followed this in the August 1952 issue with the 'Playmaster Disc Recorder' – basically a modified version of the Playmaster No.2 hifi amplifier.

But the home disc recording era was ending, only a few years after it had begun. The first home tape recorder had hit the Australian market, and firms like Byer Industries released low cost tape 'adaptor' decks, which mounted over a normal record player turntable and turned it into a modest recording/playback deck.

In the November 1952 issue, John Moyle described his 'Tape Recorder No.1'. This was a 5-valve circuit, with a pair of 6AU6's as audio amps and a 6AQ5 in the output, together with a 6SN7 twin triode as the bias/erase oscillator and a 6X5 as rectifier.

For those who couldn't afford to buy one of the commercial adaptor decks, Neville Williams described how to build one in the following issue. Many hundreds of enthusiasts used these two designs to get their first 'hands on' experience of tape recording.

Of course there were some enthusiasts who baulked at the idea of building up a complete recorder circuit. Wouldn't it be possible to make an adaptor, to go with an existing amplifier?

To meet such requests, Phil Watson described the 'R&H Tape Adaptor No.1', in the January 1953 issue. It had only two valves: a 6AU6 as mic/head preamp, and a 12AT7 as bias/erase oscillator. It was about the cheapest way to get into tape recording, and again it was very popular. A second version was described by Ray Howe in July 1953, with a higher-powered bias/erase oscillator using a 6M5.

The next development came in June 1960, when yours truly described the 'Tape Recorder No.3'. It used six of the then-current miniature valves, with EF86's for preamps, a 12AX7 driving a 6BQ5 in the main amplifier and a 6AQ5 in the bias/erase oscillator. By this stage record/play equalisation had been standardised, and the No.3 used this to achieve quite respectable performance from quite modest heads.

Derrick Williamson's portable disc recording outfit of May 1950. It used the Byer 'BRS Junior' recording deck.

I followed this up in the January 1961 issue with the 'Playmaster Tape Adaptor', a four-valve circuit designed to provide the same kind of improved performance using an existing amplifier.

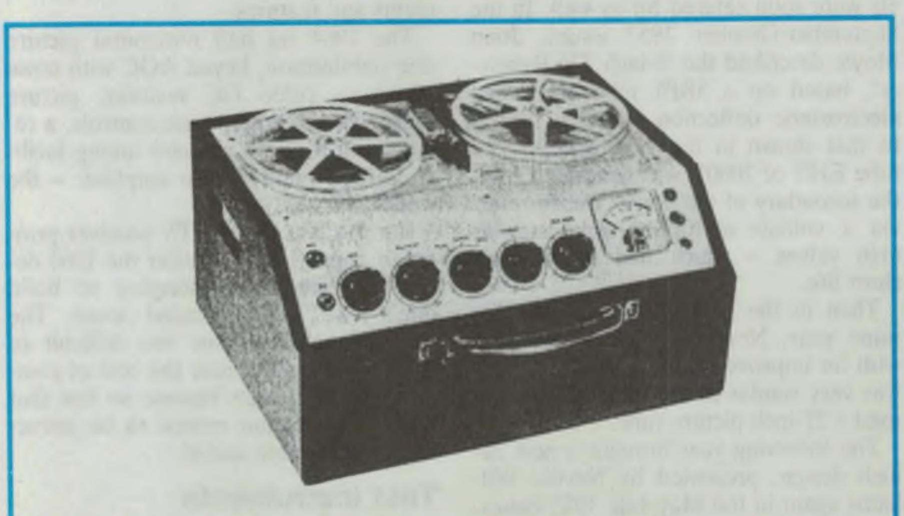
Stereo decks such as the 'Collaro Studio Tape Transcriptor' soon became available, and in February-April 1962 Alan Nutt described our first 'Stereo Tape Recorder'. It used only six valves (most of them dual types), and achieved impressive performance – although it was a bit of a monster to build, as I'm sure Alan would agree!

Then in November of the same year I described yet another 'Custom Built Tape Adaptor', this time for stereo, and in modular form to try and make it a little easier to make and get going. I followed this up in the March-June 1965 issues with the 'Playmaster 110' design, which probably provided the best performance achieved to that date from our tape recorder designs. It used 5 valves on a PCB for the basic control unit, with a choice of power/erase oscillator units so that you could either build it into an existing hifi system or make a self-contained recorder.

This was the last of the all-valve recorders, though, because silicon transistors had arrived. In September 1967 I described the 'Playmaster 119 Stereo Tape Adaptor', which was a hybrid design using transistor head preamps but valves for the mic preamp and bias oscillator. It worked well, but was obviously only a stepping-stone; sooner or later a fully solid-state design would become practical.

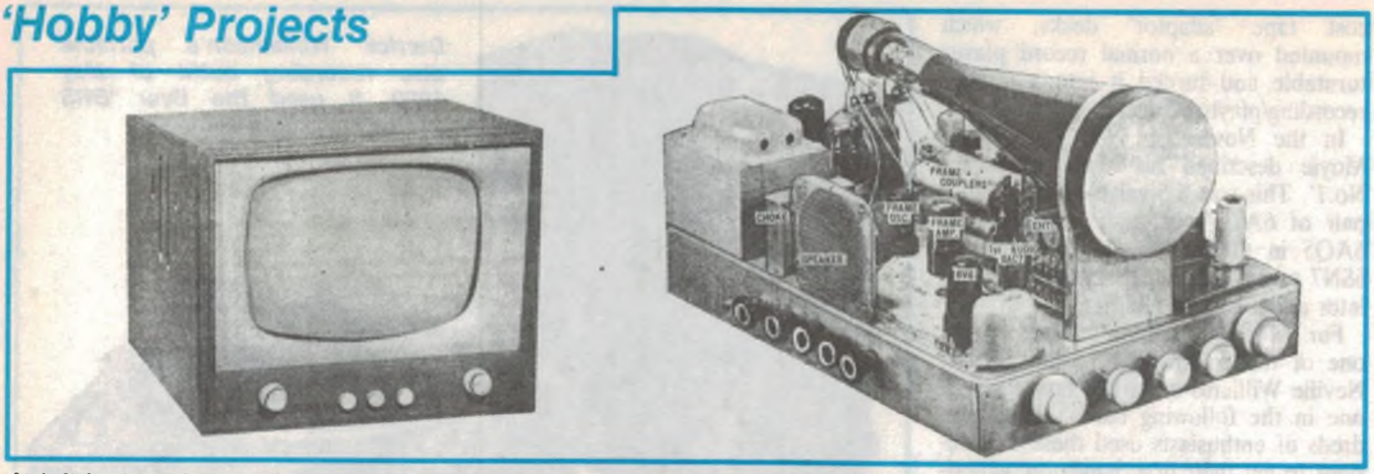
This didn't actually happen until 1974, when Leo Simpson described the 'Playmaster Stereo Cassette Deck' in the August and October issues. As the name reveals, reel-to-reel decks had by then largely been superseded by those designed for the compact cassette, and the new design took this approach. It used both discrete silicon transistors and 741 op-amps, and achieved very impressive performance.

Leo went on to describe one more 'Playmaster Stereo Cassette Adaptor' in the February 1978 issue, based on a Japanese 'Yocom' deck and using a rather different circuit with LED level 'meters'.



The 'Tape Recorder No.3', described by Jim Rowe in June 1960. It was designed to work with a variety of decks and heads.

'Hobby' Projects



At left is the original 17" Television Receiver, described by Neville Williams in the May-July 1957 issues. At right is John Moyle's 5" TV receiver, described in the September-October 1957 issues.

But that was the last recorder design to appear, because the era of home-built tape recorders was drawing to a close. As with other consumer items like broadcast radio sets, commercially marketed recorders became so attractive that interest in building them died out.

Television projects

With television broadcasting due to begin in Australia officially in late 1957, even in 1956 there was a lot of interest among hobbyists, students, technicians – and not a few engineers – in the idea of making one's own TV receiver.

For months, enthusiasts had been visiting disposals stores, picking up almost any kind of cathode-ray tube or piece of radar or Loran display equipment that looked as if it contained parts that would come in handy. It was obvious that sooner or later the magazine would have to describe a TV receiver project.

In response to the growing pressure, an article appeared in the December 1956 issue entitled 'Using a 5-inch tube for TV'. It wasn't a complete design, but basically a collection of circuits for various parts of a receiver, using disposals-type valves, that could be built up to drive an ex-radar 5BP1 tube or similar. Also given were winding details for the video and sound IF transformers and traps.

This was enough to get the more experienced (or more foolhardy) people going, and I vividly remember that when I joined AWA in January 1957 (as a trainee engineer fresh from high school) every other trainee, technician and engineer in the company seemed to be feverishly winding coils, coaxing 6SN7 sweep oscillators into working, and trying to find parts to build EHT power supplies.

Those early enthusiasts (and I became one) were spurred on by an article in the February 1957 issue, describing how to make a simple 5-channel VHF tuner for the 'front end' of the set.

But those who were not quite up to building their own set from the December 1956 article didn't have to wait long. In the May-July 1957 issues, Neville Williams described a complete '17-inch TV Receiver'. It used either the February tuner or a commercially-available unit, and also a pre-aligned IF strip module to avoid the need for alignment equipment. The rest of the set was fairly simple, but very similar to that used in the first generation of commercial receivers.

This first complete TV receiver design created a tremendous impact, and thousands of them had been built by the time regular broadcasting began that September.

Of course not everyone could afford the 17-inch tube and its associated bits and pieces, but those with tighter budgets were soon catered for as well. In the September-October 1957 issues, John Moyle described the '5-inch TV Receiver', based on a 5BP1 tube and using electrostatic deflection circuitry similar to that shown in the 1956 article. The tube EHT of 2000V was generated from the secondary of the power transformer, via a voltage multiplier using surplus 6H6 valves – which had a relatively short life.

Then in the November issue for the same year, Neville Williams came out with an improved large-screen set. This was very similar to the May design, but used a 21-inch picture tube.

The following year brought a new 21-inch design, presented by Neville Williams again in the May-July 1958 issues. It was similar in many ways to the 1957 project, but was designed to use the new tubes with a 90° deflection angle instead of the 70° tubes used in the earlier design. In the August and September issues he showed how the new design could be adapted for temporary use with one of the smaller 5-inch or 6-inch disposals tubes – which were still popular with readers on limited budgets.

Neville Williams also produced the next TV receiver, described in the August-October 1959 issues. This used one of the then-new 110° tubes, and had an improved video IF strip and vertical sweep circuit. Then in July-September 1961, Alan Nutt described the '1961 TV Receiver' which was designed to use a 23-inch 114° tube.

Finally, in the November-December 1964 issues the last of our TV receiver designs was presented, this time by yours truly. Because commercial receivers had come down so far in price, there was little point in describing another basic set – so instead, I tried to produce a 'no holds barred' design which featured all of the latest refinements and features.

The 1964 set had horizontal picture size stabilisation, keyed AGC with noise gating, a video DC restorer, picture sharpness and sound tone controls, a remote control with channel tuning facility, a high-quality audio amplifier – the works.

But this was the last TV receiver project to appear. Shortly after the 1964 design appeared, the incentive to build one's own TV set faded away. The parts required became too difficult to obtain, and in any case the cost of commercially-made sets became so low that home construction ceased to be attractive. Another era ended.

Test instruments

Along with radio receivers, amplifiers and things like TV receivers, test equipment projects have always been popular. No doubt this is partly because commercial test gear has always been relatively expensive, not being produced or sold in the same volumes as consumer equipment. So if a hobbyist or technician has wanted or needed an item of test equipment, building it has often been the only practical approach.

The first multimeter project appeared in the July-August 1939 issues – a very simple 1000 ohms/volt unit based on a low cost 0-1mA meter movement. Similar units were to appear down the years, although later on they were intended mainly as 'learning exercises' for beginners.

It wasn't long before the relatively low sensitivity of a standard 1000 ohm/-volt multimeter was found inadequate – especially for voltage measurements. Such a meter tended to load down sensitive high-impedance circuits, disturbing their operation and giving misleading readings. Yet meter movements that were more sensitive than the 0-1mA type were less readily available, quite expensive and for a while too fragile for many purposes.

As a result, the 'Vacuum-Tube Voltmeter' or 'VTVM' was developed, with (mostly) a simple one-valve DC amplifier used to boost the sensitivity of a standard 0-1mA meter.

The first VTVM design to appear in *Radio & Hobbies* was presented in the September 1949 issue by Ray Howe. It used a 6SN7 twin triode in a balanced configuration as the meter amplifier, with a 6X5 rectifier in the power supply and half of a 6H6 twin diode as rectifier for the AC ranges. In performance it was almost identical to the commercial units then available, with an input resistance of 10 megohms, five voltage ranges from 3V to 300V FSD, and five resistance ranges.

Again further VTVM designs followed over the years, all relatively similar in terms of the basic design – which was really quite adequate for all normal use. Like commercial units these VTVM's drifted in zero setting as they warmed up, but the drift was quite small after the first 10-15 minutes.

But with the coming of transistors, it was only a matter of time before the VTVM would be replaced by a solid-state equivalent. In March 1958, Maurice Findlay described an experimental unit using a pair of the first crude germanium transistors (OC71). This was before solid-state meters appeared commercially – undoubtedly a pioneering project. But the results were not entirely successful, with device matching difficulties and drift compensation being major complications.

It wasn't actually until December 1968 that we were able to describe a practical solid-state electronic voltmeter, using a pair of the then-new MPF105 junction FETs. I developed this project myself, and I still remember the problems of trying to match pairs of MPF105 devices – they had extremely wide tolerance spreads, for the main operating parameters! But once you had a pair of matched devices, the performance was quite good.

Before long, of course, the analog electronic voltmeter was superseded by the digital volt-ohm meter or 'DVOM'. The first design we published for one of these appeared in the January and February 1973 issues, again described by yours truly. It had a 4-1/2 digit readout, and provided ohms ranges as well as the usual DC and AC voltage ranges.

After that we published various DVM designs, the last of which appeared in the March 1983 issue. Since then, interest in building up such units again evaporated – due again to the falling price of commercially-available models.

Audio oscillators were another line of test gear projects which were always quite popular. The first of these to be presented in the magazine was the 'Beat Frequency Oscillator' described by Neville Williams in the May 1941 issue (before he joined the staff). It used a pair of 6J7 valves as RF oscillators, one fixed at 150kHz and the other tunable over the range 135-150kHz. The two outputs were mixed together in a third 6J7, to produce an audio output varying between about 20Hz and 15kHz.

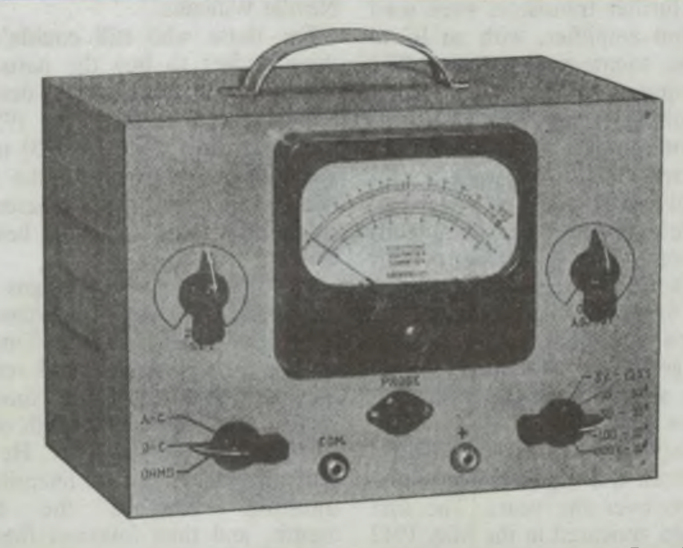
At the time, this type of 'BFO' was the only easy way to produce an adjustable-frequency audio signal, with a reasonably pure sine waveform. They drifted a bit, but were quite practical nonetheless. (Commercial designs were still in use in the 1950's.)

The first direct R-C audio oscillator was described in the April 1945 issue, by Ernest Steen (a contributor, I suspect). It used a 6J7 and a 6V6, connected in the classic Wein bridge circuit – with two two-gang tuning capacitors ganged together to adjust frequency, and a 15W lamp for amplitude stabilisation. Output voltage was about 30V RMS, with frequency adjustable from 20Hz to 30kHz and distortion rated at below 0.5%.

Derrick Williamson described a simpler unit in the July 1949 issue, based on a single 6SN7 dual triode. This used a pair of WX6 copper-oxide 'Westectors' for amplitude stabilisation.

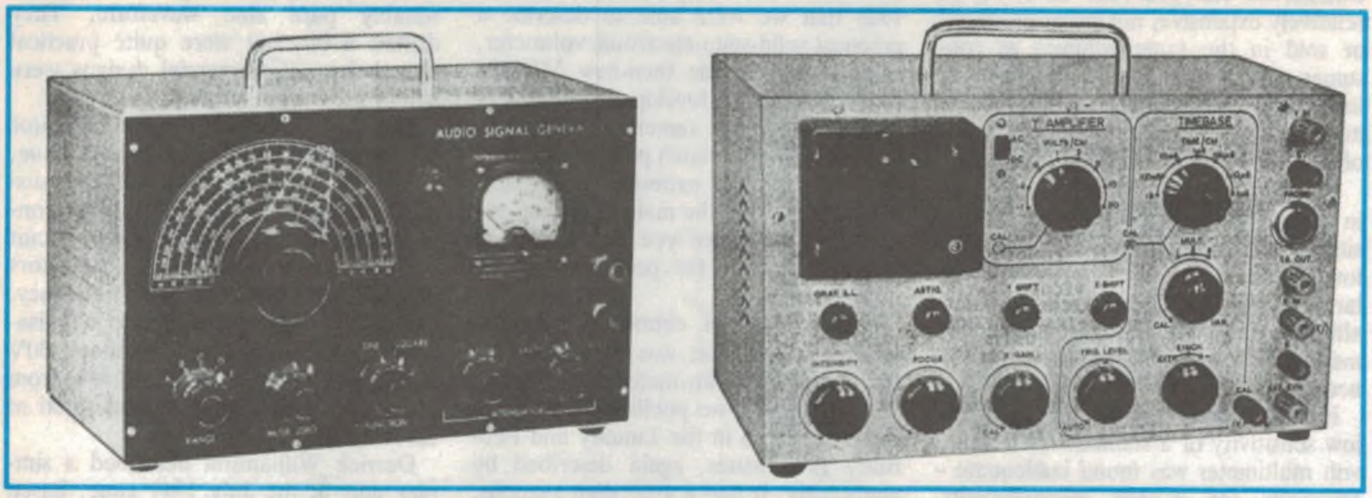
But our first *real* audio generator didn't appear until the August-September 1955 issues, when Reg Rawlings described his 'Audio Signal Generator'. This was an excellent design, again using the Wein bridge system. It had a pair of 6BX6 valves for the basic oscillator, with a thermistor for amplitude stabilisation. A 6BW6 valve was used as a cathode-follower, to give low output impedance, with a 12AU7 to produce square waves when desired. Another 12AU7 was used to drive an output level meter, and there were both switched and variable output level controls - producing a very professional instrument.

The prototype generator was still in constant use in the magazine lab, well



Our first Vacuum-Tube Voltmeter or 'VTVM', described by Ray Howe in the September 1949 issue.

50 Years of 'Hobby' Projects



Shown at left is the 1962 revamped version of Reg Rawlings' original 'Audio Signal Generator', of August-September 1955. At right is the 'Fully Calibrated 3" CRO' described by Jim Rowe in the June-August 1963 issues.

into the 1960's. In fact I myself described an 'updated' version of it in the February 1962 issue – almost identical apart from the use of a pair of silicon diodes in the power supply.

Our first transistorised audio oscillator was described in the September 1965 issue, also by myself. It used three silicon transistors in the basic Wein-bridge circuit, with another to drive the level meter. I still have the original of this design in my home workshop as a 'standby' and it works quite well.

Then in September 1968 I described the solid state 'AF Signal Generator', deliberately designed as a serious replacement for the earlier valve generator. It again used the Wein bridge system, using four silicon transistors in the oscillator and with a thermistor for stabilisation. Four further transistors were used in the output amplifier, with an IC to produce the square-wave output. The output frequency range was 3Hz – 300kHz, with THD less than .06% over the basic audio range. Maximum output level was over 10V RMS, with a calibrated level meter and both switched and variable attenuators providing 90dB of adjustment. The prototype of this generator is still in regular use in the *EA* lab, 21 years after it was built!

Since then there have been quite a few audio generators described, the latest design appearing in the February-March issues this year.

Cathode-ray oscilloscopes or 'CRO's' have also been quite popular construction projects over the years. The first simple design appeared in the May 1942 issue, described by one H.R. Harrant. It used a 2-inch 902 tube for the display, and a gas-filled 884 'thyratron' triode as a relaxation oscillator for the horizontal sweep 'timebase' – a system that would be used in many of the earlier designs.

Neville Williams described a very similar 3-inch CRO in the January 1948 issue, and followed this up in the next two issues with a 5-inch version using the readily-available 5BP1 tube. Then in the March-April 1950 issues, Derrick Williamson described a 3-inch instrument, again very similar and using the 902 tube again.

In July 1952 the 'Standard 5-inch Oscilloscope' appeared, still quite simple but capable of better performance than the February-March 1948 design. The 1952 design did indeed become a standard for some time, being re-presented in an improved form in March 1955 by Neville Williams.

For those who still couldn't stretch their budget to buy the parts for the 5-inch model, Ray Howe described a 1-inch design in the June 1953 issue. This used tiny 1CP1 (or 913) tube, and again had a thyratron for the timebase oscillator. Despite the tiny screen it was apparently quite useful for basic audio work.

Most of the earlier designs were in fact really only 'audio' instruments, but in August 1956 Maurice Findlay described a fully compensated vertical deflection amplifier using four 6AC7 valves, and with a bandwidth of 1MHz, suitable for television work. He also described a matching high linearity Miller-transitron timebase the following month, and then followed these up in the following February-May 1957 issues with the magazine's first true 'Wide Band 5-inch CRO'. It had a vertical bandwidth of just on 3MHz and was a very popular design, ending up in many a TV servicing workshop of the day.

But as before many people found the cost of a complete set of parts for the 5-inch 1957 design a little beyond their budget, so in the August and September 1960 issues John Barker and Brian Cleaves described a small '3-inch TV Oscilloscope'. This had a vertical response of 2.7MHz, a calibrated vertical channel and a Miller transitron timebase, and an illuminated graticule. Because of its lower price, it became even more popular than the larger unit.

As time passed, of course, people began to expect more from an oscilloscope – things like calibration in terms of both time and voltage. I attempted to meet this need myself in the June-August 1963 issues, with the design of a 'Fully Calibrated 3-inch Measuring Oscilloscope'. It had direct-coupled and balanced deflection amplifiers, a fully compensated vertical attenuator, a Miller transitron timebase with true triggering, and so on. The vertical amplifier was only 6dB down at 5MHz, making it comparable with quite expensive commercial instruments of the day.

Other CRO designs appeared after that, including a lower cost 3-inch 1.3MHz design which I myself described in the May 1966 issue. But the time for home-constructed oscilloscopes was beginning to pass, as expectations for instrument performance rose ever higher, CRT's became harder to get (and more expensive), and complete commercially-marketed instruments became more attractive in price.

The last complete instrument described was in October 1984, and that was in fact based on a commercially-marketed 'knock-down kit'.

In the last 20-odd years, the emphasis has been mainly on either upgrading older CRO's, or making things like dual-trace and digital storage CRO adaptors – for example John Clarke's design of November 1980 and Ron de Jong's of February 1982.

RF oscillator projects have also been fairly popular over the years. The first to appear was a very simple 'Modulated Oscillator' described by Rex Lackey of the Australian Radio College, in June 1939. It had a single 57 valve as the oscillator, with three switched coils and a tuning capacitor allowing it to cover the 'IF' (170-470kHz), 'broadcast' (525-1525kHz) and 'shortwave' (6-16MHz) bands. The 'modulation' was provided simply by operating the oscillator from unrectified AC – giving about 200% modulation at 50Hz!

Neville Williams described a rather more pretentious '7-Band Test Oscillator' in June 1951. It had a 6AM6 valve as RF oscillator, a 6J5 as audio oscillator/modulator, and a 6X5 as rectifier. It also featured a 5-position switched attenuator, in addition to a variable control, and its bands extended to over 100MHz.

An assortment of other instruments appeared over the years, all rather similar. The first simple transistorised design was in the March 1962 issue, described by myself, and for my sins I was also responsible for a rather more elegant design featured in the March 1968 issue. But virtually all of these designs were 'modulated oscillators' rather than 'RF signal generators'. It was generally recognised that home construction of a true signal generator was impractical.

Along with these designs there were also specialised RF oscillators, including instruments of the 'dip' and 'sweep' variety. The first 'Grid-Dip Oscillator' was described by Ray Howe in the April 1950 issue, using a 3V4 valve, while the first solid-state version using a pair of BF115 transistors was produced by Ian Pogson for the February 1969 issue. Phil Watson described the first sweep generator in March 1957, based on an electromechanical 'wobbulator'. He added a marker generator to produce a full 'Sweep and Marker Generator' in June of the same year.

R-C measurement bridges were also a popular instrument for home construction. The first of these appeared in the December 1948 issue, described by Ray Howe. It used 50Hz bridge drive, a 6B6 null amplifier and detector, and a 6U5/6G5 'magic eye' indicator. Ian Pogson described the first all-transistor design in May 1966 – I still have the prototype of this at home (having paid for the parts, I hasten to add!), and it still works particularly well.

Our first digital frequency counter project, described by Jim Rowe in the February-June 1970 issues.

There were many other kinds of test instrument described over the years, too many to cover them all here. But before leaving this category, I shouldn't forget digital frequency counters.

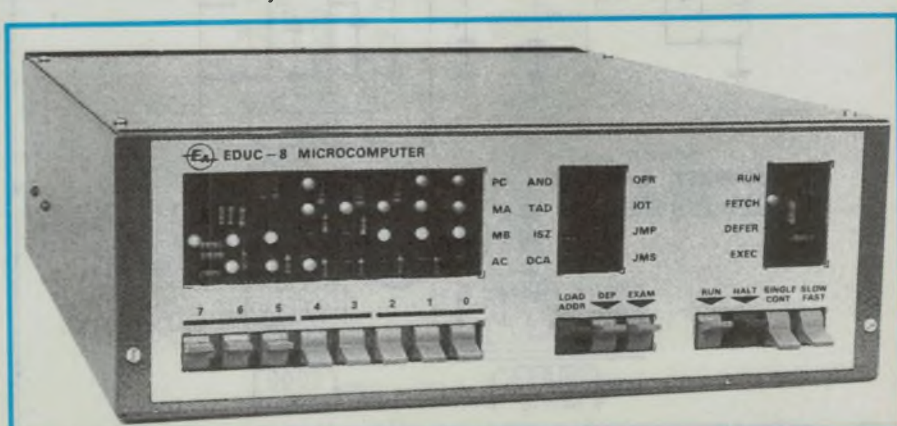
Our first counter design was published in 1970, in the issues between February and June. It used largely RTL ICs, with a few ECL devices at the front end, and gas-filled 'nixie' tubes for the 3-1/2 digit display. There were two versions – a simpler 200kHz unit with mains-derived timebase, and a 70MHz unit with crystal timebase. The designer was yours truly.

Later in the December 1973 issue I described a 200MHz instrument with 4-1/2 digit display, while in the August and September 1978 issues Leo Simpson described a much-improved 200MHz unit with 7-digit display. Ron de Jong produced a 500MHz instrument for the December 1981-February 1982 issues, also with 7-digit display, while Mark Cheeseman described a low-cost 50MHz instrument in May last year.

Computers

In August 1974, the magazine announced what was *almost* the first home-construction general purpose digital computer project described in the world. I say 'almost' because we were pipped by one month, by the US magazine *Radio-Electronics*. I remember this only too well, because our own 'EDUC-8' computer project was the result of over 12-months' concentrated design and development work by myself. The other thing I remember vividly is that although I had dreamed up the 'EDUC-8' name to rhyme with 'educate', emphasising its educational applications, for some reason most people seemed to prefer calling it the 'ee-duck-ate'!

The design itself used TTL-MSI integrated circuits, because this was the era just before microprocessor chips became readily available. To make it easier to construct, virtually all of the circuitry



Almost the first computer project ever described anywhere, Jim Rowe's pioneering 'EDUC-8' was announced in the August 1974 issue.

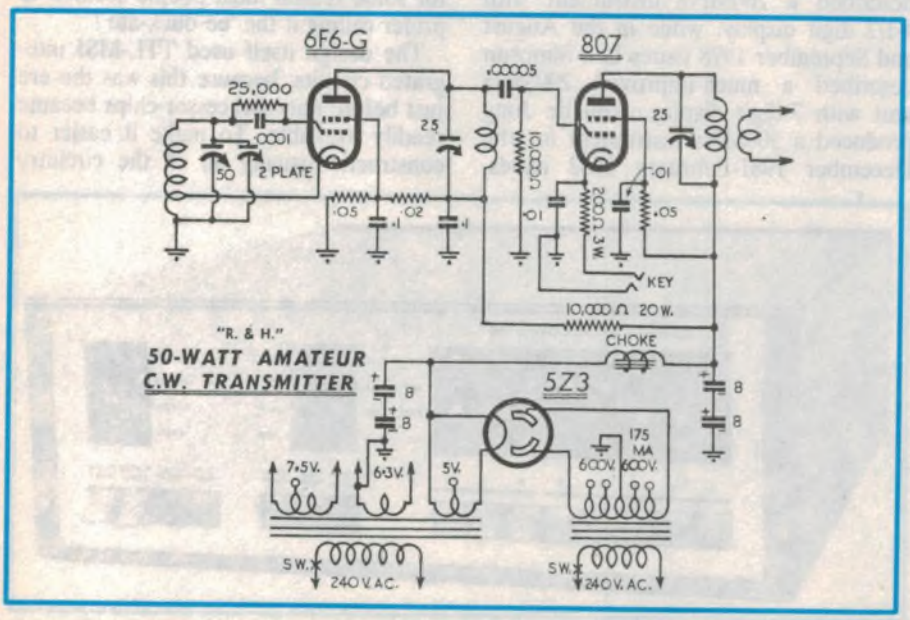
50 Years of 'Hobby' Projects

Our May 1977 'jazzed-up' version of Dr John Kennewell's very successful 'Mini-Scamp' computer, which appeared in the previous month.

was mounted on a set of PC boards, which simply plugged together. It was described in a total of 13 monthly articles, running until August 1975, and some 300-odd units seem to have been built – judging by reports from kit suppliers. I only hope that the readers concerned learned as much about computer operation as I did, from designing the thing. As finally completed, it had 1024 bytes of memory, and a total of over 100 IC chips.

As microprocessor chips became available, and their prices began falling, we were able to describe computer projects that were rather less daunting. Designs that come to mind include my own 6-chip 'Baby 2650 Computer' of March 1977, using the rather elegant Signetics 2650 processor; Dr John Kennewell's famous 'Mini Scamp' design of April 1977, based on the rather less elegant National SC/MP chip, and which we 'jazzed up' in the May 1977 issue – it became incredibly popular, too; David Edwards' '2650 Mini Computer' of May 1978; and the 'Dream 6800' design of May 1979, designed by Michael Bauer of Deakin University, and using the Motorola 6800 processor.

There was also the Z-80 based 'Super-80' design of August-September 1981, which had been developed by the people at Dick Smith Electronics. But after that, personal computers came on the scene, at attractive prices and with all kinds of great features that home-built machines had tended to lack. So interest in building complete machines has faded, although there are still lots of opportunities for projects to produce useful computer peripherals and interfaces.



The complete circuit of our first amateur radio transmitter project: John Moyle's '50W Amateur CW Transmitter' of May 1946.

Amateur radio gear

Of course I mustn't forget the amateur radio projects that we have published over the years. These were extremely popular in the earlier decades, before the advent of multi-band multi-mode 'appliances', when radio amateurs were still keen on building their own rigs.

John Moyle (VK2JU) described the first 'All-Band 50W Amateur Transmitter', in the May 1946 issue – just after amateur radio re-started after the War. It had only three valves: a 6F6 oscillator (VFO), an 807 power stage and a 5Z3 rectifier, and was capable of working on all HF bands up to 52MHz (6 metres).

He followed this up in the August-October 1946 issues with some more pretentious transmitter designs, with crystal oscillators, outputs up to 100W, and modulators for 'phone operation.

The August 1947 issue carried details of a three-valve 52MHz receiving converter, developed by Neville Williams (VK2XV), together with a crystal-locked 100W 52MHz transmitter from John Moyle.

After that transmitter, receiver, converter, antenna and antenna matching unit designs appeared very frequently for the next 30 or so years. There were too many to list here more than a few notable 'milestone' designs: the first transmitter for 288MHz, described by Neville Williams in March 1950; Maurice Findlay's 'All-Band Amateur Transmitter' of April 1956, using the Geloso 4/101 'signal shifter' module; the August 1960 'Simple 144MHz Transmitter', by Keith Jeffcoat (VK2BK) and Vol Molesworth (VK2VO); our first SSB transmitter, described by Keith Jeffcoat in the February-May 1962 issues; our first SSB transmitter for 144MHz, also by Keith Jeffcoat, in the October-November 1962 issues; our first almost-fully solid state SSB transmitter, described by Ian Pogson (VK2AZN) in the December 1966-March 1967 issues; the famous 'Tucker Tin Mk 2' low cost hybrid SSB transmitter, described in the February-April 1972 issues by Fred Johnson (ZL2AMJ); and Ian Pogson's '3.5MHz Novice Transmitter' of January 1976.

There were also many specialised amateur receivers, of course. Examples were John Moyle's '166MHz Super-Regenerative Receiver' of October 1947; the first superhet for 144MHz, described by Neville Williams in the Feb-

Our first electronic organ project, the 'Playmaster-Stromberg' described by Neville Williams in the November 1961-August 1962 issues.

ruary 1951 issue; Keith Jeffcoat's '1965 Amateur Band Ten', in May 1965; and of course Ian Pogson's justly famous 'Deltahet' receivers, mentioned earlier. And a host of specialised test gear for amateurs, including my own 'VHF Powermatch' power/SWR/impedance meter of February-June 1971.

Car Projects

Projects to help look after, maintain or get better performance from the family car have also been very popular over the years. These have included tachometers, ignition efficiency/reliability improvement circuits, burglar alarms, windscreen wiper pulsers, courtesy light delay circuits, brake lamp monitors and 'performance computers'.

With space rapidly becoming a problem for me in this article(!), I can do little here but mention a few 'milestones': our first 'Electronic Tachometer', described by Phil Watson in the February 1960 issue; our first 'Transistor-Assisted Ignition System' described by Keith Jeffcoat in the January-March 1964 issues; our first capacitor-discharge ignition system, described by A.J. Fraser in the August-October 1970 issues; our first car burglar alarm, described by Ross Tester in August-September 1973; and the 'Car Computer' of July-October 1982, described by Leo Simpson and John Clarke.

Miscellaneous

The name 'miscellaneous' may not sound very flattering, but I'm forced to use it to cover all of the projects we've described over the years, which simply don't fit into the above categories. Some of these projects have been extremely popular in their own right, and many were pioneering designs.

Again, with this article threatening to gobble up all of this anniversary issue, all I can really do is list some of the most memorable projects that spring to mind.

There was Neville Williams' memorable 'Electronic organ' project, described in the November 1961- August 1962 issues, which was built up in very large numbers; the 'Incredible Optomin', an optical version of the famous 'Theremin', described by David Edwards in June 1975; my own 'Playmaster 760' organ, of March-June 1976; my 'Movie Mixer', of September 1978; our first electronic speed controller for model trains, which I described in April 1960, and the first one with 'simulated inertia', in March 1967; our first experimental He-Ne Gas Laser, of August 1969; our first 'Auto-Dim' automatic lamp dimmer, of December 1966; the first 'Musicolour' sound-to-light display unit, described by Leo Simpson in October 1969; the first 'Photographic Darkroom Timer', described by L.Varady in the July-August 1956 issues; Ian Pogson's 'Omega-Derived Frequency Standard' of May 1987; and of course many more.

The list goes on and on, covering almost every conceivable kind of electronics project. But finally this survey must come to an end, and I must hope that those projects I've been able to mention have given you at least a feel for the way things have developed over the last 50 years.

It's surely a record that few magazines around the world could equal. But we're not resting on our laurels – we plan to produce just as many interesting and challenging projects during the *next* 50 years. So stay with us, because we've really only just begun!

DBS: the future for TV broadcasting

In most of the world's developed countries, television broadcasting has now entered a new phase. The era of direct broadcasting by satellite has begun, bringing with it a vast expansion in the range of programme choices available for city and rural viewers alike. And despite fierce resistance by existing broadcasters, even Australia's entry into the DBS age now can't be too far away.

by JIM ROWE

By the end of this year, television viewers throughout the UK will have the choice of watching anything between 10 and 15 different programme channels – over three times as many as those available last year, even to viewers in the major cities. This dramatic expansion in viewing choices will be available not just in the cities, but in the smallest rural villages. And it's all happening because of the arrival of DBS: direct broadcasting by satellite.

Six of the new channels will be carrying Rupert Murdoch's new Sky Channel programmes, broadcast from the Astra satellite launched late last year by Societe Europeenne des Satellites (SES). Astra is in orbit in the equatorial 'satellite belt' at 19.2° East. An additional Astra channel will be carrying programmes from a broadcasting subsidiary of UK retailing chain W.H.Smith.

Two further channels from Astra's 16 television transponders are to be used for broadcasts by a joint enterprise whose majority shareholders include the giant UK-based advertising agency Saatchi & Saatchi.

Later in the year, another four channels are scheduled to begin operation on a new satellite, to be launched in August. This will be placed into orbit at 31° West, and will carry programmes from British Satellite Broadcasting (BSB), the private satellite broadcasting company set up two years ago with financing from the UK Government.

To receive these extra programmes,

One of the firms currently able to supply complete systems for the reception of Intelsat V signals in Australia is Space Communications International (SCI), of 11 Ralph Street, Alexandria 2015.

UK viewers will need a receiving dish only 60cm in diameter. This is because Astra's transponders are broadcasting signals in the microwave 'Ku' band (11-12.5GHz), where quite a small dish is required to achieve an acceptable signal-to-noise ratio. This despite the fact that the transponder power available is only 45W.

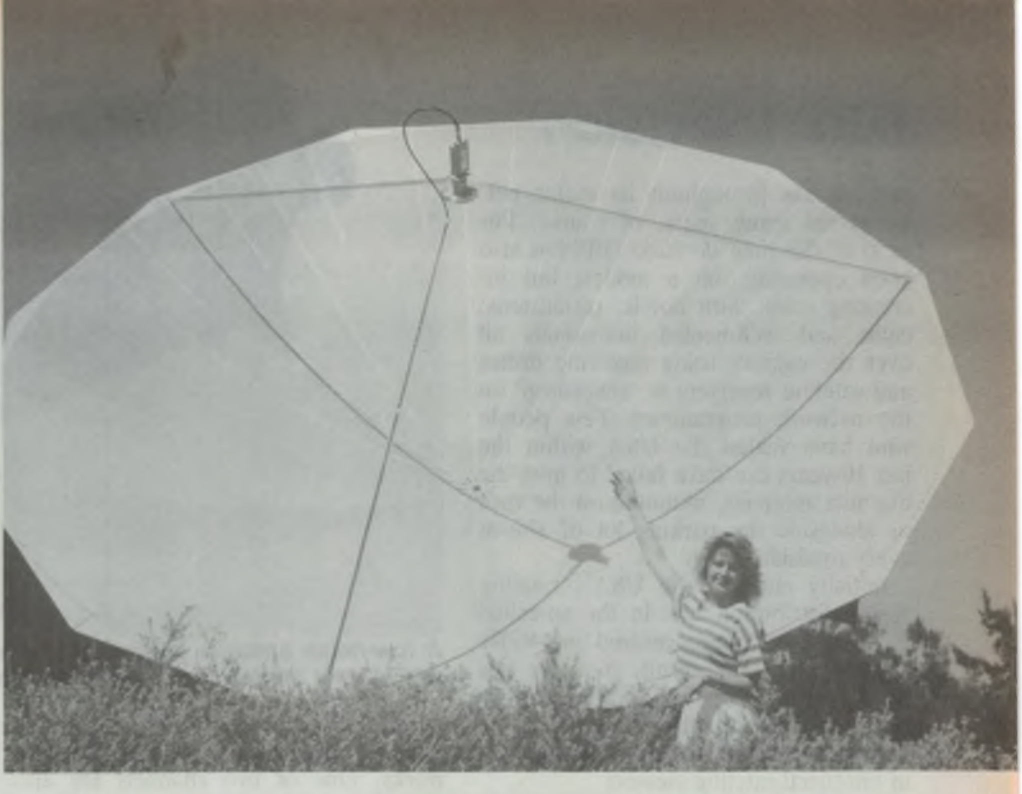
Initially, to encourage rapid growth in the number of viewers for these DBS programmes, they are being broadcast in normal PAL colour form – with no encyphering or encoding. This means that viewers will need only a dish antenna/feed horn, low noise block downconverter (LNB) and standard satellite receiving unit tuning from 950MHz to 1850MHz. The latter will produce standard PAL video and audio, suitable for feeding into a normal colour monitor or TV receiver. The typical cost for this extra hardware will be around A$500.

However later in the year, some of the new channels – particularly those broadcasting movies – will become 'scrambled', so that special decoder boxes will be required. These involve payment of a subscription fee, to pay for the programmes received. In the case of the Sky channels, the decoders will be controlled using 'Smart' credit cards, containing a semiconductor memory chip which stores the credit information. The cards will be simply purchased at retail outlets, and thrown away when the 'stored credit' expires at the end of 3 months. A quarterly subscription is expected to cost around A$75.

Similar things are happening all over Europe. A joint enterprise by Sweden, Norway and Finland called 'Tele-X' is also launching a satellite later in the year, to provide both additional TV broadcasting and communications channels for the three countries. West Germany is launching the TV-SAT2 satellite, to provide its citizens with four additional TV channels and 16 stereo radio channels using state-of-the-art digital PCM.

France launched its TDF-1 satellite last October. This also has the capacity for four TV channels plus 16 PCM audio channels, which are to be shared with three neighbouring countries. One TV channel has been allocated to the new European cultural/educational channel 'La Sept', which is scheduled to begin broadcasting before April.

Even Ireland is planning to launch its own satellite next year, with five TV channels. The company concerned, Atlantic Satellite (AS) is reported to be 80% owned by the US company Hughes Communications, and will apparently be targetting not just Ireland but the UK as a whole.



Another supplier of complete Intelsat V receiving systems is Dick Smith Electronics. Here is the company's receiving antenna system.

There's no doubt that 1989 is to be the year that Europe enters the era of DBS. US market research firm Frost & Sullivan estimates that by the end of the year, 700,000 families in Europe will be equipped for satellite reception. The figure is expected to grow to around 2 million by 1997.

The DBS revolution isn't confined to Europe, either. In fact Europe is getting under way relatively late, compared with Japan and the USA.

Japan launched its BS-2 broadcasting satellite in February 1984, and right from the beginning has been offering DBS to areas which experienced reception problems. Some 517,000 homes are now estimated to have DBS receivers in operation, while Japan's national broadcaster NHK is to begin experimental DBS broadcasting of HDTV (high-definition TV) this month. Regular HDTV transmissions are scheduled for next year, when the country's new BS-3 satellite is launched.

Japan's DBS television broadcasts already use the digital PCM system, for higher quality sound.

The USA has been using satellites for distribution of broadcast and cable TV

One of the DBS receivers available from Dick Smith Electronics, for Intelsat V reception. It tunes from 950 to 1450MHz, producing video and audio.

DBS television

programmes throughout its major networks for many years, of course. For most of this time *de facto* DBS has also been operating, on a modest but increasing scale, with hotels, restaurants, clubs and well-heeled individuals all over the country using receiving dishes and satellite receivers to 'eavesdrop' on the network programmes. Few people who have visited the USA within the last 10 years can have failed to miss the big dish antennas, mounted on the roof or alongside the parking lot of almost every roadside eatery.

Initially most of the USA's satellite signal distribution was in the so-called 'C' frequency band, centred on 4GHz (4000MHz). As a result, it is for this band that most of the satellite 'TVRO' (TV receive-only) dishes and receivers have been sold, to the growing numbers of unofficial satellite viewers.

In the last few years, the networks have been swinging over their programme distribution channels to the higher 'Ku' band, centred on 12GHz. But viewers with C-band dishes and receivers have not been left high and dry, as commercial satellite DBS broadcasters have moved in to take advantage of the situation.

There are currently about 180-200 channels in the C band being used for commercial satellite direct TV broadcasting, and this figure is now rapidly rising. It is likely to reach 300 by the end of the year, and use of the C band for DBS is expected to last well into the next decade.

The Ku band is now beginning to be used for DBS as well, however, with the planned entry later this year of major cable programming operators such as Home Box Office (HBO), Showtime and The Movie Channel. Combined C/Ku band DBS receiving systems are now being marketed, in anticipation of the expansion into the higher band. Some 300,000 satellite receiving systems were sold in the USA during 1988 alone, up 20% over the previous year.

So after years of fairly modest 'unofficial' growth, in advance of the rest of the world, the USA's activities in DBS finally seem to be getting into top gear – in the same year that services are starting in Europe and the UK.

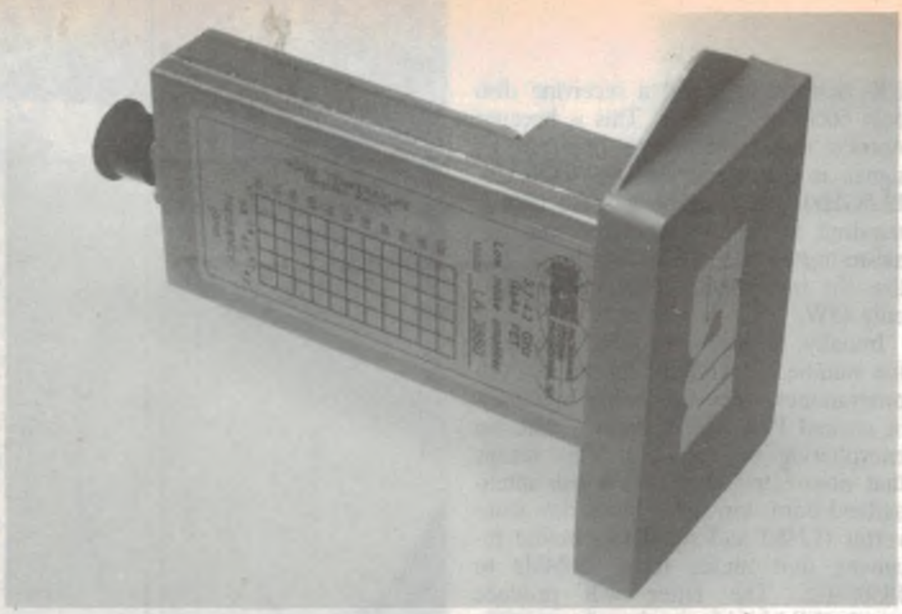
The home scene

How about Australia? Well, we've had domestic communications satellites for a while, run by Aussat and used primarily for communications links and program distribution by the TV networks. One or two channels are also used for the Bond media group's Australian 'Sky Channel' commercial service, providing largely sporting programmes to hotels and clubs.

Part of the original rationale to support the Government's investment in Aussat was the plan to use these satellites for DBS activities – the 'HACBS' (Homestead and Country Broadcasting Service) and 'RCTS' (Remote Commercial Television Service) schemes. But somehow this seems never to have happened, possibly due to pressure from existing commercial TV and radio broadcasters in rural areas. The only exception seems to be in Western Australia, where the Golden West Network operates a commercial DBS television service directed to rural homesteads using a spot beam from a 30W transponder on the Aussat 2 satellite.

So essentially, Australia has no DBS services at this stage, and officially there's been no decision to join the rest of the world in the DBS revolution.

A report recently prepared by the Department of Transport and Communications and submitted to Federal Cabinet has suggested that services could begin when Aussat launches its new set of satellites, in 1991-2, and that DBS/pay-TV could provide an enormous impetus for both the electronics manufacturing and television production industries. However it also warned of possible sociological problems, and of the likely effect on profitability of existing com-



A low-noise antenna preamp (LNA) for C-band satellite reception, courtesy DSE. Latest models include the block down-converter, becoming an 'LNB'.

A feed horn for C-band reception, normally bolted to the input flange of the LNA or LNC, at the focus of the dish antenna. It includes a circular to rectangular waveguide transition. The annular rings are RF chokes, forming a low-loss reflector. (Courtesy Dick Smith Electronics)

mercial broadcasters.

But despite the lack of an official decision, you may be surprised to learn that DBS is in fact already under way in Australia, albeit in a low-key fashion.

Some of the transponders on the Intelsat V satellites over the Pacific and Indian oceans have been used for international distribution of TV programmes for the last few years, and it was found that the received signal strengths from these C-band satellite transponders were sufficiently strong over most of Australia to allow quite good reception – providing quite large diameter receiving dishes were used.

The dishes required for good reception are typically around 3.7 metres in diameter – considerably larger and more expensive than those which would be required for reception from Aussat transponders (1 - 1.5m). However as the transmissions from the Intelsat V transponders are essentially unencrypted, they can be received using relatively low cost receiving equipment of the type used in the USA.

This contrasts with the receivers required for reception of signals from the existing Aussat transponders, which are either encrypted by the networks using a proprietary system, or use the B-MAC system of time-multiplexing the luminance and colour information together for each scanning line. Even for B-MAC reception a special decoding receiver is required, with a price tag significantly higher than for a US-type receiver.

A further complication with reception of signals from the Intelsat V transponders is that although they are largely unencrypted, most of the signals conform to the American NTSC or French SECAM colour TV transmission standards, rather than to the PAL system used in Australia. So as part of the receiving system, a multi-standard TV set or monitor must be used. This again tends to add to the cost, although multi-standard sets are gradually becoming cheaper.

So for an outlay of between $6000 and $12,000, it is already possible to receive additional TV programs in Australia from the Intelsat V transponders. At this price it's not exactly within everyone's reach, but for the well-heeled enthusiast the option is certainly there.

Programmes currently available on the Intelsat V-F8 satellite, located at 180° East, include the American AFTRS (Armed Forces Radio & TV Service) channel, broadcasting sporting programmes, news and current affairs to US military bases around the Pacific; CNN (Cable News Network), also from the USA and with mainly news; C-Span, broadcasting US Congress and Senate proceedings; the three main US commercial networks (NBC, CBS and ABC); Fujitsu TV, from Tokyo in Japan; the British BBC; and RFO (RF Oceanic), a French-language channel which apparently originates in Tahiti.

There are also channels used by the US programme producers to transmit movies and other programme material to the Australian TV networks, but these are generally either encrypted or made very difficult to view by the use of 'videoplexing' – a technique of sending two different programmes simultaneously, interleaved on an alternate-frame basis.

For the time being at least, Intelsat looks like being the only source of DBS television signals for most of Australia. But with DBS broadcasting building up steam all around the world, and many Australian viewers becoming dissatisfied with the limited choice of programmes available here, it may not be too long before Australia enters this exciting new era of television broadcasting.

New compact speaker from Dali

Danish loudspeaker manufacturer Dali has announced the release of an interesting new speaker, the Dali-15. A variety of advanced measuring techniques have been used to produce the design, including a patented vibration analysis system for detecting and eliminating panel resonances.

The Dali-15 uses a 40mm thick front baffle. Both this and the back panel are constructed from high density fibre board. The long throw 200mm woofer used in the system is made from thick (1mm) polypropylene. In addition to its conventional bass reflex box loading, it can be used with any NAD pre-amplifier having the 'BASS-EQ' facility, which provides more bass extension by taking advantage ofthe system's power handling capacity. According to Dali, this bending of the laws of physics provides deep bass response (-3dB at 33Hz) from a fairly compact enclosure.

Both the 75mm midrange and the 20mm ferrofluid tweeter are of the doped fabric type and are positioned towards the inside of each speaker.

The close positioning of the drivers together on the front baffle provides wide dispersion in the vertical plane, whilst the close tolerance crossover components and heavy cabinet contribute to stable stereo imaging. The connecting terminals are of the gold plated type and will accept banana plugs or heavy bared wire.

The new Dali-15 is finished in genuine wood veneer, either American walnut, black stained oak, or light ash. Priced at just under $2000 per pair, Dali-15 is supplied in mirror imaged pairs. Matching spiked stands are available for $169 per pair.

Further details are available from Scan Audio, 52 Crown Street, Richmond 3121 or phone (03) 429 2199.

New Sanyo VCR has 'clear still'

Sanyo's newest video cassette recorder with HQ (high quality) picture system, the VHR-4100, has built-in features which set it apart from its similarly priced competitors.

One feature of the unit, which comes with a 32-function infrared remote control, is a 'Clear Still' capability. Usually found only in higher-priced models, this function allows one to 'freeze' a video picture in perfect clarity, without a distoring noise bar. The VHR-4100's Clear Still' function works by pulling out the noise bar when the Freeze button is pressed, giving a perfectly clear still picture.

The unit also boasts a Lesson Repeat function that allows one to replay any section of a tape up to five times – a feture not found in other comparatively priced models.

With a height of only 79mm, the VHR-4100 has one of the sleekest, slimmest designs on the market. This means much smaller shelf space needed, and therefore more room for storage of tapes.

Anothe feature of this unit is its instant-start loading system. This innovative tape loading system reduces the time involved in starting up the system. The tape is drawn out of the cassette and wound around the head drum in a much faster time than that of a conventional system.

RRP for the VHR-4100 is $679.00.

Creek Audio now owned by Mordaunt-Short

Late last year Creek Audio Systems became a wholly owned subsidiary of Mordaunt-Short Ltd. Mike Creek will retain responsibility for all future engineering and design development within Mordaunt-Short's own expanding electronics facility.

The principal intention underlying this new association is that Creek Audio System will now benefit from access to Mourdaunt-Shorts's financial and administrative resources, while Mordaunt-Short in turn, will enjoy access to the electronics design and engineering skills which have brought Creek Audio Systems such acclaim in recent years.

As a result of this new association, Creek products are now being reintroduced into the Australian maket, initally the product range will include the CAS4040 and CA4140 integrated amplifiers, plus the VAS3140 integrated amplifiers, plus the CAS3140.

Further details can be obtained from the importers – Concept Audio, of 17/98 Old Pittwater Road, Brookvale 2100 or phone (02)938 3700.

New amps from Marantz

Marantz has released new additions to its range of amplifiers for the audiophile market, all designed in Europe under the direction of Marantz International's well-known chief designer Ken Ishiwata.

Mr Ishiwata, who visited Australia in mid-October 1988 to speak to the industry and press on trends in hi-fi design, has masterminded a major change in corporate direction by Marantz, which has seen the company return to the philosophy on which US designer Saul Marantz founded it in the 1950's: production of top quality audiophile equipment – at affordable prices.

One of the new amplifiers is the PM55, an unconventional new high-speed integrated design for dealing with the dynamics and sudden transients of digital sound.

The PM55 delivers 80 watts per channel. In order to produce the dramatic swings in sound level, dynamics and super stereo imagery of CD sound, particular attention has been paid to the design of the input stage and the choice of output devices.

Conventional amplifiers ordinarily use several stages of differential amplification, which gives high stability but a 'low-speed' amplifier. In the PM55 the pre-driver current is increased to twice the value found in equivalent amplifiers. This gives the amplifier very 'high speed' music reproduction and gets the most out of its triple-layer MESA power transistors.

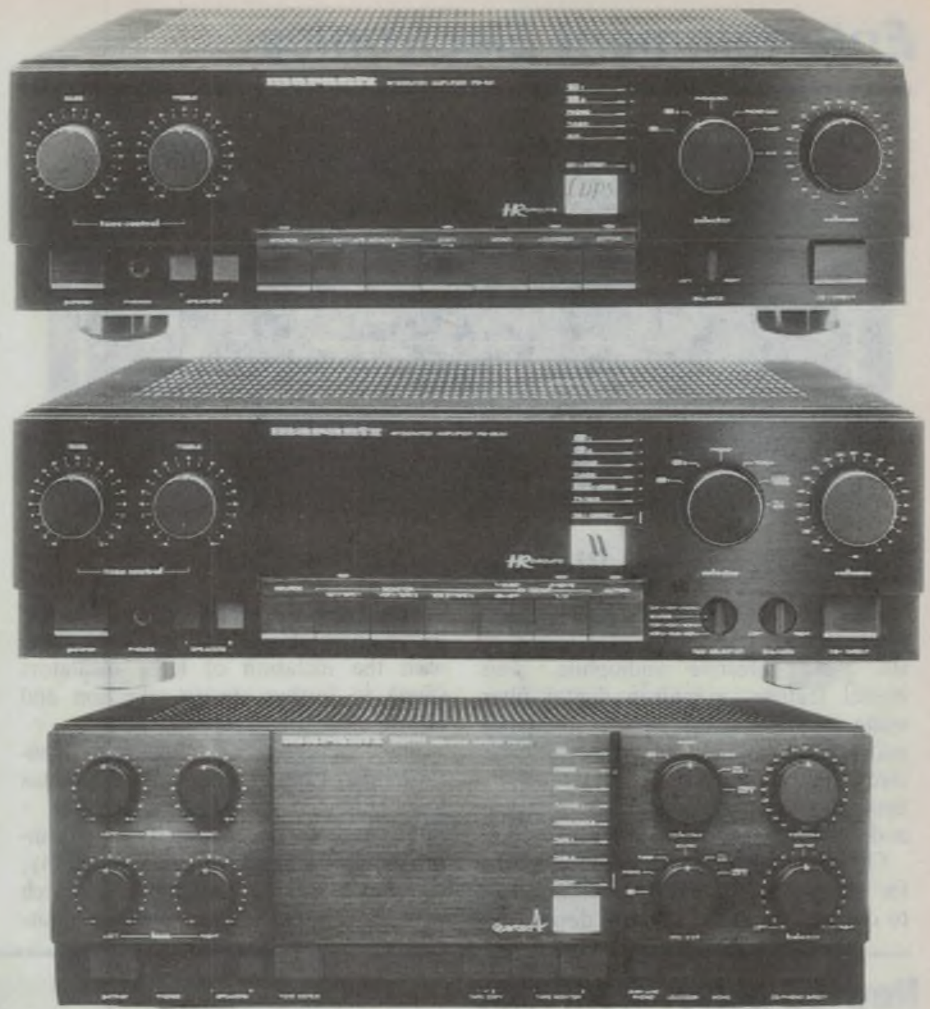
The PM55 provides no fewer than nine inputs, able to handle phono (magnetic and moving coil cartridges), CD and the soon-to-be launched Compact Disc Video format, tuner, TV/aux, two cassette decks and two video recorders. Two pairs of speakers can be driven, either independently or simultaneously.

A 'CD-Direct' switch feeds the signal from compact disc player direct to the power amplifier stages, bypassing the preamp circuit for maximum sonic clarity and resolution.

Great attention to detail has gone into the design. Non-magnetic copper-shielded screws and copper-plated fixings are used to anchor power transistors, and passive components have been hand-picked.

The PM55 sells for a recommended $599, and like all Marantz equipment, it carries a two-year warranty.

Another of the new amplifiers is a radical new design which will boost video signals as well as audio. This is the 85 watts per channel PM65AV, an ideal partner for hi-fi video tape recorders and the soon-to-be-released CD Video players, as well as top-flight audiophile sound systems.



The PM65AV is designed to make the best of both audio and video signals.

To maintain the very high picture quality from sources such as CD-Video or Super-VHS, on their way through the amplifier to the TV monitor, great care has been taken with the video circuitry. Video amplifer circuit boards are made from high quality polyester to improve shielding and resist vibration.

Because off-the-shelf chips will not preserve signal quality, video buffer amplifiers have been designed around discrete components, resulting in a 10dB improvement in video crosstalk – and consequently better sound quality.

For improved stereo imaging and dynamics there are totally independent video and audio input boards. Both video and audio circuits have independent power supplies.

When the amplifier is used for sound only, an electronic switch cuts video connections that could radiate noise into the audio circuits, thus maintaining the highest audio performance.

A dedicated AV-sound feature even helps restore life to poorer video sound. An 'AV1 Music' setting boosts frequencies below 50Hz to give added bass weight to music videos. 'AV2 Movie' setting boosts frequencies below 200Hz to give added presence to the sound from feature films.

Sockets are provided for a Dolby Surround sound processor, to provide cinema-style special effects from Dolby encoded video tapes and CD-Videos.

The PM65AV also incorporates many of the widely-hailed features of Marantz's award-winning PM94 and PM64II flagship audio-only amplifiers. These include a CD Direct switch to feed the signal from a compact disc player directly to the power amplifier stage, bypassing the preamplifier circuits for the highest possible signal clarity and resolution.

A special hotline to the company's Sydney headquarters – on (02) 742 8322, or elsewhere in Australia – on (008) 22 6861 – ensures availability of sales and product information anywhere in Australia for the price of a local phone call.

Top-of-the-range Pioneer amp

Pioneer's A-91D Reference Digital Amplifier is designed to appeal to even the most selective audiophile. This model features a built-in digital filter using 4 times oversampling frequency and twin glitch-less D/A converters, for direct digital coupling of today's sophisticated music sources. Five electrical and optical digital inputs are provided.

Optimum performance is the keyword for the A-91D, with close attention paid to creating an anti-resonance design. As a result, the amp features an insulating 'honeycomb' chassis and heatsink, along with the inclusion of large insulators (feet) to further absorb vibration and ensure clear sound reproduction.

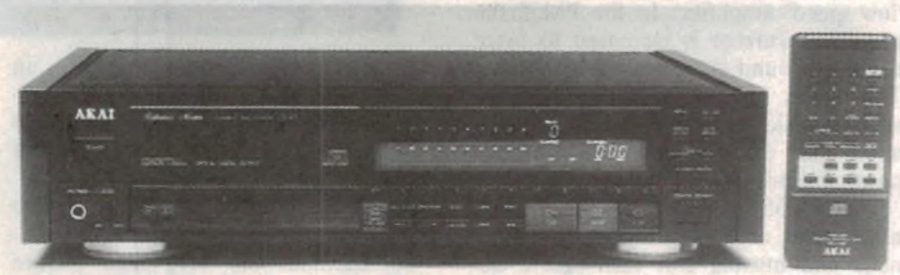
The inclusion of Pioneer's Non-Switching Circuit Type III eliminates any annoying switching distortion – often audible on playback – and improved low-impedance drive capability, catering to the true audiophile in search of optimum performance. By minimising signal paths and thereby reducing the scope for loss of signal, the A-91D's direct circuit connection helps to maintain signal integrity – as does the use of separate circuit blocks for processing each channel individually.

Presented with a classy 'Urushi' finish and complete with gold-plated phono and CD inputs to further assure signal quality, the Pioneer A-91D amplifier is yours for $2699 (RRP).

While the A-91D presides over the Pioneer amplifier range and caters to the buyer seeking the very best in home hi-fi equipment, many features of this model flow on to the Pioneer A-717 and A-616 models and continue to filter down throughout the range which caters to all types of audio consumers.

For example, Pioneers A-443 Non-Switching Integrated Amplifier would suit almost any hi-fi enthusiast looking for high performance audio quality and innovative functions in the middle-market bracket. Available at the RRP of $599.00, the A-443 also features non-switching circuitry to end switching distortion, low-impedance driving capability, direct circuit connection and the inclusion of anti-resonance designs such as honeycomb chassis, heat sink and bottom plate – wrapped up in a simple but classy black matte finish.

New CD player from Akai



Akai's new CD-93/73 compact disc players are the latest additions to compliment the company's Reference Master series. Epitomising the latest advances from Akai's R&D, the two players boast 18-bit 4-times oversampling, high rigidity resonance-free construction to suppress extraneous vibrations, and independent and isolated power supplies for the analog and digital sections (CD-93).

A major benefit of 18-bit digital filters with quadruple oversampling is to maintain linearity down to the lowest signal levels, where most CD players have substantial amplitude errors. Additionally the four-times oversampling frequency (176.4kHz) effectively removes switching products from the analog output, without requiring the use of high order analog low pass filtering.

Internal signals are transmitted via the use of optical couplers and fibre-optic cables within the player. The reduction of vibration transmission has been achieved firstly by the players' massive, rigid mechanical construction – even the disc drawer (typically a moulded plastic assembly in other CD players) is a single rigid piece of diecast aluminium. Also there is an aluminium clamp for damping disc vibration during play.

Both units utilise a 3 beam laser pick up, with two error detecting sub-laser pick-ups to assure more accurate reading of the disc. Dual D/A converters maintain precise phase and imaging.

Provision is made for digital output via optical and coaxial outputs, plus gold plated RCA output connectors for line output connection to amplifiers.

Technical specifications include a frequency response of 2 to 20,000Hz, THD of 0.0025% (ref 1kHz), a dynamic range of 97dB and channel separation of 90dB at 1kHz.

Both the CD-93 and CD-73 are covered by Akai's two year warranty. The CD-73 has an RRP of $1199.99 and the CD-93 an RRP of $1999.00. Both units are available at selected Akai dealers and department stores.

High quality loudspeakers

Recently released and available from Quiptek Australia are a range of high quality loudspeakers from KTC for TV, automotive and muscial instrument as well as standard applications.

KTC offer woofers, tweeters, midrange as well as a wide selection of full range speakers. Physical sizes range from 1" to 18" for such applications as guitar systems and in most cases electrical specifications can be make to order.

For further information contact Quiptek Australia, 83 Stoneham Road, Attadale 6156 or phone (09) 330 6300.

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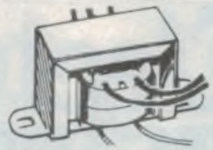
1/4" 10K Ohm		R-1806	75c	1/4" 20K Ohm Dual	R-1836	$1.50
1/4" 20K Ohm		R-1807	75c	1/4" 100K Ohm Dual	R-1840	$1.50

Quality Transformers Bargain Prices!



DSE2851
Primary: 240V. 50Hz Secondary Voltage: 6.3 - 0 - 6.3V Secondary Current: 150mA Terminators: Flying leads Cat M-2851

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DSE0144
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DSE2155
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DSE2840
Primary: 240V, 50Hz Secondary Voltage: 4.5 - 0 - 4.5V Secondary Current: 150mA Terminations: Flying Leads Cat M-2840

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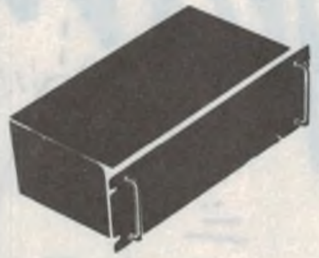

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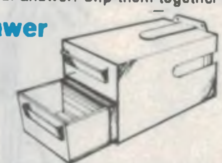

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74LS21	Dual 4 input positive NAND gate	Z-4924	87c
74LS27	Triple 3 input NOR gate	Z-4927	59c
74LS30	8 input NAND gate	Z-4930	66c
74LS54	2 way and/or inv	Z-4954	66c
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74LS109	Dual JK flip flop	Z-5109	80c
74LS196	Decade counter	Z-5196	$1.71
74LS138	3-8 decoder/demulti	Z-5184	84c
74LS153	Dual 4 input multiplexer	Z-5186	84c
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4015	Dual 4 bit shift register	Z-5615	$1.00
4023	Triple 3 input NAND gate	Z-5623	66c
4030	Quad EXCLUSIVE OR gate	Z-5630	66c
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74HC27	Dual JK flip flop	Z-5827	66c
74HC30	8 input NAND gate	Z-5830	66c
74HC32	Quad 2 input OR gate	Z-5832	66c
74HC76	Dual JK master/slave flip flop	Z-5876	87c
74HC85	4 bit magnatude comparator	Z-5885	$1.36
74HC139	1 of 8 decoder/multiplexer	Z-5920	87c
74HC157	Quad 2 input multiplexer	Z-5925	$1.36
74HC165	Par load 8 bit shift register	Z-5930	$1.57
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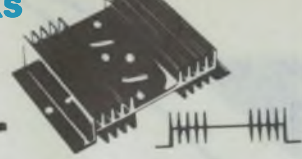

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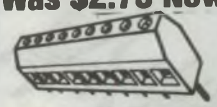

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Screw type. 4-Way with pre-tinned solder lugs and mounting holes. Cat H-6704

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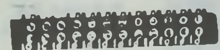

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4 terminals. Positive locking connection. Cat H-6770

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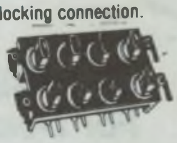

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BF463	Z-2040	45c
2N6557	Z-2041	45c
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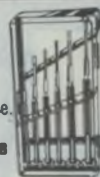

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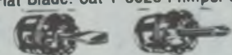

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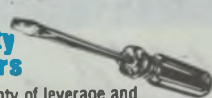

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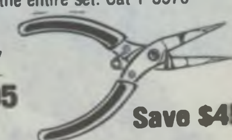

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Easy to use, great for virtually any application. 5 volt, 3Hz. Cat Z-4000

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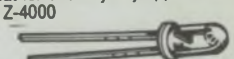

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Premium quality rectangular LED. Matched brightness, consistent quality. 2mm x 5mm. Ideal for bar graphs. Cat Z-4093

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7 Segment Display

8mm. 7 segment display. High brightness common cathode. Cat Z-4103

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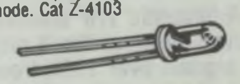

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12 Volt 30 Watts!

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The go anywhere soldering iron that just clips onto the car battery or any 12V source. Fast heating, it's lightweight and comes with 2 metre leads and large alligator clips. Cat T-1915

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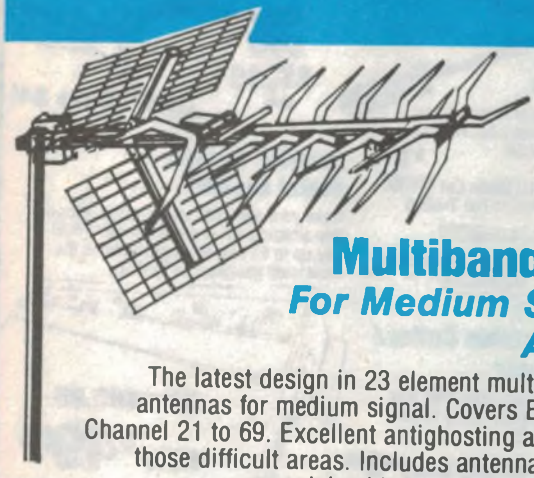

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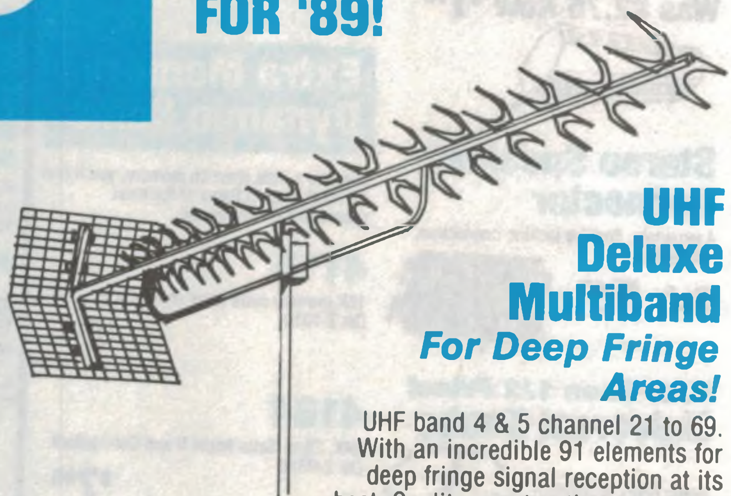

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For Deep Fringe Areas!

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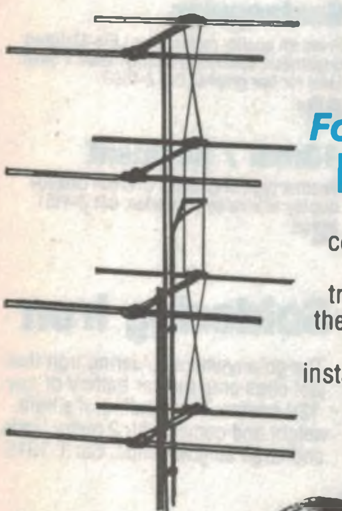

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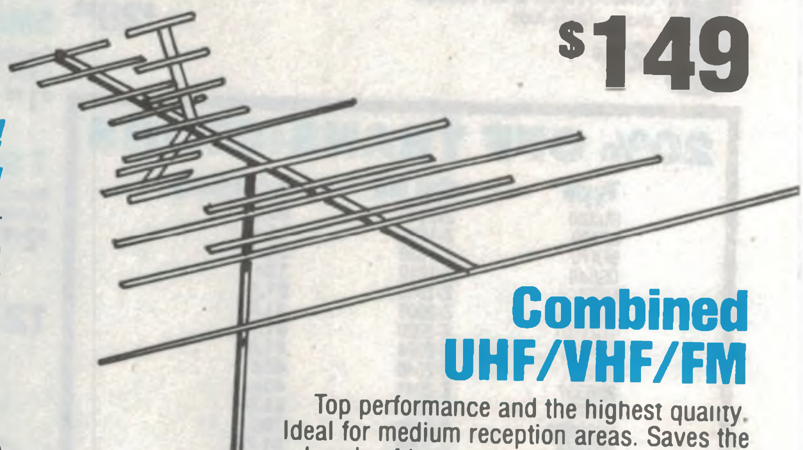

Combined UHF/VHF/FM

Top performance and the highest quality. Ideal for medium reception areas. Saves the hassle of two antennas. The very latest in design, this superb high gain antenna gives the best reception and minimum ghosting. Easy to install yourself on your existing antenna mast. Cat L-4021

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Brand NEW kit's are now in stock! Here are just a few. Don't miss our complete range of exciting do-it-yourself projects in our bigger, brighter 1989 catalogue - Out Soon!

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Introducing, Beepo - winner of the Grand Hobby Electronics Contest! Pocket sized it features three tones over six decades of resistance, automatic polarity reversal to save lead swapping and an ambient current so low that it needs no on/off switch. It's a must for trouble shooting and provides a much faster response than a digital multimeter. Cat K-7700

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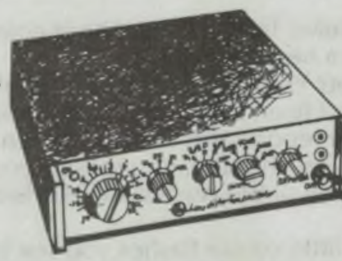
Audio Oscillator

At last, an audio oscillator that is both simple and inexpensive! This unusual approach has led to a design which uses high performance op amps together with a clever third harmonic cancelling network. This has lead to a circuit that is far simpler and cheaper than current high-tech (and high priced!) designs. Plus it can easily be converted to a Low Distortion Oscillator by inserting an RA53 Thermister (Cat R-1796).



$99

Cat K-7300

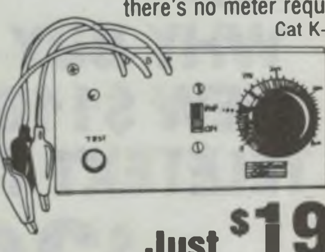
PCB Short Locator

A great idea that can save you hours of unnecessary work. This easy to build project can help locate shorted tracks on PCB's. Because it uses Audio Tone, you'll know instantly where the fault is, without taking your eyes off your work to check meters, etc. Practical, simple and inexpensive.
Cat K-7400

Just $29.95

Transistor Beta Tester

Simple to build, easy to use! This fantastic Transistor Beta Tester allows you to measure the gain of any bipolar transistor in seconds. Just connect a transistor, push the button, rotate the knob and read off the beta scale - there's no meter required!
Cat K-7200



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Dent Preventer!

Reversing Car Alarm

With the high cost of panel repairs (even a small bump can cost hundreds of dollars) this project is a real saver! The Reversing Car Alarm is a simple ultrasonic indicator, which when mounted on the rear of your car, gives you an audible signal if you get too close to any large object. Cat K-4600

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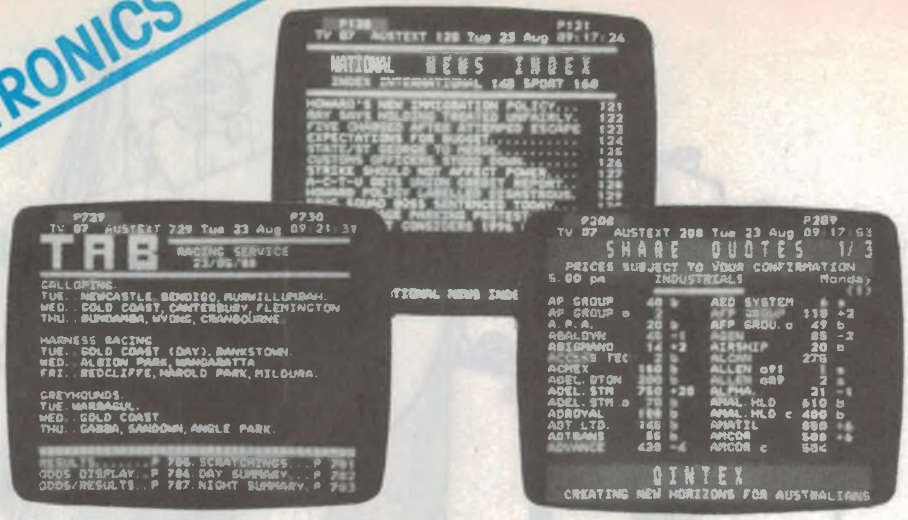

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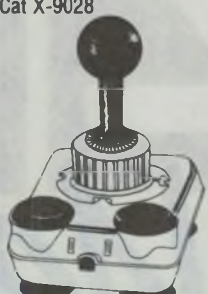

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Move to water down Metric units

Metrication may not be as permanent as it perhaps seems. The might of public opinion and the stance adopted by the US is causing a rethink in Canberra. Here's a report that may be the first of many, on the possibility that Australia will return to a modified form of Imperial measurement.

by PETER PHILLIPS

When metrication was first introduced in 1971, it was done amidst much controversy. The government of the day asserted that most industrialised countries were also going metric and that the new system was better than the Imperial system. Those against this change argued that the Imperial system could be cleaned up, and referred metric supporters to the USA, where metrication had been declared too expensive.

However, it seems that the debate is not over yet. In fact, if the findings of a parliamentary committee set up in 1987 by the Hawke government are implemented, Australians may yet find themselves with a new measurement system that borrows from both the metric and the Imperial systems. Because of the almost total lack of publicity, many readers may not yet be aware of this potentially significant initiative.

The committee was set up by the government following findings that many industries in Australia were missing out on US manufacturing contracts. It seems the metric standard observed in Australia is a contributing factor to this problem. For example, in 1987 a report was prepared by the Industries of Australia Board, titled 'Australian Industry and the US'. Included in the report was an indictment of the metric system, the report stating '... our preoccupation with metric has meant that we are now often unable to comply with the requirements specified in US contracts.'

Following the apparent disquiet with metric within industry, the Minister called for representations from those groups with complaints about the metric system. As a result, numerous reports were filed, giving rise to some fairly interesting findings.

For example, a report submitted by the Australian Crimefighters League claimed that since metric measurements to describe a felon were introduced, apprehension rates have dropped by some 30%. The Electronic Industries Association has been particularly scathing of metric. It criticises the use of the square millimetre measurement for electrical power wiring, the terms Hertz and Seimen, and the use of the millimetre as a standard unit of length. 'In nearly all cases, a standard metric unit is at least one thousand times too small.'

In June 1988 the Minister responsible for the report, Mr Philip Footit, presented the committee's findings to Parliament, prompting a review of the hard-line stance previously taken by the government towards metric. As yet no decisions have been taken, but it seems likely there will be changes.

For example, the use of 'hard metric' is likely to be outlawed, which will effectively bring back the Imperial measurements. However, new terms for standard units are likely to be introduced as well, to overcome some unforeseen difficulties with the existing terms, and to identify the new measurements.

From the electrical point of view, several important changes have been suggested. The Footit report has suggested that the Hertz should be replaced by 'cycles per second' (cps) as the unit for frequency, and the Seimen replaced by amps per volt. The kilowatt-hour is also seen as 'being unnecessarily verbose', although the alternative of 'horsepower-hour' is not generally favoured. The Minister has offered the 'Footit' as a possibility, in lieu of either term.

When questioned about metric multipliers, the Minister has remained noncommittal. It is believed that some multipliers will be retained, although the use of the nano, femto and giga multipliers will be discouraged, and users may require a licence. However it has been suggested that sexist terms, such as 'milli', 'micro', 'mega' and the 'Henry' may be renamed, as they are reminiscent of names associated with a gender. Instead, milli would be replaced by the limi, micro by ocrim, mega by agem and the Henry by a suitable non-sexist term.

This line of opinion is further supported by the concept that all terms should be words, rather than people's names. Units such as the farad, volt, amp, watt and ohm would be replaced by, for example, the cap, the emf, (pronounced emph) the colps (from coulomb per second), the emfcolps (current times volts) and the res, respectively. A milliamp would become a limicolps, and a microfarad an ocrimcap. The kWh would be a kiloemfcolpshour, which tends to make the 'Footit' look good.

To make the agemcps (millions of cycles per second) roll off the tongue more easily, suggestions have been made that the term 'agemsups' (pronounced ajem-supps) be introduced, mainly to facilitate radio station identification announcements. 'You are tuned to radio station 2xx, operating on 45 agemsups' is seen as being more sensible than 45MHz, for example.

The 'kilo' may also be replaced, as many social workers have suggested that the current trend to violence is, in part, due to the continual reminder of the word 'kill'. The term 'peace' is favoured as a replacement, and we might yet see the 1k resistor become a 1 peaceres resistor and the kilovolt a peaceemf.

Whatever the outcome, it is likely that over the next few months, considerable debate will occur on a revision of our entire measurement system. The good news, according to the Minister is 'Not only will we have a measurement standard that everyone can understand, but we will have a whole new set of terms. This time there will be absolutely no confusion.'

Electronics in today's China

Electronics manufacturers in the world's most developed countries may be eyeing the People's Republic of China as a vast and largely untapped potential market, but the country's own industry is rapidly gearing up to address that market itself. In fact at least one major manufacturing group in Guangzhou has already achieved healthy export sales, and is about to begin exporting to Australia.

by THOMAS E. KING

A scant 10 years ago the household shopping list of the average family in China was short and simple: a sewing machine, fan, bicycle and a radio. Today the four priorities, a refrigerator, washing machine, radio cassette and, most importantly, a colour TV, reflect a more sophisticated consumer.

The significant change in demands over the intervening decade is the result of many factors, not the least of which has been the implementation of the Chinese Government's 'Open Door' policy. This opening of China to the world and of the world to China in the late 1970s not only signalled the start of major social reforms, it also heralded the dawn of the modern electronic age in the world's most populous country.

'Electronic fever' certainly hasn't captivated each and every member of the 1.1 billion-strong nation, but at least there's growing awareness of some of life's little pleasures for those who work a little harder and save a little more. Good old capitalistic-style mass media advertising has seen to that, on everything from Beijing billboards to Nanjing newspapers and Tibet television.

Vastly outpacing the ever-so-slow rise in per-capita income – currently averaged at about $600 a year, but higher in metropolitan centres and through southern Guangdong Province – but not overtaking the yearly increase of the new consumers, has been the meteoric rise of China's electronics industry. This multi-faceted industry has not only been responsible for the appearance of electronic items unseen even a few years ago, but it has been the stimulus for the development of many associated services and activities.

While China's burgeoning electronics industry doesn't boast of a 'Silicon Valley', the massive country does have a 'Silicon Street' in Zhongguancun on the western outskirts of Beijing. More than 150 high-tech enterprises established in this part of the capital over the past 8 years employ some 3800 workers, 1800 of whom are technical personnel.

About 80% of the companies to be found here specialise in computers and other electronics products, with the rest engaged in biological projects, new materials, instruments, chemistry and consultancy services.

In 1987 the combined turnover from all 'Silicon Street' high-tech businesses was around $300 million. (Fixed assets were valued at some $16 million.)

The area around Zhongguancun has long been famous for its scientific and academic activities. Nearby are over a hundred research institutes, 30 universities and colleges and around 50,000 scientific and technical personnel. Since the formation of the People's Republic in 1949, the government has gazetted the district as a 'culture and education area' and invested nearly $3 billion in related construction and equipment.

For decades, research here was carried out purely for research's sake! Many achievements were made, the results were written up in lengthly papers but virtually no attempt was made to introduce innovative research findings into assembly line product results.

It was during this time that China's first electronic computer was completed. On-line in the autumn of 1958, it was a

Locally made goods on display in Wanbao's Guangzhou showrooms.

'state-of-the-art' machine with numerous valves and several magnetic memory drums. This was followed in April 1959 by a unit of 4200 valves and 4000 transistors, which was capable of 10,000 calculations a second.

Despite occupying 200 sq. metres for the mainframe and another 200 sq. metres for the power supply and other accessories, this cumbersome computer was used to design tables for underground waterways in northeast China. Its capabilities were also applied to economic construction and national defence.

The first generation of Chinese computers was filled with valves, while the second generation in the mid 1960s was transistorised. In the early 1970s computers designed around ICs began to be seen – seen but not produced. The problem at this time was that emphasis was on research, hardware and main components. Manufacture, software and necessary accessories were all but neglected. In the 1970s Chinese computers were decorative status symbols; few went into mass production and fewer still found widespread application.

The early 1980s saw changes in the way scientific research was carried out, and the manner in which findings could be applied in practical situations such as computer manufacture.

One individual who can be at least partly credited with applying the practical rather than theoretical concept to China's computer industry is Chen Chunguang. By late 1980 Mr Chunguang had been a researcher with the Chinese Academy of Science's Physics Research Institute for more than 20 years. Combining this experience with

Wanbao's appliance group director Den Shao Shen demonstrates his firm's audio equipment, shortly to be released in Australia.

the knowledge gained from a study of California's 'Silicon Valley', he joined a dozen other senior technical people in setting up the independent Beijing Advanced Technology Service Company.

Other companies soon joined this pioneering organisation. Competing with one another to put research into practical application as quickly as possible, these cooperative-owned businesses and private enterprises flourished.

One of the most successful of these new enterprises is the Stone Group Company. Founded in mid-1984 by computer engineer Wan Renan and others who quit their secure jobs with the state-run enterprises, the company was established with a loan of just $7000 from a local agricultural-industrial collective agency.

With more ideas than money, Renan and his fellow colleagues mapped out a plan to become 'China's IBM!'. At the time many Chinese factories and offices were buying IBM-compatible computers. Most Chinese-made printers, however, were not compatible and imported printers capable of working with Chinese characters were expensive.

The Stone Group signed a joint development contract with a Japanese company for what is now called the M-2024 printer. A bank loan was secured to finance the initial run, which subsequently sold out in three days. The entire loan was repaid in just 17 days!

The 1980s is the decade of success stories in China's computer and electronic industry. One involves the Keli Advanced Technology Company, a Beijing-based high-tech organisation specialising in large screen, high resolution colour monitors which are in great demand by engineers, architects and others for computer-assisted design.

The company's 'Control Board No.4', which took four months to develop and came onto the market in early 1986,

The assembly line at Wanbao's largest refrigerator factory, which turned out 450,000 units in 1988.

brought in a profit of just under $2 million. In May 1987 the No.5 'Added-feature Control Board' was released in response to consumer needs, as was the later No.6 board after only a few months of research.

When company technicians learned that an American group had developed a control board with 32-bit graph processing functions, research efforts were intensified and a similar Chinese-designed board went into production in early 1988. The company's speed in developing new products is said to be three years ahead of state-run enterprises!

The success of the Keli Advanced Technology Company and dozens like it, along Beijing's 'Silicon Street', is based in large part on attention to market demand and quick response. An ability to fully understand end-user applications has also helped Chinese electronic equipment manufacturers extend computer sales far beyond laboratories and scientific institutions. In this country of 'tea and rice' computers are increasingly found in industrial, agricultural, commercial, educational and military establishments. Applications are widely varied.

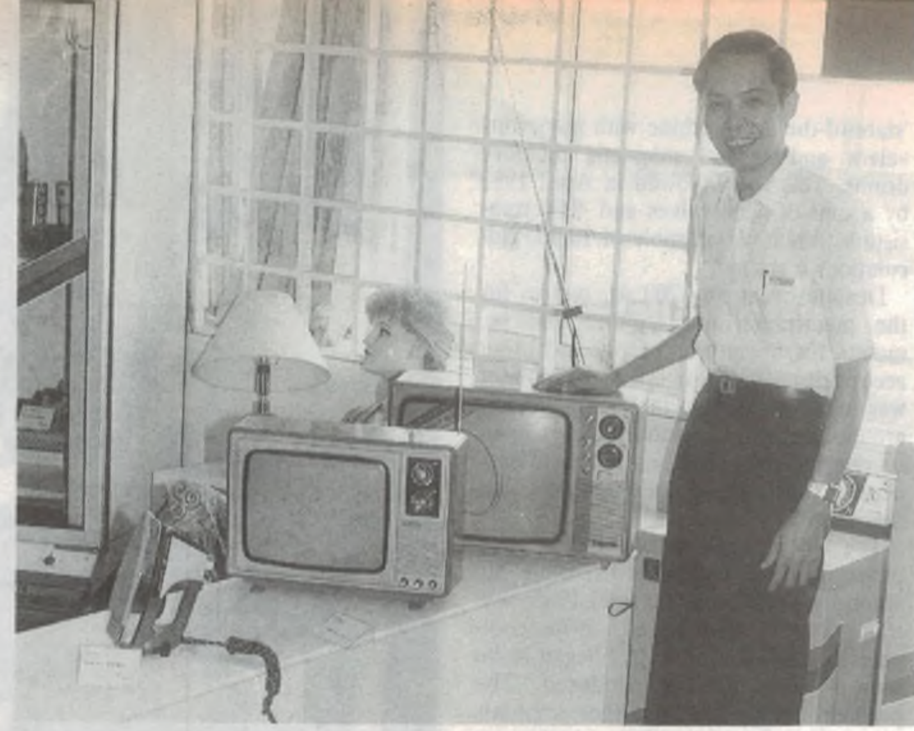
The Shanxi Textiles Mill uses a computer control system for specialised weaving of artificial fibres, to make automatic alteration of flower and animal designs. At the Xi'an Coal Mine, computer control is used to monitor mine environment and to control mine hoists for greater safety.

The computer at the Fuchunjiang Hydroelectric Power Station in Fujian Province forecasts flood peaks and thus helps to increase the power station's generating capacity.

A computer at the Shaanzi Agricultural By-Products Company has automated the process of recording weights and prices in the purchase of cotton and other products, while the Dagang Oil Field has automated the management of oil extraction with a computer.

And the Shanghai Telegraph Office uses a computerised automatic telegram relay system to shorten the time for relaying a telegram from an average of 45 to 2.7 minutes. Any measure to improve the communications facilities in China's largest city are more than welcome.

In addition to its ranking as the third largest city in the world (after Mexico City and Tokyo) 12 million-strong Shanghai is also one of the nation's



Den Shao Shen with Wanbao's monochrome TV sets. These are likely to be joined by colour sets in 1990.

most important industrial bases, the largest port and a major economic, technological, financial, information and trading centre. Helping put Shanghai into top position has been the establishment of over 300 foreign ventures, with an investment of nearly $3 billion.

As might be expected, communications demands from these information-hungry firms far exceed system capacities. But at least one foreign funded venture is in a position to do something about the antiquated telephone system which is mirrored through much of China.

The Postal and Telecommunication Industry Corporation of China, the Bell Telephone Manufacturing Company and the Belgian Government are involved in China's first joint equity venture in software and semiconductor technology. The programme aims to introduce S-1240 digital switching technology to the Chinese industrial environment, and provide Shanghai Bell with the capacity to produce the high-tech telephone equipment. Advanced S-1240 exchanges have already been installed in over a dozen major cities.

Bell isn't the only big name in Shanghai. McDonnell-Douglas and the Shanghai Aviation Industrial Corporation have a joint project licensing agreement for the assembly of 147-seat MD-82 aircraft. This project, expected to extend to $7 billion, will when completed next decade be the largest Sino-US technology transfer and cooperation programme, both in terms of dollar value and technological content.

Shanghai may be the leading business-based Chinese metropolis, but Guangdong Province is the true heart of this surging industrial 'tiger'. Located in the far south of China, away from much of the capital's bureaucracy and aided by the strong links with Hong Kong, Guangdong has become China's number one exporting province with around $6.5 billion worth of goods shipped in 1987. And it attracted some $6.2 billion in foreign investment in 1987, more than 60% of the nation's total.

Numerous small scale to medium sized industries established in larger villages and provincial centres have helped secure top ranking for the province, but the lion's share of output comes from Guangzhou itself, an historic city known previously as Canton.

An ancient port on the Pearl River and site of the massive biannual Trade Fair (well worth including in any holiday or business trip for a total review of the best China can manufacture), Guangzhou is an ultra-busy commercial centre. With a population well over the 5 million mark, there's no shortage of workers for the seemingly endless number of factories and manufacturing plants extending well beyond the sprawling suburbs of this city – which first established trade links with the British in 1685.

Some 300 years ago the British bought tea and silk from Canton merchants. Today that rather limited list of exports has been electronically expanded to include such items as microwave ovens, refrigerators, air conditioners, audio equipment, dishwashers, washing machines and kitchen appliances. A number of Guangdong-based manufacturers assemble some of these products; Wanbao makes all of them and has several more product categories on the drawing boards of its boardroom walls.

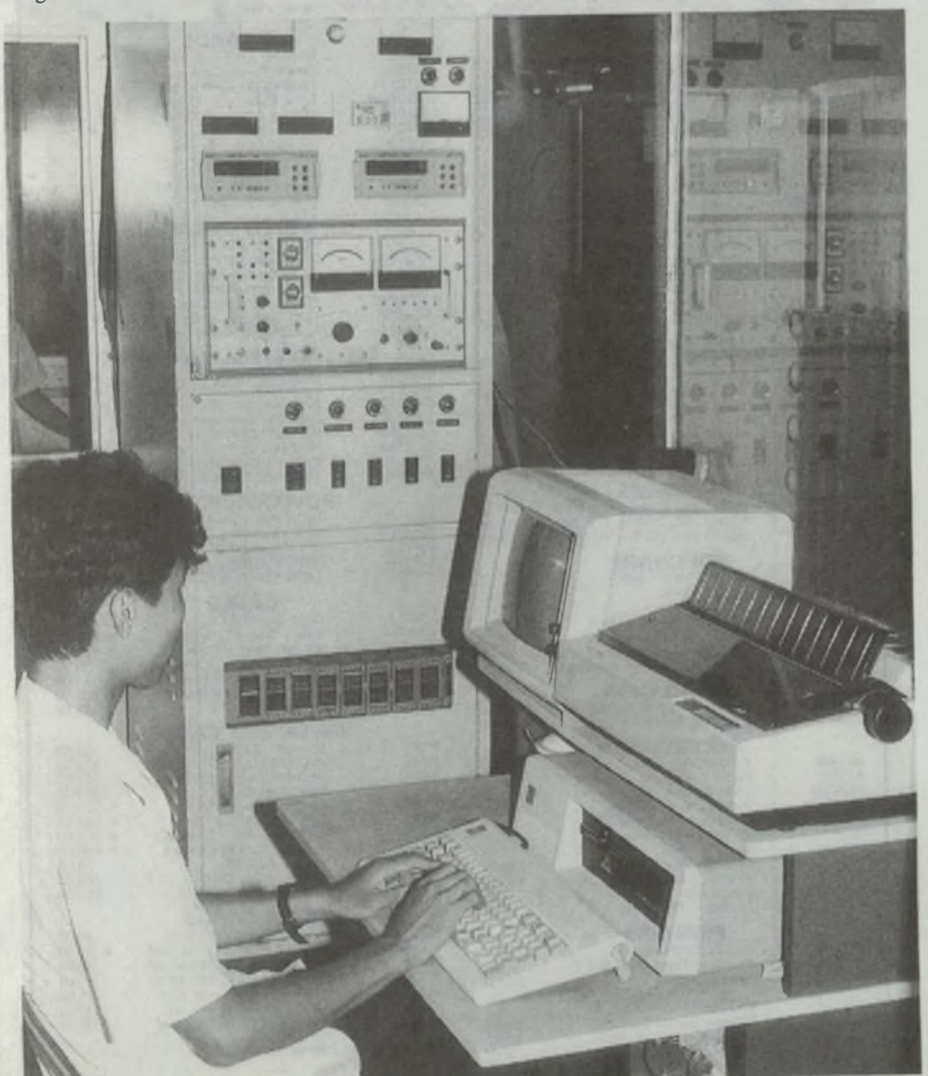
Beginning operations in 1984, Wanbao is a forerunner of the new generation of export-oriented Chinese factories with its emphasis on computer-assisted assembly lines, stringent quality control and design assistance from Hong Kong. This mammoth group of companies (44 members and more than 50 factories with over 3700 employees) does not, however, typify the state-of-the-overall-art in the country's domestic electronics and electrical scene.

No other company competes in size or diversity of products. Wanbao is not only the largest electrical and electronics group in China, but it also manufactures the widest range of goods. In refrigeration alone it is one of the eight largest manufacturers in the world.

No other Chinese company competes in research and development. Wanbao has an entire division devoted to R&D, whose current spheres of interest are vacuum cleaners and colour TVs. (The biggest problem faced in colour TV manufacture is securing sufficient quantities of suitable picture tubes.)

No other company competes with its level of computerisation or the extent of quality control. While Wanbao does not have 100% computerised assembly lines, the company has installed sophisticated computerised testing facilities for assembly of refrigeration units and some electronic products. Where computers cannot be used, an integrated testing system at all stages of assembly has been adopted. Monthly meetings between engineers and supervisors analyse products and reinforce standards.

Few other Chinese companies are allowed such commercial independance as the well known Guangzhou group. While Wanbao's factories are either owned by the state or by a people's collective they all have the right to import and export directly. (Other manufacturers need to deal through the China National Electronics Import and Export Corporation, a professional foreign trade corporation which has established links and cooperation with organistations and institutions in more than 100 countries and regions in less than a decade.)


Fully computerised QC equipment tests Wanbao refrigerators before they are crated and exported to four continents.

As well, Wanbao companies can export under their own brand name or can tailor production runs to meet the needs of a buyer – including the customised branding of goods.

Wanbao director Den Shao Shen heads the electrical appliance group which, as a major contributor to the overall group helped to achieve a 2 billion RMB or $625 million sales target in 1988. (This is compared to 1.4 billion RMB for 1987!) The $117 million component in 1988 export sales included virtually no remittance from down under.

"Australia is our next challenge," said Mr Den, "and we have made many preparations for our entry into this new market over the late 1988/early 1989 period."

Some different 16 Wanbao products ranging from irons, refrigerators and microwave ovens to toasters, washing machines and rice cookers are due for distribution across the country, by Melbourne-based Houseworks Australia. Other items such as air conditioners, audio equipment and black and white TVs are expected to follow later in the year.

Mr Den said that although there was strong competition in the Australian marketplace, Wanbao's electrical and electronic products would be successful because of their durability, design appeal and low price. As well, he noted, a guarantee of 3-5 years – depending upon the product – and a capital city service network would stimulate acceptance.

Before any Wanbao electric product could be exported to Australia it had to undergo a rigid procedure of testing from the Standards Association of Australia and receive technical approval. "Although safety standards are more strict in Australia than those found in other countries, we have been able to meet the requirements," said Mr Den. "And when Australian regulations require the use of an alternative to CFCs as a coolant, we'll put our R&D team on the environmentally-important matter and come up with a solution", he noted.

Continued on page 255

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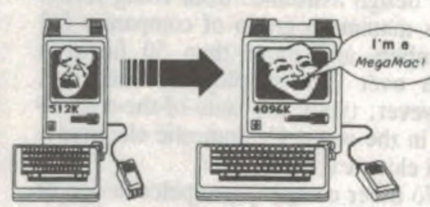

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DD1137H	Disk Drive, NEC 1.44M	★ 199.00
DD1157C	Disk Drive, NEC 1.2MB	199.00
DD3146H	Hard DD, NEC 40MB, 35mS	695.00
DD5126	Hard Disk Drive, NEC 20MB	399.00
DD5146H	Hard Disk Drive, NEC 40MB	645.00
DD3142H	Hard Drive, NEC 42MB 28mS	745.00

SYSTEMS

SY28612	System 286,12MHz, 1MB RAM	1745.00
SY28616	System 286, 16MHz, 1MB RAM	2195.00
SY28620	System 286, 20MHz, 1MB RAM	2395.00

SOFTWARE

SW410	MS DOS V3.2 – (NEC)	80.00
SWCCSD	CCS Designer	179.00
SWPAINT	CCS Paintshow	55.00
SWSL1	CCS Symbol Library No. 1	79.00
SWSL2	CCS Symbol Library No. 2	79.00
SWSL3	CCS Symbol Library No. 3	79.00
SWWM	Wordmagic, Wordprocessing	139.00

KEYBOARDS

KB101	Keyboard, 101 Keys XT/AT	115.00
KB84	Keyboard, 84 Keys XT/AT	★ 99.00

ACCESSORIES

AC2MP	Printer Cable, 2M, 25 pin	12.00
AC3MP	Printer Cable, 3M, 25 pin	15.00
AC5400	14 EGA Colour Monitor	★ 695.00
ACDA	9 pin Designer Adaptor	10.00
ACDM	Designer Mouse (290 DPI)	99.00
ACLA	25 pin Logitech Adaptor	10.00
ACLM	Logitech Mouse	130.00
ACM2	NEC Multisync II Monitor	1249.00
ACMA	Monitor – TTL Amber	199.00
ACMAT	Mouse Mat	7.50
ACMG	Monitor – TTL Green	199.00

PRINTERS

PR2200	NEC P2200 Printer	695.00
PR22CSF	Cut Sheet Feeder – P2200	155.00
PR30	Printer, Olympia 9 pin	425.00

CONSUMABLES

COD1200	Diskette, box of 10, 1.2M	50.00
COD360	Diskette, box of 10, 360K	20.00
CODB1200	Diskette, 1.2M, Bulk Pack	6.00
CODB360	Diskette, 360K, Bulk Pack	2.50
COMD720	Micro Disk,Box of 10,720K	66.00

I/O CARDS

IO1005	Multi I/O Card – XT only	★ 129.00
IO1009	Parallel Printer Card	★ 27.00
IO1010	Serial RS232 Card,XT only	55.00
IO10102P	Serial RS232 X 2, XT only	79.00
IO1014	I/O Plus Card – XT Only	★ 106.00
IO2210	Serial/Parallel Card – XT	★ 75.00
IO2230	I/O Plus Card – AT only	★ 125.00
IO2240	Multi-Serial Card, 4P – AT	245.00
IO2250	Multi I/O, 2S, 1P, 1G, AT	★ 299.00
IO2280	Multi-Serial Card, 8P – AT	645.00
IOCHIP	Chip Set for IC1010	25.00

VIDEO CARDS

VC0800	VGA Card, 800 x 600	545.00
VC1024	VGA Card, 1024 x 768	895.00
VC1623	Turbo Colour Graphics Cd	★ 99.00
VC1625	Colour Graphics/Mono Card	★ 115.00
VC1629C	EGA Card, W/Hercules Mode	★ 225.00
VC1633	Turbo Mono/Graphics Card	★ 99.00
VC1635	Turbo/Mono Printer Card	★ 115.00

DISK CONTROLLER CARDS

DC1004A	Floppy Disk Card, 4 Ports	★ 55.00
DC1220	1.2M/360K,720K/1.44M FDC	★ 99.00
DC1240	Disk Cont. 2in, 2Ex, or 4in	★ 130.00
DC2200	Hard Disk Controller – XT	145.00
DC2210	HDD/FDD Cont/Board – XT	175.00
DC2300	Hard Disk Controller – AT	245.00
DC2310	HDD/FDD Controller – AT	249.00
DC2340	2HDD/4DD Controller – AT	299.00

POWER SUPPLIES

PS9150CB	150W PSU, Circuit Board	85.00
PS9150S	150W Switching PSU – XT	★ 124.00
PS9180	180W Switch PSU – Baby AT	★ 145.00
PS9180L	180W PSU, Baby AT, L Type	★ 145.00
PS9200	220W Switching PSU – AT	220.00

CASES

CAAT	Case, hinged AT	155.00
CAATB	Case – Baby AT, hinged	★ 125.00
CAEX3	3.5 Ext. Case + Cable	99.00
CAEX5	5.25 Ext. Case + Cable	99.00
CAMCASE	5.25 Case for 3.5 Drive	25.00
CATOWER6	Case, Tower for 6 Devices	★ 399.00
CAXT	Case, hinged XT	95.00

INTERFACE CARDS

IF045	Serial RS-422 Adaptor	135.00
IF046	Industrial I/O Card	445.00
IF054	Universal Wire-wrap Card	125.00
IF055	Dual Serial RS-422 Card	195.00
IF286S	80286 Speed-up Card	595.00
IF488	IEEE 488 Interface Card	★ 399.00
IFADDA12	A-D/D-A Conv, 1 Channel	★ 199.00
IFADDA14	A-D/D-A Conv, 2 Channel	★ 449.00
IFCLOCK	Clock Card – XT	50.00
IFEPROM	EPROM Writer Card	245.00
IFTEGA	Orchid Turbo EGA Card	950.00

RAM CARDS

RC1015	Universal RAM Card,0K RAM	99.00
RC2000	2MB EMS Memory Cd, 0K RAM	★ 245.00
RC2000EEA	2MB RAM Cd, 0K LIM/EEMS AT	295.00
RC2000EEX	2MB RAM Cd, 0K LIM/EEMS XT	295.00
RC2350	3.5MB M/Funct Cd – 0K RAM	495.00
RC2500	2.5MB RAM Cd, 1S, 1P – AT	345.00
RC3350	3.5MB RAM Cd, 0K RAM – AT	235.00

*0K RAM MEANS ZERO RAM FITTED.

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CAT DD1053
Japanese manufacture 360K 5.25 inch floppy drive
Standard double sided/double density featuring brushless DC motor design
- Track to track access: 3ms
- Transfer rate: 250Kbits/sec
- Recording method: FM/MFM
- Dimensions: 41mm (H) x 146mm (W) x 203mm (D) (not including front panel)
- Power consumption: +12V/390mA (startup), 210mA (idle), +5V/460mA

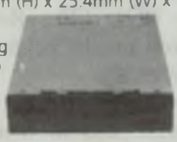
price only **$175.00**

CAT DD1157C
NEC 1.2MB/360K 5.25 inch floppy drive
This dual standard high/low density drive features a brushless DC motor for high reliability. Head positioning is via a steel band and stepper motor for high accuracy
Specifications:
- Track to track access: 3ms
- Transfer rate: 500Kbits/sec
- Dual speed design enables reading of 48 tpi and 96 tpi media
- Recording method: FM/MFM
- Dimensions: 41mm (H) x 146mm (W) x 203mm (D) (not including front panel)
- Power consumption: +12V/390mA (startup), 210mA (idle), +5V/460mA

only **$199.00**

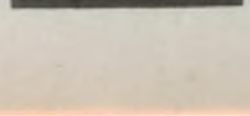
CAT DD1137H
1.44MB 3.5 inch slimline micro-floppy drive
This high reliability drive features low power consumption and high reliability. It incorporates an autoshutter and head load solenoid to protect media
Specifications:
- Data transfer rate 500 kbits/sec
- Power dissipation: 0.015W standby, 1.5W steady state
- Seek time: 3ms
- Size: 101.6mm (H) x 25.4mm (W) x 130mm (L)
- Weight 0.39kg

price only **$299**



CAT DD5126
20MB 5.25 inch half height hard disk drive
The DD5126 combines advanced technology with rugged design. The DC servomotor and split steel band access mechanism provides an access time of 85ms. A dedicated head landing zone, automatic carriage lock and low mass heads protect the media during shipment
- Access time track to track: 8ms. Average seek time 85ms
- Formatted capacity: 20.1MB
- Data transfer rate: 625Kb/sec
- Power consumption: 20W
- Size: 146mm (W) x 41mm (H) x 208mm (D)

price only **$399.00 Limited stocks at this price.**



CAT DD3146H/DD3142H
40 Megabyte 3.5 inch hard disk drive
- Access time track to track 8ms. Average seek time 35ms (28ms for DD3142H)
- Formatted capacity 40.3MB (43.3MB for DD3146H)
- Data transfer rate 625Kb/sec
- Power consumption 9.2W
- Non-operating shock: 40G
- Size: 41.3mm (H) x 101.6mm (W) x 146mm (D)

price only **(DD3146H) $695.00 (DD3142H) $745.00**

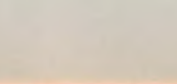
CAT CAMCASE
3.5 inch Tray
This adaptor tray enables a 3.5 inch slimline floppy drive to be mounted in the same space normally occuppied by a 5.25 inch drive. It comes complete with a 5.25 inch to 3.5 inch power adaptor cable
price only **$25.00**

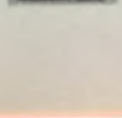
CAT CAEX5
5.25 inch External Drive Case
This case permits external mounting of a 5.25 inch hard or floppy drive. It comes complete with 37 pin connector and cabling to connect to a controller with an external socket
price only **$99.00**

CAT CEAX3
3.5 inch External Drive Case
This case permits external mounting of a 3.5 inch half height hard or floppy drive. It comes complete with 37 pin connector and cabling to connect to a controller with an external socket
price only **$99.00**

CAT DC2300
IBM Hard Disk controller
The DC2300 is a high performance hard disk controller card for IBM PC, AT or compatible computers
- Half size, suitable for the rightmost short slot
- The most reliable Digital Phase Lock Loop circuitry
- CRC and ECC functions ensure data integrity
- ON board copyright BIOS
- Default 3 to 1 interleave. Selectable from 1 to 9 by user
- User-friendly on screen physical format, parameter settings
- On-screen user selectable drive types
- Shipdisk software included in the BIOS
- Support 2 ST506-type drives. The drives can be in different types

Included: 1 x 20 way cable, 1 x 34 way cable
price only **$199.00**





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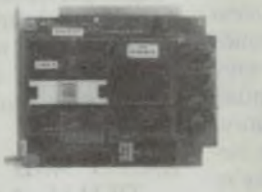
NEC
Don't compromise!! Get NEC quality for the price of a "cheapy"!!

Whatever your disk drive needs, Electronic Solutions has the answer, with a complete range of floppy and hard disks, adaptors, external cases and compatible disk controllers. We sell the superb quality NEC drives – at prices as low as the "cheapies". Now you don't have to compromise! NEC make the most reliable and hard wearing drives in the industry. Don't settle for less!!

CAT DC2200
IBM XT Hard Disk Controller
The DC2200 is a high performance hard disk controller for IBM PC/XT and compatible computers. It is fully hardware compatible with the IBM XT hard disk controller
- Half sized card,
- Uses highly reliable Digital Phase Lock Loop circuitry
- CRC and ECC functions to ensure data integrity
- On-board copyright BIOS
- Default 3 to 1 interleave factor can be varied from 1 to 9 by the user
- User-friendly on-screen physical format, parameter settings
- On-screen user selectable drive types
- Shipdisk software included in the BIOS
- Supports 2 x ST506 type drives. The drives can be different types

price only **$149.00**



CAT DC2210
Hard Disk/Floppy Disk Controller Card

This card provides high performance of up to two (2) hard disks, while also controlling up to two (2) floppy disk drives, either 5.25" 360KB or 1.2MB, or 3.5" 720KB or 1.44MB, for the PC "XT" or compatible computer.
- Digital Phase Lock Loop circuitry
- CRC and ECC functions ensure data integrity
- On board BIOS (copyright)
- Default 3 to 1 interleave factor Selectable from 1 to 9 by the user
- Shipdisk software is included in the BIOS
- It supports two (2) ST506-type drives The drives can be different types.
- It controls up to two (2) floppy disk drives

The drives can be different types in any combination of 5.25" 360KB or 1.2MB, or 3.5" 720KB or 1.44MB.
price only **$175.00**

CAT DC1240
Floppy Drive controller: 2 Internal/2 external or 4 internal drives
This is a high performance floppy disk controller card for IBM PC XT/AT and compatibles. The card can interface up to 4 floppy disk drives configured as 2 internal and 2 external or 4 internal. The diskette drives can be the combinations of any of the following diskette drives:
5.25inch – 360K or 1.2Mb
3.5 inch – 720K or 1.44Mb
An external drive can be added by purchasing the appropriate drive and case/cable (part number CAEX5/CAEX3).
price is only **$149.00**

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When I Think Back...

by Neville Williams

And the magazine was very young...

What was it like, running a radio magazine – this magazine – fifty years ago? What do I remember of the people who started it? How did I come to get involved? Has the magazine made a significant contribution to the electronics industry over the years? These are just some of the questions that Editor Jim Rowe put to me, as ideas for this special anniversary instalment of 'When I Think Back'.

Curiously, although employed in the industry during the 1930s, my recollection of the contemporary wireless/radio publications is, at best, hazy. In the early stages, most post-depression bench workers – like me – were too strapped for cash to buy the bits and pieces necessary to pursue radio as a personal hobby.

Most of what we learned flowed directly from the job at hand – assembling, wiring, testing and troubleshooting, plus occasional service jobs for friends on the side.

For sure, I remember *Wireless Weekly* receivers like the '1933 Standard' and '1934 Champion', because they were more ambitious than the routine sets we were producing in the factory. But reading about projects and kits becomes somewhat off-putting, if they're perpetually out of one's financial reach!

Later on, at the A.W.Valve Co, I was faced with so much job related literature – much of it at an engineering level – that the local publications tended to be 'scanned' rather than absorbed. For the most part, the editors and contributors were names on articles or, at best, voices on the telephone.

As a result, much of my current knowledge of early Australian technical literature is based, not on what I remember, but what I've gathered since. With that proviso, I'll do my best to respond to Jim Rowe's questionnaire.

Enter 'Radio & Hobbies'

Wireless Weekly, from which this present magazine emerged, was successful for the best part of twenty years, because its spontaneous mix of programs, personalities, correspondence and technical topics suited the generation which had to adapt to radio in the home. At threepence (3c) a copy, unchanged from 1922 to 1939, it was certainly affordable!

But during the 1930s, with radio no longer a novelty, the natural link between programs, personalities and technical material was progressively eroded and the then management (Associated Newspapers/Sungravure) decided to split it into two separate publications:

WIRELESS WEEKLY, to be enlarged, with up-graded program information and personality profiles, plus extra sections covering movies, stage, sport and simple technicalities. This was probably an intuitive move towards the now dominant womens/family format.

RADIO AND HOBBIES IN AUSTRALIA, a monthly to be devoted primarily to the technicalities of radio, but with space allocated for popular science and other practical handyman and hobby interests, even to stage 'magic'. The price would be a modest sixpence (5c) per copy.

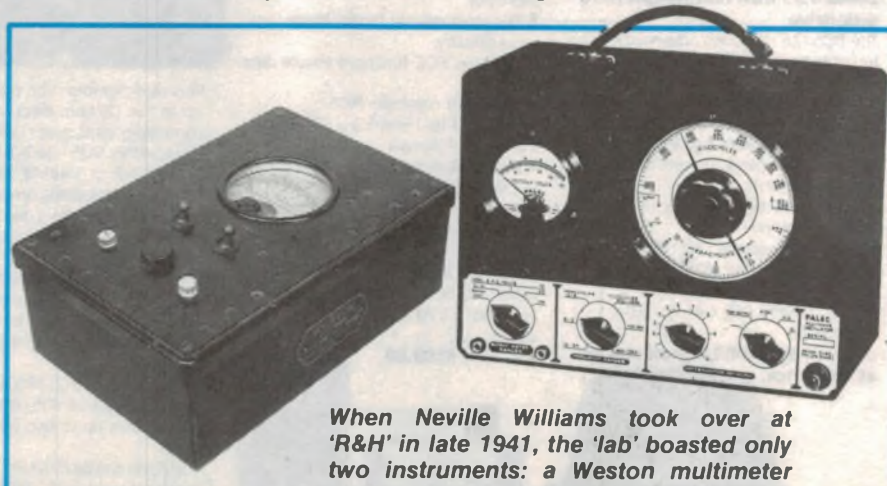
The decision was publicised in *Wireless Weekly* during February/March 1939, with the first issue of *Radio & Hobbies* (datelined April) to be available on March 23. As such, it would become a competitor for the existing *Australasian Radio World* monthly, established around 1935 and edited by Earl Read.

R&H personalities

The man responsible for implementing the split-up was Jack Lillis, whom I later came to know as a friend and mentor. A pleasant and capable executive journalist, Jack was totally frank about his ignorance of technical matters. He was to retain full responsibility for *Wireless Weekly*, but would be involved with its new technical offshoot in a purely administrative role.

The Editor of *Radio & Hobbies*, as announced in its first issue, was A.G.(Galbraith) Hull, who had succeeded his brother Ross as Technical Editor of *Wireless Weekly* in late 1930/early 1931. (The Ross Hull story was featured in this column in the February 1989 issue).

At the time, 'Braith Hull, whose main interest was in mechanical engineering, fast cars and model aircraft,



When Neville Williams took over at 'R&H' in late 1941, the 'lab' boasted only two instruments: a Weston multimeter and a Paton RF oscillator.

did not share his brother's detailed knowledge of radio technology, but he seemed to have adapted readily enough to the new situation. This much I gathered later from another *Wireless Weekly* old-timer, the genial if not overly modest Advertising Manager P.A.(Pop) Morse.

Back in 1931, according to Pop M., he had found 'Braith Hull slumped in the chair that his brother had vacated a few days previously, staring in dismay at a blank 'dummy' of the next issue. How could he possibly fill all that (adjectival) space? But, after being duly calmed down and talked up by you-know-who, he had gone on to provide the requisite copy and to do a good job thereafter!

(If old-timers seem to recall the name Morse in connection with power transformers, you're absolutely right. He set up a small family company, at one stage, to manufacture transformers and chokes, in potential but short-lived competition with firms such as Radiokes and Henderson).

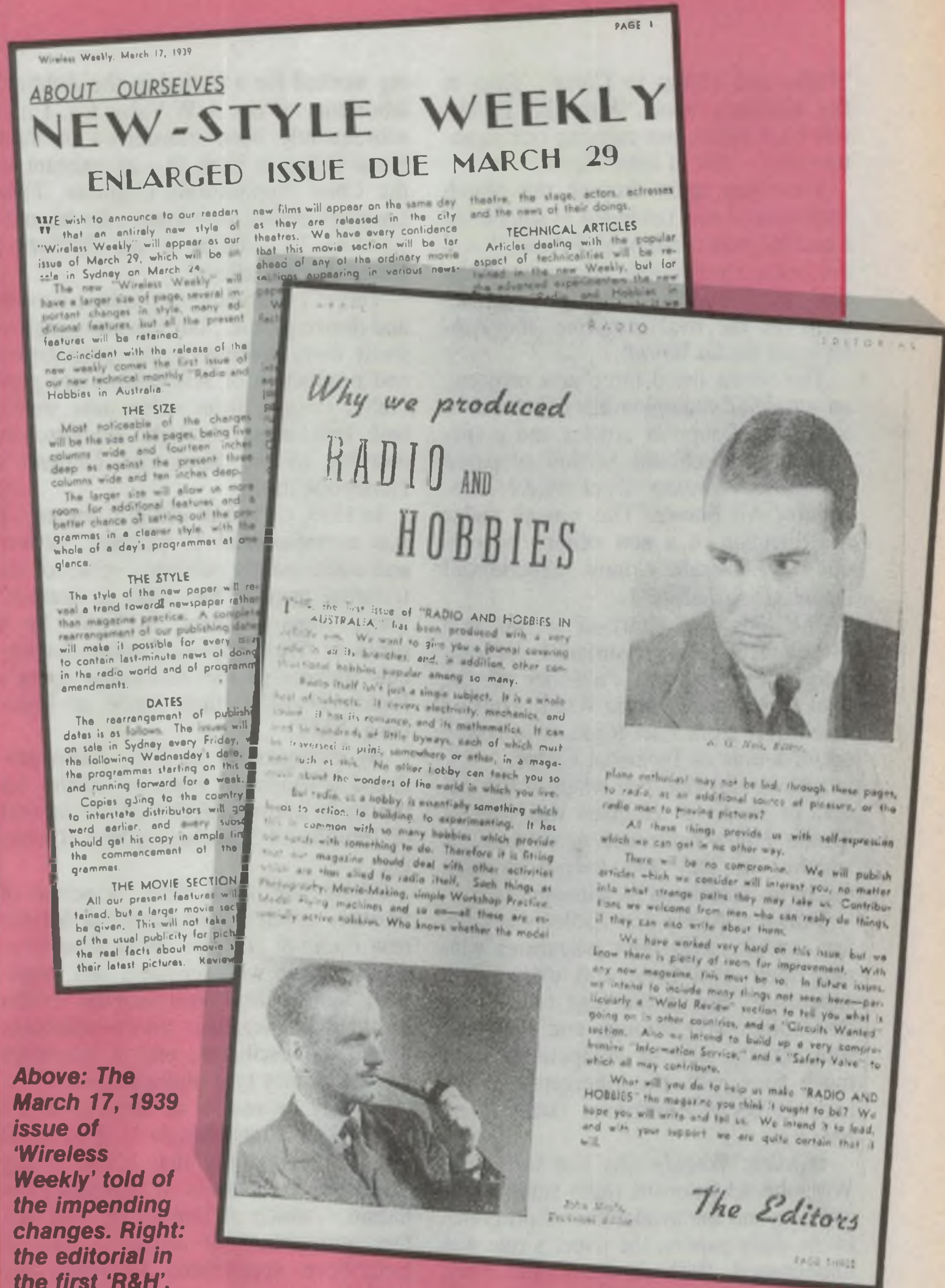
John Murray (Johnny) Moyle, Technical Editor of the new *Radio & Hobbies*, had joined the staff of *Wireless Weekly* in the mid 1930s as 'Braith Hull's assistant. While still at Scots College, Melbourne, John had developed an avid interest in radio which overwhelmed any other plans his family might have had for his subsequent career.

Ironically, John Moyle was, in many ways, a next-generation replica of Ross Hull: a natural writer and communicator, interested in music and a wide range of technical subjects, but totally committed to radio, amateur radio and hifi. Like Ross, he thought nothing of spending all day and half the night building, testing and writing about radio equipment, for the sheer satisfaction of so doing.

It is noticeable that, in the issues of *Wireless Weekly* leading up to April 1939, the weekly classical record reviews, plus many of the technical and constructional articles carry his byline. To quote just a few:

'Little Jim' receiver for bedside listening, May 27, 1938; 'Stereoscopic Six' receiver, Sept.2, 1938; 'Stereoscopic Amplifier', Oct.7, 1938; 'Remote Control' (tuner), Oct.21, 1938; 'Stereoscopic Eight', Nov.18, 1938; 'Stereoscopic Nine', Dec.16, 1938; 'La Perouse Receiving Centre', Dec.23, 1938. And so on.

The 'Stereoscopic Nine' must have been a major undertaking, especially for a weekly publication. The separate tuner featured dual-wave coverage, with an RF stage, combined dial and pushbutton (lever?) tuning, and a 2-position selectivity switch. The amplifier used push-pull 2A3 output triodes, driven by an Australian made full-range Airzone transformer, and feeding multiple Australian Rola loudspeakers.


Wireless Weekly, March 17, 1939 PAGE 1

ABOUT OURSELVES

NEW-STYLE WEEKLY

ENLARGED ISSUE DUE MARCH 29

WE wish to announce to our readers that an entirely new style of "Wireless Weekly" will appear as our issue of March 29, which will be on sale in Sydney on March 24.

The new "Wireless Weekly" will have a larger size of page, several important changes in style, many additional features, but all the present features will be retained.

Co-incident with the release of the new weekly comes the first issue of our new technical monthly "Radio and Hobbies in Australia."

THE SIZE

Most noticeable of the changes will be the size of the pages, being five columns wide and fourteen inches deep as against the present three columns wide and ten inches deep.

The larger size will allow us more room for additional features and a better chance of setting out the programmes in a clearer style, with the whole of a day's programmes at one glance.

THE STYLE

The style of the new paper will reveal a trend towards newspaper rather than magazine practice. A complete rearrangement of our publishing dates will make it possible for every issue to contain last-minute news of doings in the radio world and of programme amendments.

DATES

The rearrangement of publishing dates is as follows. The issues will be on sale in Sydney every Friday, with the following Wednesday's date, the programmes starting on this date and running forward for a week.

Copies going to the country and to interstate distributors will go forward earlier, and every subscriber should get his copy in ample time for the commencement of the programmes.

THE MOVIE SECTION

All our present features will be retained, but a larger movie section will be given. This will not take the form of the usual publicity for pictures, but the real facts about movie stars and their latest pictures. Reviews of new films will appear on the same day as they are released in the city theatres. We have every confidence that this movie section will be far ahead of any of the ordinary movie sections appearing in various news-

theatre, the stage, actors, actresses and the news of their doings.

TECHNICAL ARTICLES

Articles dealing with the popular aspect of technicalities will be retained in the new Weekly, but for the advanced experimenters the new ... Radio and Hobbies in ...

RADIO

Why we produced

RADIO AND HOBBIES

THIS, the first issue of "RADIO AND HOBBIES IN AUSTRALIA," has been produced with a very ... We want to give you a journal covering radio in all its branches, and, in addition, other constructional hobbies popular among so many.

Radio itself isn't just a single subject. It is a whole host of subjects. It covers electricity, mechanics and ... It has its romance, and its mathematics. It can lead to hundreds of little byways, each of which must be traversed in print, somewhere or other, in a magazine such as this. No other hobby can teach you so much about the wonders of the world in which you live.

But radio, as a hobby, is essentially something which leads to action, to building, to experimenting. It has this in common with so many hobbies which provide our hands with something to do. Therefore it is fitting that our magazine should deal with other activities which are thus allied to radio itself. Such things as Photography, Movie-Making, simple Workshop Practice, Model Flying machines and so on—all these are essentially active hobbies. Who knows whether the model

A. G. Hull, Editor.

plane enthusiast may not be led, through these pages, to radio, as an additional source of pleasure, or the radio man to moving pictures?

All these things provide us with self-expression which we can get in no other way.

There will be no compromise. We will publish articles which we consider will interest you, no matter into what strange paths they may take us. Contributions we welcome from men who can really do things, if they can also write about them.

We have worked very hard on this issue, but we know there is plenty of room for improvement. With any new magazine, this must be so. In future issues, we intend to include many things not seen here—particularly a "World Review" section to tell you what is going on in other countries, and a "Circuits Wanted" section. Also we intend to build up a very comprehensive "Information Service," and a "Safety Valve" to which all may contribute.

What will you do to help us make "RADIO AND HOBBIES" the magazine you think it ought to be? We hope you will write and tell us. We intend it to lead, and with your support we are quite certain that it will.

John Moyle, Technical Editor

The Editors

PAGE THREE

Above: The March 17, 1939 issue of 'Wireless Weekly' told of the impending changes. Right: the editorial in the first 'R&H'.

Immediate success, but...

The first issue of *Radio & Hobbies* proved so popular with readers that it had to be reprinted a few days later, with both press runs selling out completely. Successive issues are notable both for the obvious enthusiasm of the production staff and the range of contributed articles.

But despite this, the Hull/Moyle editorial team survived for only about nine issues, with 'Braith Hull leaving, unsung, to 'take up other activities' and John Moyle emerging, unannounced, as Editor.

Without debating the whys and wherefores, the issues up to December 1939 carried a joint promotional editorial headed 'With the Editors'. In the Xmas/January 1940 issue there was no editorial, as such, the space being occupied by an article from Sir Ernest Fisk:

When I Think Back...

'Radio and Things to Come'. Then in the February issue 'With the Editor' was back again, but carrying one signature only – that of John Moyle.

Thumbing again through the March 1940 issue, I was reminded of something I had forgotten, although I recall that it did cause considerable comment at the time: of all things, a full-page advertisement for the rival magazine *The Australasian Radio World*!

The advert listed three new projects, an amplifier championship competition, a variety of support articles and a special Junior Technical Section prepared by former *Wireless Weekly/R&H* contributor Alf Barnes. This was all under the direction of a **new editor**, "who is one of Australia's most experienced technical journalists".

The long and short of it was that 'Braith Hull had re-surfaced immediately as Editor and Publisher of the rival *Australasian Radio World* – having taken over from Earl Read, who stayed on for a time as Technical Editor.

I never did find out whether the advert in *Radio & Hobbies* was part of 'Braith Hull's severance agreement, or whether he still had friends in high places in Associated Newspapers Ltd!

Sufficient to say that rivalry was keen for a while, with both magazines winning their own loyal and often vocal supporters. But in the long run, *Radio & Hobbies* won through and remained substantially free of competition until much later, with the emergence in the early 1970's of *Electronics Today International*.

Wireless Weekly was less fortunate. With the adoption of radio station networking and the availability of programs in the daily papers, the paper's role was undermined. With an eye to the rising fortunes of *Reader's Digest*, it was subsequently reduced to octavo size and restyled as *Wireless Weekly Story Book*, under the guidance of Jack Lillis and Julian Russell – the latter in his alter-ego the Company's official music critic.

It never did become vigorous enough to justify its existance and was ultimately discontinued. In semi-retirement, Julian Russell was later to become a good friend and Classical Record Reviewer for *Electronics Australia*.

My own involvement

During this same period, I had been doing my own thing in the distinctly 'institutional' atmosphere of AWA. Having worked for a period in the Ashfield laboratory of the A.W.Valve Co, I had subsequently been transferred to their Head Office in York St – as assistant to the Chief Applications Engineer, Fritz Langford-Smith, best known for his outstanding 3rd edition of the *Radiotron Designer's Handbook*.

There, I continued to produce circuits and drawings, etc., but became progressively more involved in the preparation and production of AWV literature generally, ranging from valve data sheets and brochures, through *Radiotronics* monthly to the *Radiotron Designer's Handbook* itself.

In 1939, on behalf of the Company, I was commissioned to prepare, deliver and subsequently publish a series of six technical lectures for radio servicemen. These were followed, in 1940, by a series of five company lectures for signals trainees of the Australian Army's Eighth Division, then based at Ingleburn, NSW.

By arrangement, in 1941, I also produced a couple of featured articles for the trade journal *ERDA* on the subject of 'Multiband Superheterodyne Receivers'.

About the same time, a series of monthly articles were prepared for the new *Radio & Hobbies*. Most were theoretical, to do with receivers and amplifiers, but practical do-it-yourself articles included a negative transconductance modulated oscillator, and a simplified beat-frequency type audio generator.

Largely by reason of these articles I got to know John Moyle at a personal level, little realising that I was setting myself up for a career in technical journalism – which at that stage, was neither anticipated nor sought. I had, in fact, been approached to rejoin my original employer, as technical director on a profit sharing basis, and I could quite easily have finished up back in the marketing field.

Towards the end of 1941, however, John Moyle decided to accept a virtually automatic commission with the RAAF, with a view to preparing manuals for, and training recruits in, the then new and top secret radar technology.

Would Neville Williams take over the job of running *Radio & Hobbies* in his absence, as Technical Editor and – for the forseeable future – as Acting Editor as well?

With my roots firmly established in AWA, I nearly didn't take up that invitation either; but I finally did, and the rest is now history. That's how I got involved, Jim!

What was it like?

Life in the two situations could scarcely have been more different. In AWV, publications were produced with meticulous care but with no more than a respectable degree of urgency.

They were backed by the resources of a large, technically orientated company, vith even larger overseas high-tech affiliates. Distribution and readership of their publications was assured, and there were no complicating factors to consider like cover price, advertisers and newsagents!

For sure, Associated Newspapers was also a very large company but one that concerned with just about everything *but* technicalities: news, politics, sport, entertainment, fashions, gossip, newsprint, radio broadcasting. You name it; they were into it!

In an environment of mass circulation newspapers and popular magazines, *Radio & Hobbies* was a small, eminently respectable but rather incongruous publication, confined to a couple of small rooms on the 12th floor and produced by two or three people curiously obsessed with the underside of wireless sets!

Immediate neighbours on the same floor were *Pix* magazine (long since absorbed into *People*), *Wireless Weekly* in its new non-technical form, and the now defunct *Worlds News* – a weekly potpourri of lightweight articles, short stories and humour, beloved of country

Shortly after his quiet departure from 'R&H' in 1940, founding co-editor 'Braith Hull reappeared as editor of its rival.

readers. When it had been passed around to all and sundry, it was traditionally cut in half, punched through one corner and hung on a nail behind the door of country 'dunnies'.

I know, because I was brought up in the country!

Technically, the staff of *Radio & Hobbies* were very much on their own in the organisation, with a workbench, a soldering iron, a few hand tools and a steel cupboard containing an odd assortment of left-over wireless bits and pieces. By way of test equipment, the department boasted a Weston multimeter and a Paton modulated oscillator – the latter probably acquired following its review in the Aug.'39 issue. That was all!

What a contrast to the AWV lab, with its quality control equipment, its own array of individually calibrated reference meters in traditional polished wood cases, and routine access to any amount of other equipment from elsewhere in the Ashfield complex. Get it right, or else!

Up there, on the 12th floor of the (then) 'Sun' building in Elizabeth St, Sydney, the very existence of the magazine depended directly on the two or three individuals producing it, on the strict observance of production schedules, on cover price, newsagent sales and support from advertisers. If you didn't get those things right, you didn't have a magazine and you didn't have a job!

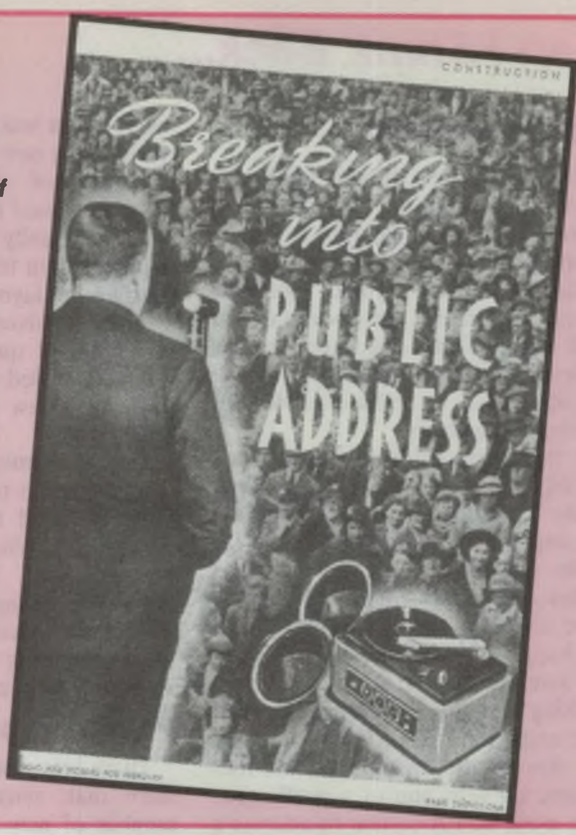
That's the way it is still is with radio/electronics magazines except that, in December 1941, I had to ingest the new situation in one quick gulp. Hardly had I hung my coat on the peg, than John Moyle had to report to the RAAF to begin boning up, himself, on what radar was all about. He had no choice but to shake my hand, wish me well and leave me to produce the very next issue.

It was in that exact situation that I first heard Pop Morse's story about 'Braith Hull's arrival ten years earlier. It was recounted, not by way of comment on 'Braith Hull, but for my benefit as the most recent arrival.

Apart from Pop Morse and Jack Lillis, my only direct link with the immediate past was a young assistant, Charles Birchmeier, who at least knew the production routines and how to contact the various contributors. Between us, we somehow got the February 1942 issue together and out to the newsagents – on time.

It didn't take long to learn what the Hull brothers and John Moyle already knew: that, for the editor of a radio/

In his first issue, for February 1942, Neville Williams used this picture of a portly gentleman addressing a crowd. If it wasn't the Hon. R.G. Menzies, it might well have been...



electronics magazine, bed is something you crawl into after you've completed two or three day's work in one!

Thumbing back through my rather battered copy of the Feb.'42 issue, I was reminded of the contributors who had become a vital component of the still-new magazine. There were others, but the ones whose articles appeared in that particular issue were:

L.B.Montague: a PR (public relations) contact and part-time writer who looked after Ken-Rad (valve) interests in the choice of cover pictures. The Ken-Rad adverts became so identified with the publication that readers began to refer to it as the 'Ken-Rad' magazine!

Calvin Walters: By day, sales representative for a wholesale stationer; by night, an keen science writer, and a good friend whose articles were popular over many years.

R.M.Younger: Expert in keeping track of – and drawing – new aircraft, plentiful during the war years.

John French: An avid aircraft modeller, particularly adept in outline drawings for solid recognition models.

W.G.(Wally) Nicholls: Traditional home handyman, bench-top woodworker and an excellent illustrator of his own work.

Ray Simpson: A methodical and reliable short-wave DX reporter who set a presentation style that lasted for decades.

'Joe': I don't remember ever meeting Joe. His whimsical handyman column just turned up month by month.

Last but not least, there were 'Do-You-Know' and 'Serviceman' articles provided gratis by the L.R.Graham organisations – the Australian Radio College and Radio Equipment P/L. To the magazine, they were welcome copy; for the Graham group, they were good publicity.

In fact, a significant proportion of these articles were 'ghost' written by Philip Watson, who was a part-time, later full-time, employee of the group. He did it so well that we did not hesitate, when the opportunity came, to offer him a job on *R&H*. In due course, he became my Assistant Editor.

Incidentally, in glancing through some of the contemporary science articles by Calvin Walters, I came across one in the November 1939 issue entitled 'Frozen Sleep Fights Disease'. It dealt primarily with a presentation by Drs Fay and Lawrence, of the Temple University School of Medicine in the USA. But cut into it was a news item about drug-induced deep sleep therapy being practiced in Melbourne – a therapy that later gave rise to tragedy, scandal and the current inquiry in NSW. But back to the original theme:

When I Think Back...

Different approach

In the AWV lab, designs were prepared and presented for the guidance of engineers and manufacturers, with a particular emphasis on valve operating conditions. Articles would normally comprise a circuit, specifications for critical components, measured results and design notes. No photographs, no layout diagrams, no friendly advice for would-be constructors.

For that February 1942 issue, I had time only to muster a couple of hasty projects – including a simple public address amplifier, intended principally for use in small suburban halls and churches, and likely to be built up by anyone called 'Tom, Dick or Harry', who happened to know something about wireless.

Lacking a picture with which to head up the amplifier article, I searched diligently through the company picture files and came up with one of a portly gentleman using an PA system to address a very large crowd. Such was his profile that, if it didn't belong to the Hon. R.G.Menzies, it should have! But it served the immediate purpose...

Oh yes – there was also a hassle in that same issue about the editorial. It didn't contain one. Shades of the Xmas/January 1940 issue mentioned earlier.

At AWA, I neither learned nor practiced the art of writing an editorial. As with most other such companies, manuals were concerned strictly with unembellished facts – compiled by an anonymous writer for persons unknown.

Indeed, I later came to realise that a good *magazine* writer is the very antithesis of someone trained to compile technical manuals. An effective writer must do more than merely present facts; in the process, he/she must also *motivate interest* and communicate with the targetted readers.

A well-written editorial falls into that same category. It will hopefully help to crystallise ideas, for or against a particular relevant proposition. The editor may be respected for his/her opinions, or cast into the role of someone that readers love to hate. Either way, the editorial should provide food for thought.

During the production of the Feb.'42 issue, Jack Lillis had taken no more than a fatherly interest, assuring me that he really didn't have clue about technical matters. But when I showed him my first editorial, his uncompromising reaction was that it read for all the world like a new-year message from one or other of the local archbishops. Maybe I should try again!

I didn't really have either the time or the inclination to do so and, instead, reshuffled the layout to fill the space with a full-page advert. In turn, that seemed to disappoint quite a few readers, who were undecided as to whether I was a wimp or a few pages short of being a real editor.

I've never missed an editorial since – even though at times, like other editors, I've wandered through the catecombs muttering: "What can I write an editorial about?" (*Editor's comment: I know that feeling well!*)

That was what is was like Jim, when I was learning the hard way about magazine production!

Preparing copy

There was one other lesson I had to learn that, since then, has faced any number of new recruits to the staff of *Radio & Hobbies/Electronics Australia* – the preparation of magazine copy.

At AWV the normal procedure, when producing copy for books and brochures, was to sit quietly at one's desk and write it out long-hand, clearly enough for a non-technical person to read. It would then be passed to a typing pool – about which male persons in the organisation could only speculate. It was a totally female precinct.

In due course, a perfectly executed draft copy would appear on one's desk, which one could proceed to amend as necessary, always remembering that it would have to be interpreted again by a non-technical person. After one or more such cycles, it would emerge as a letter-perfect final copy for the printer, plus as many carbon-paper copies as necessary. In those days, practical photostat copiers did not exist.

Believe it or not, many of the valve brochures that old-timers will remember, were produced this way, plus a large proportion of *Radiotronics* and the various editions of the *Radiotron Designer's Handbook*. In longhand!

In a newspaper/magazine environment, things didn't work this way. Reporters were required, and feature writers were encouraged, to type their stories directly on to octavo (half-quarto) size 'copy' paper, with preferably a single not-too-long par (paragraph) per slip.

The main reason for so doing was that the linotype machines used for typesetting in those days were fitted with octavo size copy holders, and linotype operators (a very select breed at the time) preferred one par per page.

It also happened to suit reporters and sub-editors, because it made it easy for them to amend or re-shuffle stories, by discarding or adding slips as necessary. Page numbering, which started out as 1,2,3,4 etc., became 1&2,4,3 or 1,1a,1b,2,3 and so on. As a concession, linotype operators would tolerate hand corrections to the text, provided they were made clearly in the approved manner.

If the system seemed wasteful of paper, it wasn't really. Surplus paper of all kinds, from left-over newsprint through to coated art, was put through a guillotine and reduced to copy paper, to be used without restriction.

It didn't take me long to realise the speed and flexibility of this system compared with what I had been used to. So, with a typewriter on my office desk, and an affordable second-hand counterpart at home, I wasted no time in picking up the art of typing all my own copy using the 'Hunt & Peck' system; Hunt till you find the right key and then Peck it!

If all that sounds like ancient history, it is. But, at the time, the transformation from the longhand/typing pool routine to producing text under pressure, in the office, on one's own typewriter was just as much a revolution in personal methodology as the changeover from typewriter to word processor in more recent times.

Following years

With the outbreak of war in the Pacific area, the production of *Radio & Hobbies*, along with all other local publications, became a holding operation, under strict manpower and materials control.

And, with that paragraph, I merge with the story as presented by invitation in the August 1987 issue: 'A Dream That Lasted 65 Years' (page 28, but particularly pages 29-32). Part 2, 'From Wireless to Electronics' appeared on p.42 of the January 1988 issue.

Over all those years, whether called *Radio & Hobbies*, *Radio, TV & Hobbies* or *Electronics Australia*, the magazine has benefited from a succession of staff engineers, technicians and writers, from independent contributors, supportive advertisers and, of course, from successive generations of readers.

Which brings me to Editor Jim Rowe's final question: "Has the magazine made a significant contribution to the electronics industry over the years?" Most decidedly, yes!

It has been regarded for decades as a tangible mirror for Australian electronics, reflecting consumer ideas and attitudes, marketing trends, technological progress, and who's doing what around the industry. Even more so for overseas readers.

The other way round, it has promoted a local awareness of overseas scientific and technological developments, by normal press facilities, by direct contact, and by cordial relationships, over the years, with overseas magazines such as *Radio-Electronics*, *Radio News*, *QST*, *Wireless World* (now *Electronics and Wireless World*), *Practical Wireless*, and so on.

Such is the standing of the magazine that, as its then Editor, I was invited to attend or address professional groups or conferences around Australia, and to undertake sponsored technical tours in Britain, Germany, USA and Japan.

Over the decades, the fortunes of many companies have been linked to the magazine, as an effective means of drawing attention to their products.

Immediately after the war, when the Managing Director of Goldring (UK) visited Australia to set up the company here, the *R&H* office was the very first call on his list. The company went on to manufacture and market both Goldring and BSR products in this country.

About the same time, Doug Ferguson moved from electronic service into large-scale transformer manufacture, at the suggestion of *Radio & Hobbies*.

Radiokes, RCS, Crown, Rola, Amplion and an array of other manufacturers and distributors relied heavily on publicity through the magazine. So also have components dealers from Levensons and Murdochs in the old days, through the postwar disposals dealers to present day parts suppliers in Sydney, Melbourne and Perth.

They've admitted as such, many times – in their franker moments – when not bargaining for a lower advertising rate!

But more personal, and more rewarding is the number of people who have simply expressed gratitude for a lot of pleasure gained through the magazine and the contribution it has made to their lifestyle. Whether an ordinary enthusiast, an academic, an engineer or a well rounded executive, it's reassuring to be told that: "I've been a reader of the mag for twenty, thirty, forty, fifty years – or more!" EA

News Highlights

Benchtop ASIC verification system

Tektronix Australia has introduced a new ASIC Verification System targeted specifically at ASIC designers. This new system, the Tektronix LOV 500, is the first ASIC Verification System to provide timing capabilities previously found only in large production test systems.

The LV 500 provides the design engineer with quick and convenient tools to debug today's complex ASIC devices. Even with this new level of performance, it compresses 256-pin functional testing into an easy-to-use benchtop package that fits design department space and budget constraints.

In the past, complex ASIC's, requiring variable cycle and clock generator timing, could not be tested on engineering verification systems. Now the LV 500 brings these capabilities to the engineers benchtop. The system's per-pin architecture and powerful timing resources provide extensive test capabilities, including per-pin control of channel direction, timing, and formats; and per-cycle control of cycle lengths, clock timing, channel direction, masking, and inhibit.

Yet, for all its power, the LV500 is said to be exceptionally easy to set up and use. A colour display, spreadsheet-style control and data entry, and integrated waveform graphics displays organise and emphasise critical information for quick assimilation. System operation intuitive for designers. The system can interface to any logic simulation data format and includes extensive vector editing and generation tools.

To compress all of this into a benchtop system. Tektronix created a 256-pin test head on a single printed circuit board. Ringed around the board in close proximity to the Device Under Test, are the pin-driver ICs, each with 16 channels of pin I/O. Ringed in turn around the drivers are timing generators that provide 16 clock phases (32 edges). By placing all of the timing and pin-drive facilities on a single board, driver-to-DUT connection runs are reduced to under 10cm with a typical loading of only 25pF.

Revolutionary new conducting material

Researchers at the University of California, Santa Barbara have created an electronic material that contains an array of wires so tiny that 6 million of them could fit in a human hair. They have also demonstrated that this material exhibits novel physical properties that may provide the basis for revolutionary electronic devices.

A research team headed by Pierre M Petroff, professor of engineering materials and electrical and computer engineering at UC Santa Barbara, describes measurements that clearly demonstrate the existance of the world's first 'quantum-wire superlattice'.

Essentially, a quantum-wire superlattice is a region in a semiconductor chip that contains millions of ultrafine wires. By measuring the material's response to polarised laser light, the scientists have demonstrated that these wires are so small that they force electrons to behave in a radically different way than they do in ordinary materials. In so doing, they have established that it is the most sophisticated of a new class of materials that contain 'quantum electronic structures' ever produced.

This class of materials is generating considerable excitement among university and industry researchers.

In recent years, lasers and transistors that are smaller and more efficient than conventional designs have been commercially produced by incorporating a type of quantum structure, called a quantum well, that is considerably simpler than the quantum-wire superlattice reported here.

These developments have led industry researchers to speculate that, within the next decade, such materials may allow them to make 'superchips' that cram over 100 times as much function in the same amount of space and run over a thousand times faster while consuming substantially less power. If current expectations are met, such materials may make possible advances such as shrinking currently cabinet-sized supercomputers into a laptop package that runs on flashlight batteries, according to industry sources.

AWA enters Smartcard business

AWA has acquired a controlling interest in Electronic Transactions Pty Ltd, the Australian distributor of advanced technology 'Smartcards' and their readers, made by European electronics leader Schlumberger Industries.

Schlumberger Industries has some 70% of the Smartcard world market, with current production at the rate of 2 million cards per month.

Costing typically between $2 and $8 each, Smartcards are the same size as plastic credit crads but feature a microchip, instead of a magnetic strip, which is read by an external reader.

Smartcards are used in such areas as public payphones, electronic payment devices at point of sale, security access control and prepaid transaction tokens (e.g. for theatre or travel tickets, where an automatic reader can progressively reduce the available purchasing power as it is used).

China's rockets to launch Aussat B satellites

China's 'Long March' rockets have been selected to launch Aussat's two 'B' series replacement satellites into orbit in 1991 and 1992. This was announced recently by Aussat's managing director, Mr Graham Gosewinckel.

Mr Gosewinckel noted that Aussat's decision to use Long March remined conditional upon approval being received from the Co-ordinating Committee for Multi Lateral Export Control (COCOM) which is currently considering the US Government's proposal on this topic.

He added that negotiations between the US and Chinese Governments regarding conditions relating to the issue of the export licences were expected to be concluded by the end of the year.

Mr Gosewinckel said that Aussat's selection, in consultation with the Hughes Aircraft Company, the prime contractor for the Aussat-B satellite program, of the Long March rocket was taken after a world wide tendering process for satellites and launch vehicles.

The Chinese tender was highly competitive in price and Aussat's decision to use the Long March was taken on the basis that the bid from the China Great Wall Industry Corporation was the most cost effective method of getting the satellites into orbit.

SMPTE awards Japanese TV pioneer

Japanese television pioneer Kenjiro Takayanagi has been awarded Honorary Membership of the US Society of Motion Picture and Television Engineers (SMPTE), in recognition of his long and distinguished career in the pioneering research and development of television. Honorary membership is the highest grade of membership and greatest distinction that can be conferred by the Society.

Often referred to as the 'Father of Japanese Television', Professor Takayanagi has written many papers since his first 'Experiments on Television' was published in 1928. His first video transmission took place in 1926 (see *Electronics Australia* April 1988, pp. 26-30).

Professor Takayanagi holds over 200 patents in Japan. Many of his inventions led to the success of electronic television.

EA subscription prizewinner

Lucky first prizewinner of our September-November subscription promotion was Mr Shane Wilson, of Mareeba, near Cairns in Northern Queensland. Mr Wilson is now the proud owner of the three professional-quality test instruments from Emona Instruments: a Kikusui DSS-5020 20MHz dual-trace oscilloscope with inbuilt digital storage facilities, a GW Instruments GFG-8019 multi-function 0.2Hz-2MHz function generator with built-in sweep generator and 6-digit 10MHz frequency counter, and a GW Instruments GDM-8035T high accuracy 28-range 3-1/2 digit digital multimeter. Together, they are valued at over $4500.

Interested in electronics for many years, Mr Wilson worked in commercial broadcasting before leaving to run his own music business/electronics store. He is also an electronics hobbyist, a keen DX radio listener and restorer of old TV receivers. He reports that he has already put the test gear to good use, both in the business and his home workshop.

"It certainly is wonderful gear," he notes, "And I'm sure a lot of other subscribers had their hearts set on winning it. The CRO has already helped me track down an elusive vertical fault in a TV. Once again, thanks – both for this great prize, and more importantly for EA each month."

The five consolation prizes of top-quality Escort EDM-1122 hand-held digital multimeters, each valued at $149, went to Mr Lockwood, of Maffra in Victoria; Mr Worland of Queenscliff, also in Victoria; Mr C. Wojczys of Coolaroo, again in Victoria; Reverend N.G. Robinson of Arncliffe, in NSW; and the Radiocom Book Club, of Roma in Queensland.

Congratulations to all six lucky prizewinners, and our thanks to Emona Instruments for supplying the prizes.

Toshiba marketing superconductive MRI

In the United States, Toshiba America, Inc.'s Medical Systems Division has started marketing the MRT-50A superconductive MRI (Magnetic Resonance Imaging) system, which uses a superconductive magnet to produce high-resolution images. The superconductive magnet is rated at 0.5 tesla (one tesla equals 10,000 gauss), the class most commonly used in hospitals. US sales are projected to reach 200 systems within the next three years.

MRI systems are one of the most advanced types of medical equipment for image diagnosis. By applying a strong static magnetic field to the human body, these systems directly detect the density and the distribution of hydrogen nuclei in soft tissues, such as brain, kidney and liver, and thus create vivid, cross-sectional images of these organs. They are particularly effective for the detection of brain tumors, herniated disks, and other disorders obscured by bones. Moreover, the MRI systems are free from X-ray radiation.

Toshiba's MRT-50A system is more compact than any other MRI system in its class, and only requires 60m^2 for installation – less than half the area required for previous systems. This is achieved by the optimum design and the reduction of the size of the superconducting magnet, and by shielding to minimise magnetic leakage. The equipment also features superior operational cost, by reducing the boil-off rate of liquid helium (used to maintain the magnet in a superconducting state), to less than one-eight that of conventinal systems.

Toshiba is by far the leading supplier of MRI systems in Japan, having delivered or received orders for 130 systems.

News Highlights

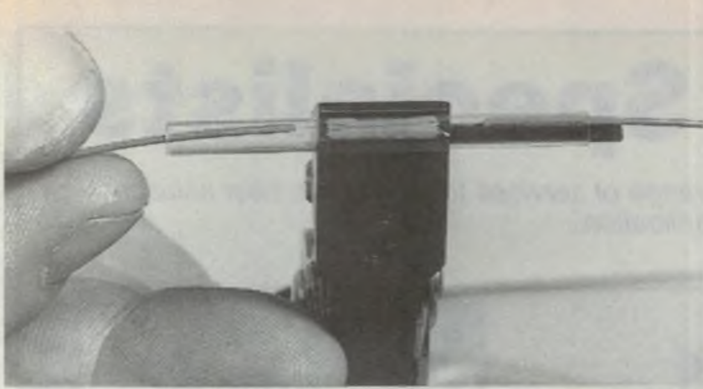
Bureau of Meteorology buys video printers

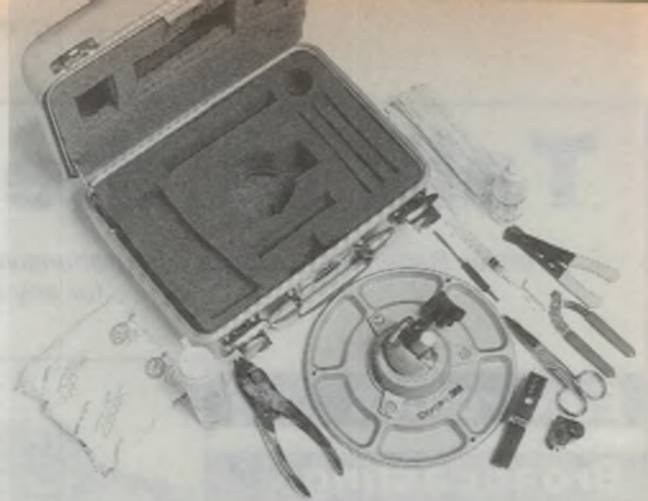
A need to reproduce high resolution hard copies of weather pattern photographs from computer output has led the Bureau of Meteorology to award a tender for the supply of 14 video printers to Amtex Electronics.

The requirements for the printers, Model TP6490 from Toyo Corporation of Japan, comes from the Bureau's involvement in a global meteorlogical satellite system.

The forecast of Australia's weather had always been difficult prior to the advent of meteorological satellites in the 1960's as there were virtually no observations available from the surrounding oceans and large areas of the unpopulated inland not covered by the Bureau's conventional network. However, from the 1st January 1989, the Bureau is receiving hourly photographs from Japan's Geostationary Meteorological Satellite (GMS), stationed 35,700kms above the equator directly north of Australia. It produces two kinds of photograph, 'visible' obtainable only in daylight, and 'infrared', obtainable day and night by sensing heat radiation from the earth and its atmosphere.

The pictures are received at the Bureau's Head Office in Melbourne, where a computer stores them on disk, then adds coastal outlines and grid lines. Subsets of these images are then transmitted on a digital network to the Bureau's Regional Forecasting Centres in capital cities around Australia. There an AT personal computer, using software developed by Bureau engineers, stores the information on disk, displays it on a high resolution monitor or produces hard copies of the photographs on the Toyo TP6490 video printer – in just 28 to 46 seconds.





Fast splicing of optical fibres

It takes just 45 seconds to splice together an optical fibre cable with the new Fibrelok Optical Fibre Splice from 3M's Telcomm Products Division. This is at least four times faster than other mechanical splicers on the market.

The splicer consists of a metallic element and plastic body construction. It assembles with a snap of a cap, which closes the element and aligns and captures the fibres.

3M Australia has expanded rapidly into the fibre optic area with a range of products manufactured by Dorran Photonics, EOTec Corporation and 3m Electro-Telecommunications Group. The broad range of products now available from 3M Australia includes connectors, connector accessories, pigtails & cable assemblies, sensors, programmable controller interfaces, distribution boxes and buried splice closures.

Another type of mechanical splice is the Dorran Optical Fibre Splice from the 3M Fibre Optics Product Division. This splice is a re-usable, transparent splice that uses a grooved ceramic insert in a deformable sleeve. This allows each fibre to be either inserted or removed individually, whilst capturing the opposite fibre. Its transparency allows a craftsperson to see the fibres align while its ability to be re-used lets the craftsperson salvage an improper splice.

Both splices are designed to be used on 125um cladded fibre with outer coatings of 250um or 900um, or a combination of both. Unlike previous mechanical splicing technology which relied on ultraviolet (UV) adhesives or epoxies, both the Dorran and Fibrelok Mechanical Splices simplify splicing procedures and typical insertion losses of better than 0.2dB are achieved from both splices. The splices replace expensive fusion splicing and take the worry out of using adhesives or epoxies.

News Briefs

- The ***Consumer Electronics Suppliers Association (CESA)*** has appointed Mr John Boettcher of Philips Industries Holdings as its new Chairman, and Mr Graham Bird of NEC Home Electronics Australia as Vice chairman.
- Sydney-based test and measuring instrument supplier/distributor ***Emona Instruments*** has opened a Brisbane office, at 416 Logan Road, Stone's Corner 4120. The phone number is (07) 397 7427, fax (07) 394 4316. The company has also appointed Bruce Ibbotson, formerly with Hewlett-Packard, as its Queensland manager.
- After more than a decade of writing most of the distinctive copy for the advertisements, brochures, manuals, commercials and annual catalogues of Dick Smith Electronics, technical wordsmith ***Ross Tester*** has left to form his own copywriting, publicity snd marketing company. It is well known that Tester had a major influence on the dynamic 'Dick Smith' marketing style, which was extremely successful in building the company to its present size. Tester's new company is Writech Pty Ltd, 78 Mactier Street, Narrabeen 2101 or phone (02) 982 9624.
- Melbourne-based ***Westinghouse Systems*** has been appointed sole Australian distributor for US diode and rectifier maker Electronic Devices Inc. (EDI), and also UK-based Telematic Systems – which specialises in lightning protection devices and 'Microtest', a calibration/diagnostics repair centre for disk drives.
- Victorian cable and components distributor ***Acme Electronics*** (part of the James Hardie Group) has promoted David Fraser to the position of general manager. Mr Fraser has held senior sales and management positions in the company for over 10 years.
- Sydney-based PCB manufacturer ***Printronics*** has appointed Philip Keane as its new managing director. Previously general manager, Mr Keane succeeds Michael Brinsdon – who left the company to become Director General of TAFE in NSW.
- Mike Osborne has been appointed technical director of ***CIMA Electronics***. Mike joined the Centre for Industrial Microelectronics Applications (CIMA) on secondment from Chisholm Institute, where he was senior lecturer in digital design.
- New Brisbane-based PCB manufacturer ***PCBFast*** has been formed by Brett Smith and Edward Machura of Brett Smith Technologies, Kerry Ryan – formerly of RIFA – and ex-Coopers & Lybrand accountant Craig Black. The company is specialising in fast turnaround of prototype and small runs PCBs. PCBFast is at 4/600 Sherwood Road, Sherwood 4075, or phone (07) 379 4840.
- ***Dick Smith Electronics***, Australia's official factory-appointed agent for Yaesu Musen amateur radio equipment, has doubled the warranty period on Yaesu transceivers, linear amplifiers and antenna tuners, from 12 to 24 months. DSE communications product manager Chris Ayres says that experience with the equipment has shown it to be extremely reliable, making it possible to extend the warranty on all of these products purchased from DSE since December 1, 1988.

$500 million cable group formed

Following a $160 million buyout of minority holdings, Metal Manufacturers Limited has combined all of its substantial cable interests into a new wholly owned division to be called MM Cables.

Merged in Australia were Austral Standard Cables (ASC), Cable Makers Australia (CMA), Pyrotenax, Austral Data Networks (ADN) and MM Metals – Energy Cables. In New Zealand, Associated British Cables Ltd (ABCAL) and ASC (NZ), are also part of MM Cables.

The combined division employs about 2200 people and will have a turnover of about $500 million annually.

FORUM

Conducted by Jim Rowe

Whatever happened to amateur radio?

This month I'm really going to stick my neck out, and tackle a subject that to some is almost sacred: amateur radio. The question is, does it still exist? Is there any real difference nowadays between hams and those dreaded CB operators – apart from the number of fancy knobs, pushbuttons and dials on their transceivers?

A few weeks ago I met a bloke who happened to be a long-time radio amateur. After we had talked for a few minutes about generalities, he tossed in one of those innocent little time-bomb questions that readers love to ask editors of electronics magazines: "You don't seem to have any designs for amateur radio gear in the magazine any more – why not?".

He was right, of course. As it happens we haven't run much in the way of amateur radio projects for some time. But while I was trying to think of the various reasons for this, I stalled for time by throwing back another question: "Um - well, what kind of amateur radio projects would you like to see?".

Now this really stumped him. He couldn't actually think of anything, and promptly changed the subject. Which saved my bacon at the time; but all the same, it set me thinking.

Not long after, I was trying to stem the frightening growth of my 'keeping up with it all' pile of overseas magazines – following a tactful comment by my better half that we soon wouldn't be able to fit into the loungeroom! And in one of the amateur radio mags, I came across yet another of those perennial letters from an aggrieved amateur, complaining that the popular press tends to call anyone who fiddles with transmitters or transceivers a 'ham'.

Didn't they know the difference between a true radio amateur and a mere CB operator? Why did they persist in using that awful term 'ham', in any case, when the correct description was *Licensed Amateur Radio Operator* – or at least 'radio amateur'? How would the public ever know what was right, if the media persisted in getting it all wrong?

Hmmm... It gives one to think, as the old Hercule Poirrot might have observed. On the surface, the said aggrieved amateur might seem to have a point, but what was the reality behind it all? Could there – horror of horrors – perhaps some points of similarity between radio amateurs and the smoked hindquarters of a porcine quadruped?

Then I looked more closely through not only the same amateur radio mag, but copies of others that happened to be on the pile, and I noticed two things. One was that the amount of actual amateur radio gear described for construction, even in these magazines devoted entirely to amateur radio, was really quite modest. Most of technical material (and there really wasn't much of it anyway) was dealing with reviews of the latest commercially-made gear, while the rest of the magazines seemed to be devoted to endless reports of operating contests.

The other thing that became pretty clear was that most of the advertisements were offering fully built up, all-singing all-dancing whizzbang transceivers. Multiband, multimode marvels, offering almost every conceivable technical feature in either a desktop or handheld package. Very neat, very elegant, very impressive – but also very complete, in almost every detail. Nothing much left to do except hook them up to an aerial, plug them in and twiddle the knobs.

It struck me that in most respects, there really wasn't all that much difference between this equipment and that sold for Citizens' Band operation – on either the 27MHz or UHF bands. Both kinds of gear are essentially pre-packaged *appliances*, with almost exactly the same operations involved in getting them going. The 'amateur radio' gear just tends to have more knobs and buttons, and carry a bigger price tag.

And judging by the bulk of the editorial content in the magazines concerned, the main activities of today's radio amateurs seem to be very little different from that of the CB operators they've traditionally viewed with such scorn. They both seem to use the equipment almost exclusively as 'black boxes' for communication with each other.

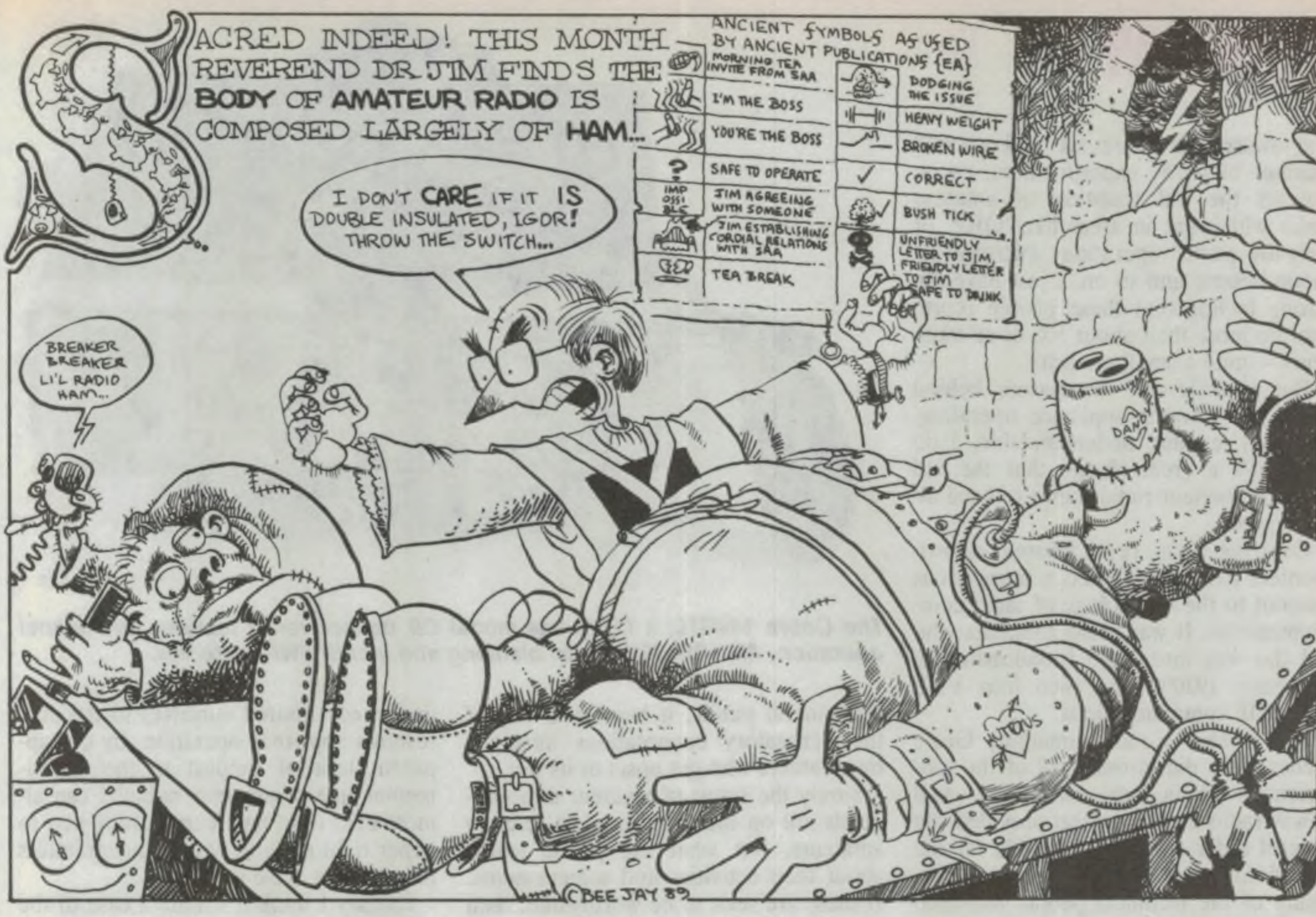
The only obvious difference, as far as I can determine, is that CB-ers seem to be interested in what we might call 'socialising' over the air, while amateurs seem mainly interested in notching up the largest possible number of token and ever-briefer contacts in the shortest possible time – or to/from the weirdest possible locations.

Whatever happened to the original idea of radio amateurs as people interested in experimenting with radio and communications technology?

If you look back through either our own magazine or the amateur radio magazines, during the 1920's – 1960's, and even later, it's clear that radio amateurs then really *were* interested in furthering the science and technology of radio transmission, propagation and reception. They were always experimenting, designing, modifying, improving, trying out the latest devices, working out new ways to measure what was really happening in RF circuits, and so on.

Nowadays, I get the strong feeling that most amateurs do very little if any experimenting. Not only on the HF bands, but on the lower UHF bands as well, the vast majority of amateurs seem to have become pure 'appliance operators' – driving a store-bought transceiver, hooked up to a store-bought antenna sitting atop a store-bought tower.

If it doesn't work properly, or develops a fault, I suspect that in most cases they don't even bother taking the lid off the case, or even looking in the technical manual. It's purely a matter of packing it up in the original carton, and sending it back to the



manufacturer/distributor's service workshop. Just as any CB operator would do...

In fact from what I can see, there almost seems to be a kind of 'class structure' among amateurs nowadays. The really 'serious' or 'first-rank' amateurs seem to be those with the biggest, most expensive store-bought transceivers and so on, while it's only beginners and those in the 'second rank' who bother to fiddle around with 'corny' home-made gear.

Now perhaps I am being a bit tough on the amateurs. No doubt there are all kinds of factors which have caused amateur radio to develop in the direction it has over recent years. I can think of a few myself.

As the technology of radio communications has developed and become more complex, it has obviously become harder for many people to understand.

It was no doubt a lot easier to be a radio experimenter in the old days, when there was less to learn. Almost any butcher, baker or candlestick-maker could pick up enough basic knowledge to pass the exams, build their own rig and get it going.

Later on it became a bit harder, when operation pushed into the VHF and UHF sections of the spectrum. But then a lot of people were trained in the armed forces during World War 2, and brought the knowledge back with them when they returned to civilian life. So there was an enormous second burst of activity and enthusiasm in the late 1940's and 1950's.

But things started to become tougher when single-sideband came into vogue, and more recent developments such as frequency synthesisers and digital packet switching certainly haven't helped.

In parallel with this trend toward greater complexity has been a gradual reduction in the number and variety of electronic components available, as I suggested here last month. And my impression is that some of the specialised components needed for radio gear – decent tuning capacitors and dials, for example – have been affected more than most. So it has probably been getting harder and harder to make your own radio gear, even for those who want to and have the necessary knowledge and skills.

At the same time, all of those pre-built and tested amateur radio 'appliances' have been getting more and more tempting, with impressive performance, loads of features and almost every operating convenient one could want. They're now all imported, of course, and like most of our other appliances, made in Japan or Taiwan or Korea. So although the prices tend to be pretty staggering, they're still not as steep as they would be if they were made here – or the price you'd pay if you were to try making a comparable one yourself.

And of course once you've bought such a unit, and adjusted your budget for the monthly payments, there are no real problems about getting it going. No fiddling, no head scratching, no need to delve back into the data books when it doesn't work properly. Either it works, and works well, or you whizz it back to the dealer for servicing under warranty. Just like any other modern appliance.

So it's not hard to understand why there has been this trend towards appliance operation. It's so seductively easy – particularly if you're not really interested in the technology and really just want to have a natter over the air, or become a 'worked all countries/states/-Greek Islands/boy scouts (or whatever)' contest freak.

By the way, I'm not suggesting that ALL radio amateurs have become appliance operators and/or contest freaks.

FORUM

I'm aware that there are still a small number of hardy experimenters, carrying on the old tradition of amateur radio with work in areas like 'QRP' or very-low-power operation, microwaves, moon-bounce and so on. I just have the strong feeling that these people represent no more than about 5% of all amateurs – quite a small minority.

But regardless of the reasons behind this trend towards appliance operating, and they're quite understandable, I do think it's a great shame that the old spirit of amateur radio seems to have almost gone.

Over the years, radio amateur experimenters have contributed a tremendous amount to the technology of radio communications. It was radio amateurs who led the way into radio broadcasting in the early 1920's, and then into VHF and UHF communications.

It was also a radio amateur, Grote Reber, who did virtually all of the pioneering work in radio astronomy. And it was radio amateurs who provided the core of radar and signals people for the armed forces, during the various wars. Many of the technical people recruited for the first TV stations came originally from the ranks of amateur radio, as well.

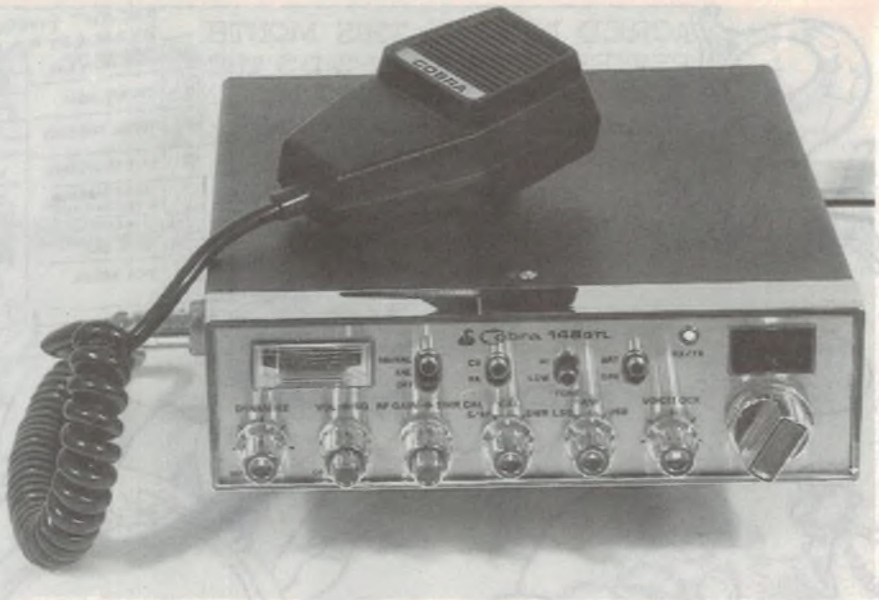
Now that this traditional aspect of amateur radio has all but died, I can't see how the hobby will be able to make similar contributions in the future. And that's sad, don't you agree?

If you're a radio amateur yourself and you're still with us at this point, no doubt you're pretty upset with the above comments. Fair enough – I've deliberately tried to be provocative, to get your juices flowing.

As I see it, there really isn't much difference now between most radio amateurs and CB operators. Even though amateurs have to pass technical exams to get their licences, once they're over that hurdle there seems to be very little difference between the two apart from the size and complexity of the appliances they operate.

But if you disagree, and believe you can show where I'm wrong, by all means write in and state your case. That's what Forum is all about!

By the way, what's actually wrong with calling radio amateurs 'hams'? To my mind, it's a friendly enough label, and one that has been applied to radio amateurs by non-technical folk ever since the hobby began. I'm sure that to



The Cobra 148GTL, a fancy late-model CB transceiver. It features 40-channel operation, AM/LSB/USB, noise blanking and inbuilt SWR metering.

the general public, it has few if any of the derogatory connotations imagined by amateurs who get upset at its use.

Surely the status of amateur radio depends not on the name used to refer to amateurs, but what the public learns about their activities and achievements. If these are seen to be worthwhile, then the word 'ham' will have attached to it just as much credibility as any other.

Frankly, I suspect that amateurs who make a big fuss about being called 'hams' would be better off demonstrating that true amateur radio isn't dead, and can indeed be more than mere appliance operating. What's in a name, after all...

Cause or effect?

But getting back to the original question, it's true that *EA* hasn't described many amateur radio projects over the last few years. This struck me only a few days ago, when I started looking through back issues of the magazine in preparation for this month's special 50th anniversary articles.

Back in the 1930's, 1940's, 1950's and even the 1960's and 1970's, we certainly published oodles of amateur radio articles and projects – transmitters, receivers, converters, RF preamps, modulators, aerials, matching units, SWR and power meters, you name it. I described a reasonable number myself, in the late 1970's, before leaving for a while to try my hand at other jobs. Then they slowly started to peter out, with only a few appearing by the mid 1980's.

Well, why *have* we published so few of them in the last few years? Have we in fact contributed ourselves to the drift towards appliance operation, by our apparent lack of support to the experimental side of amateur radio? I can almost hear irate amateurs putting pen to paper right now, to write stinging letters to me along these lines.

Frankly I think it's more a case of the scarcity of projects being a symptom of the drift in interest, rather than a cause.

Basically, magazines like *EA* that sell on the news-stands have to appeal to as many readers interests as possible, to survive. And the fact is that on the whole, in the last few years there seems to have been very little interest in the technicalities of amateur radio. I think I've had only about two requests for any kind of amateur radio project or article, in the almost two years I've been back in the editorial chair.

Now I fully agree that one factor contributing to this apparent lack of interest could be that like computer enthusiasts, radio amateurs tend nowadays to prefer specialised magazines which deal exclusively with their own area of interest. And that's fair enough too, because such magazines can give them a lot more of the kind of material that interests them.

If this *is* the case, it would mean that few radio amateurs are reading broad-interest electronics magazines like *EA* – and hence the apparent lack of interest from our point of view. But conversely, it would also mean that there's little point in our describing amateur radio projects either, because there may be so few radio amateurs among our readers.

I'm also prepared to admit that an-

The Yaesu FT-736R, a fancy late-model VHF/UHF base station for amateurs. It features 99-channel operation, SSB/CW/FM, noise blanking and more knobs than the CB rig – plus a considerably higher price tag.

other possible factor contributing to our meagre number of amateur radio projects in recent years is that we had no licensed radio amateurs on the staff for about 4 years, between mid-1983 when Neville Williams retired and mid-1987 when I returned. But I'm sure this wouldn't have stopped the editorial people at the time from recognising and publishing good 'meaty' amateur radio articles, if these had been sent in from contributors.

In fact there *were* a number of significant amateur radio projects published during that time, but it's interesting to note that they were virtually all contributed by a major kit marketing company – not by individual amateurs without a commercial interest. That's not to criticise the firm concerned, the people in it responsible for developing the actual project designs, or the designs themselves; these were all quite laudable, and I'm aware that the projects were well received. I'm merely noting that the impetus for developing them was basically commercial in origin, rather than a burning enthusiasm from amateurs themselves.

I'm sorry folks, but whichever way you slice it, the reason why we've had relatively few amateur radio projects in recent years basically seems to stem from, and reflect what has happened to amateur radio itself. Because radio amateurs have largely lost interest in experimenting and building their own gear, and turned to buying and using 'appliance' equipment, they have neither asked us to publish such projects nor submitted any for publication. It's as simple as that.

You disagree? Fine – prove me wrong. Write an article describing the last gee-whizz piece of amateur radio gear you've built, and send it in to me. If it's any good, I'll be delighted to publish it and admit I was wrong – at least in your case!

Frankly, I'll be over the moon if hordes of radio amateurs prove me wrong, by sending in all sorts of interesting project designs and articles. It would be great to find out that the original kind of amateur radio *isn't* really dead, after all.

Come on, Igor, let's wind up the lightning rod, and see if we can shock a bit of life into the corpse. Wouldn't it be a thrill to see a hand or foot twitch, and be able to echo those classic lines from *Frankenstein*: "It's alive – it's alive!"

Postscripts

Before ending up this month, I should acknowledge some letters sent in from readers, commenting on topics recently covered in this column.

My piece in December about oxygen-free copper cables and their performance in audio systems has brought a response from Mr J. Jeltes, of Salisbury East in SA. While agreeing with my final comment that Japanese researcher Osao Kamada's theory of grain boundary distortion is not entirely convincing, Mr Jeltes still believes that his basic experimental *findings* may be quite correct. Fair enough – I think there may indeed be *something* in the use of OFC, but the hard part is to say exactly what the benefits are, and their degree of significance. Quite apart from the business of explaining *why* OFC does offer any benefits over ETP copper.

Mr Jeltes himself offers an explanation, which seems to be a variation on the 'random current path fluctuations' theory suggested by Mr Vickers. But I have to confess I still find this unconvincing, for the reasons I gave in the December issue. At audio wavelengths it seems to me that the phase or delay variations produced by changes in path length are likely to be extremely small – even less than the variations caused by thermal energy.

If the changes in path length caused by oxygen at the grain boundaries were significant, that would suggest that we would achieve even more of an improvement in performance by cooling the speaker cables right down, to reduce thermal noise. And as yet I haven't seen anyone claiming that we should use speaker cables cooled down with liquid nitrogen – or is that the next stage, after oxygen-free cables?

I hesitate to even suggest it as a joke, in case I trigger off the next hifi fad!

The great circuit symbols debate of January and last October has bought in a couple more responses, also. One came from retired professional engineer Mr Bill Chidzey of Sandringham, Victoria, who has apparently been reading the magazine (plus lots of others) for over 50 years.

Mr Chidzey writes that although he's generally in favour of standardisation, he basically agrees strongly with our decision to stick with our conventional 'de facto' symbols. He agrees with me that they're much easier and faster to read than the rectangular ones in the IEC/SAA standards, and believes that the latter is best ignored. A man after my own heart!

The other letter came from Mr Tony Ellis of Blaxland NSW, who also backs our decision to keep our present symbols. Mr Ellis says that in his opinion, it is best to use the symbols in widest use at a particular time, and only change or 'update' when you get out of step with the majority. Fair enough, and of course that's exactly what we're doing.

Mr Ellis reminds me that back in the early days of transistors, we started using a transistor symbol which looked like a diode with an extra leg coming out the side. It was easier to draw, and I think it had been offered as some sort of standard from the UK. But as Mr Ellis points out, we tried changing too early, and got out of step with what the majority wanted. As a result we had to change back to the symbols we (and most of the world) are still using today. Good point, Mr Ellis – thanks!

One further little comment offered by Mr Ellis is that despite the fact that the Electricity Commission of NSW is officially a supporter of the IEC/SAA circuit symbols, he has struck all sorts of different circuit conventions and symbols in use within the Commission for different purposes. The radio systems circuits are different from those used for the computer systems and the high-voltage power systems, and so on. Yet there's apparently no attempt to redraw everything so that it conforms to one unified standard – this would cost a fortune. Instead everyone just gets used to the various conventions.

Entirely sensible, of course. But all the same it sounds ironic, wouldn't you say?

The final letter of note this month came in response to the discussion on 'tingles' from unearthed double-insulated equipment, in the January column. It's from Mr Michael Gamble, of South Yarra in Melbourne, who seems to have had quite a lot of experience with audio systems used for making recordings.

Mr Gamble writes that in his experience, reversal of the power-plug connections can often reduce the magnitude of the problem considerably. He suggests that this is presumably due to a lack of symmetry/balance in the stray capacitances which form the leakage path responsible for the 'tingle'.

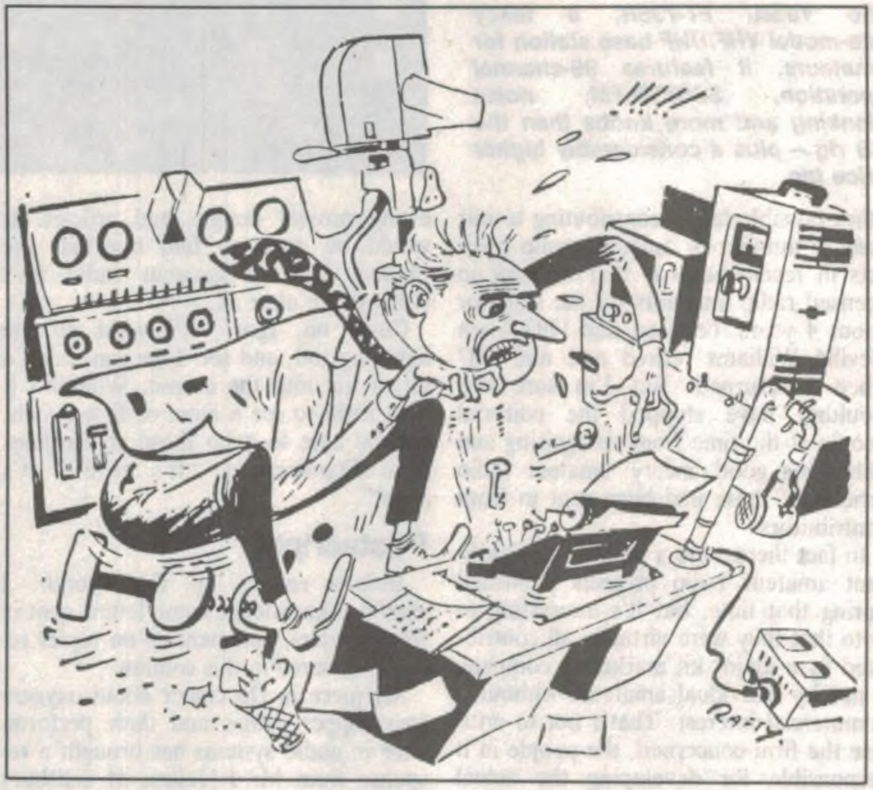
That sounds entirely likely, to me. The main capacitances concerned are likely to be those within the power transformer itself, and mainly those between the primary winding and the core/frame. These may well be unbalanced, as one end of the primary is often going to be closer to the core than the other end. So the power plug connections which result in the 'active' lead being connected to the end of the primary with the smaller capacitance to the core may well give a much smaller 'tingle' than the other way around.

The only complication here is that Murphy's Law may easily operate, and ensure that the plug connections which give a smaller 'tingle' could also result in the equipment's power switch being connected in the 'neutral' lead rather than in the 'active' as it should be. So swapping the plug connections may actually make the equipment less safe, even though it can reduce the 'tingle'.

Oh what a tangled web we wove, when first we started to double insulate!

And that's Forum for another month. Love me or hate me, I hope you'll join me again next month. And as usual if you'd like to comment on the subjects discussed, feel free to write in.

How the 'Forum' column began – almost 39 years ago



The 'Forum' column has been running in our magazine for almost 39 years now, under either its present name or the original title 'Let's Buy An Argument'. The title of the column was changed into its present and somewhat more staid form with the April 1965 issue, when the magazine itself became *Electronics Australia*.

Many of our older readers will no doubt remember the Tony Rafty cartoon above, which appeared above the original title for many years. We're not sure who Rafty used as a model for the cartoon, except that it can't have been Neville Williams – he has a lot more hair than the cartoon figure even now, some 39 years later!

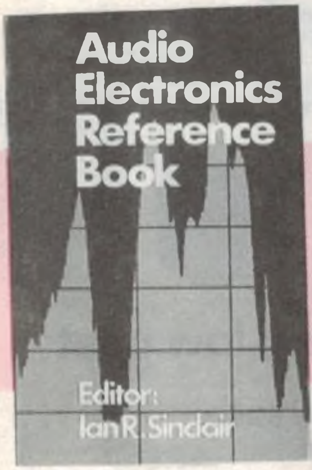
Neville conducted the column for just over 37 years, from its inception until November 1987, when he had to bow out due to pressure of other committments (things can get rather hectic, even when one is nominally 'retired'). Since then, the column has been in the hands of our current Managing Editor Jim Rowe.

How did the column start? Neville relates that as Technical Editor at the time, he became 'hopping mad' about some of the common misconceptions that were being bandied around regarding direct coupling in audio amplifiers. When he voiced his objections to then Editor John Moyle, the response was: "Don't waste all these objections on me – write them down and we'll publish them. Readers love a fight!"

John Moyle himself came up with the original title for the column, and arranged for company cartoonist Tony Rafty to produce the original illustration.

The rest is history. The column has been the centre of technical arguments and discussions ever since, and has long since become a traditional and much appreciated part of the magazine. Even if the relationship between its conductor and the readers continues to have elements of a love/hate duality, from time to time!

Books & Literature



Audio reference

AUDIO ELECTRONICS REFERENCE BOOK, Edited by Ian R. Sinclair. Published by BSP Professional Books, 1989. Hard covers, 242 x 162mm, 615 pages. ISBN 0-632-01929-8. Recommended retail price $224.

Audio electronics has changed considerably during the 1980's, and this new book edited by well-known technical author Ian Sinclair is intended to provide an authoritative reference to the current state of the art. Or as the editor writes in his preface, to act as 'a summary, a guide, and a celebration of the new state of audio.'

He has certainly gathered together an impressive collection of well-known British audio writers and authorities to author the various sections: Donald Aldous on Sound Recording Techniques and Disc Reproduction; John Linsley Hood on Tape Recording, Tuners and Radio Receivers, Preamps and Inputs, Voltage Amplifiers and Controls, and Power Output Stages; Stanley Kelly on Loudspeakers and Loudspeaker Enclosures; Barry Fox on Stereo and Compact Disc; Alvin Gold on The LP Record; Mark Jenkins on Sound Synthesis; Dr W. Tempest on Sound Waves; Peter Mapp on Studio and Control Room Acoustics and Public Address & Sound Reinforcement; Jimmy Hughes on Noise Reduction Systems; and Dave Berriman on Headphones and In-Car Audio.

Yet after looking through it, and bearing in mind the book's rather horrifying price tag, I confess that I find it on the whole rather disappointing. Somehow the author doesn't seem to have been able to decide whether he was trying to produce a true reference volume for the professional, or a rather more superficial look at current technology for the interested non-professional.

As a result, some chapters seem intended for one kind of reader, with solid engineering reference data, while others are little more than a general overview of the topic with pretty pictures of the latest commercial boxes. It's almost as if bits of two quite different books have been interleaved.

For the money being asked, and bearing in mind the credentials of authors and authorities like Aldous, Fox, Linsley Hood and Stanley Kelly, I'd have expected a really authoritative engineering reference volume. Especially as the editor himself has dedicated it to the memory of Fritz Langford-Smith, of *Radiotron Designers' Handbook* fame – suggesting that he has intended to produce a work of equivalent value.

I know that it would require an enormous amount of effort to produce that kind of book, considering the dramatic developments which have taken place in the audio field. But I have to say that in my opinion, the present book falls a long way short of this worthy standard. More's the pity.

The review copy came from Blackwell Scientific Publications (Australia), 107 Barry Street, Carlton 3052. (J.R.)

Broadcasting data

RADIO AND TELEVISION BROADCASTING STATIONS 1988, published by the Australian Government Publishing Service, 1988. Soft covers, 294 x 211mm. ISBN 9 780644 086714.

The latest list of reference information on Australian radio and television broadcasting stations, from the Federal Department of Transport and Communications in Canberra, and reproduced from the department's central database.

There are six sections devoted to radio, dealing in turn with:

1. HF Radio
2. MF AM radio in callsign order
3. VHF FM radio in callsign order
4. MF AM radio in frequency order

5. VHF FM radio in frequency order
6. All MF/VHF radio by area served

This is followed by the TV sections, four in number, and dealing with:

7. Television in callsign order (by State)
8. Television in channel order
9. Television by area served
10. Television input link notes.

A further Technical Information section at the rear provides brief extracts from various radio and television standards, which I understand are currently out of print and due to be republished in updated form soon.

The information given in the main listings is quite comprehensive. For example, MF radio station data includes not only all of the basics like callsign, area served, frequency, power, mode and class, but also things like exact geographical co-ordinates, antenna mast height, radiation pattern and the date that the station began operation. Similar data is given for TV stations.

In short, a very useful reference book for anyone who needs to know more than the basics about Australian broadcasting stations.

Copies of the book are apparently available from Australian Government bookshops, and also from some major bookstores. (J.R.)

Silicon Valley NEWSLETTER . . .

IBM's PC chief resigns

Under William Lowe, IBM has seen its position in the personal computer industry slip from a dominant supplier to one that today controls just 22% of a market, in which skepticism towards the family of PS/2 systems continues to cast a dark cloud over the system's future prospects.

It came therefore as no great surprise that Lowe has announced his resignation from IBM. He is moving over to Xerox, where he will be put in charge of that company's planning, development, and manufacturing operations.

IBM immediately replaced Lowe with James Cannavino as head of the Entry Systems Division. Cannavino is a veteran of IBM's mainframe systems business and is described by industry insiders as a 'high-flyer with very high energy.'

"They brought in a heavy hitter. They intend to focus even more heavily on personal computers," commented industry analyst Melinda Reach.

It may look like just another PC clone, but the Step 386/25 runs its 386 processor chip at a blistering 25MHz – claimed to be fastest in the industry. It's made by Silicon Valley computer maker Everex, which was started in 1983 by Chinese entrepreneur Steve Hui. Everex machines have been selling extremely well in the US of late, with 1988 sales of US$267 million – 69% up from 1987.

Latest consumer gadgets at show

If the recent Winter Consumer Electronics Show is any indication, and it usually is, consumers should brace themselves for an onslaught in the coming years of new products powered by sophisticated integrated circuits.

More than 100,000 visitors and 1,400 exhibitors packed the Las Vegas Convention Centre. Following are some samples of things you can expect to see in the stores soon:

• How about a speaker telephone built into a cuddly stuffed animal that lip-syncs and rolls his eyes to the caller's voice. The KC Bearfone will retail for $US80.

• Need a watch-dog, but you like doberman pincers about as much as the average burglar? No problem. A small electronic box will produce life-like sounds of a barking vicious doberman, as soon as the sensors placed around the house detect someone snooping around. The Radar Guard Dog was developed by Max International in Silicon Valley, and will retail for $US140.

• A company by the name of Rabbit Systems has introduced the ultimate car burglar alarm. Rather than setting off an external horn or siren that ends up irritating both car owners and their neighbours, the CounterAttack emits a 100dB high-pitched shriek inside the car. At that level, the would-be thief will quickly take off, or have his ear drums melted.

• There were of course a wide assortment of new audio products, including a $4,000 stereo headphone set from Sony. This ultimate Walkman, known as the MDR-RIO, is designed to please even the most aristocratic audiophile. With sheep-skin pads, the set is carved out of the wood from Japan's rare 200-year-old Zelkova trees.

Chips and living cells meet

The inevitable joining of semiconductor and biotechnology is finally taking place in San Francisco, where a 5- year-old Silicon Valley start-up introduced an innovative component that its inventors hope will radically change the way medical and biological research and testing is conducted.

The 1-square-inch 'Threshold' device from Molecular Devices of Menlo Park allows researchers to place living cells or other microscopic living material on top of the chip. The Threshold's highly sensitive circuits then measure the minute quantities of electrical activity.

The information can be used to detect the presence of certain bacteria or viruses, in a fraction of the time it would take with traditional testing methods.

Molecular Devices offcals said Threshold devices could radically alter experimental medical and biological research. The chips would be able to tell researchers the precise effects new drugs have on human cells, greatly eliminating the need to use and kill laboratory animals.

Molecular said it expects to start shipping the Threshold almost immediately. The complete 'Threshold Array Instrument' will sell for $US2800 each and additional reagent kits will cost $US600. "Think of it as a cellular monitoring device. It is a very elegant, but simple device," said Gary Steele, Molecular president.

IBM, Apple, DEC and H-P join planned HDTV partnership

Sixteen major US computer and electronics firms, including IBM, Digital Equipment, Apple Computer and Hewlett-Packard have announced the formation of a partnership to study the feasibility of jointly developing high-definition television technology.

The American Electronics Association, which is pushing hard for a reentry by the US high-tech industry into the television market, announced that the 16 firms have reached an agreement on funding a two-month study aimed at drawing up a business plan for an HDTV limited partnership. At this stage, however, none of the participating firms will be committed to joining the partnership, and others may still enter the group.

Besides IBM, DEC, H-P and Apple, other companies participating in the HDTV effort are Zenith Electronics (the last American television manufacturer), Texas Instruments, Motorola, Varian Associates, Prometrix, Raychem, ITT, Tektronix, Harris Corp., AVX, Cohu Inc., PCO Inc., and the Micro Electronics Computer Technology research consortium.

If the partnership is indeed formed, it may well represent the most far-reaching of any of the several co-operative ventures that have been formed in the US in the last couple of years, including MCC, the Semiconductor Research Corporation and – most recently – Sematech. All of these groups have been established in a rather desperate effort to provide the US electronics industry with the kind of technology and manufacturing capability to remain competitive on a worldwide basis, particularly against Japan.

None, however, goes much beyond conducting basic research which is subsequently transferred to member companies. The HDTV partnership, on the other hand may actually get involved in the manufacturing and marketing of HDTV products. "The vision is beyond Sematech", said Pat Hubbard, vice president of the AEA and the driving force behind the formation of the partnership.

The apparent willingness by a number of major US firms – which to date have little or no experience in the television or other consumer electronics markets – to enter the TV arena is remarkable in itself. However, a growing number of firms apparently believe that the HDTV technology has opened an unusual opportunity for US firms.

This is because the new television receivers will require a complete overhaul of the entire television industry to adjust for the broadcasting and reception of the high-density pictures. HDTV's will feature at least twice as many lines as current sets.

Also, because no standards for the American market have yet been announced by the FCC, the US industry may actually have somewhat of an edge over Japanese competitors – which may be forced to start almost from scratch, as the US standard is likely to be radically different from the one being proposed by Japan.

The technologies involved in the development of HDTV's largely overlap technologies required for future computer markets, including signal processing (ISDN), and high-density graphics displays. Semiconductor firms are also interested in the HDTV market, as the sets will also require a large number of advanced processors, support chips and massive amounts of DRAM memory (up to 30 megabits).

TI to build wafer fab in Italy

Texas Instruments has announced plans to build a massive $US250 million semiconductor manufacturing facility in Avezzano, some 60 miles east of Rome in Italy. The move is designed to better serve the expanding European chip market.

TI offícals said the facility could come on-line as early as late 1990, with full production some time in 1991. When fully staffed, the facility will provide work to some 500 people.

Among the products to be produced at the facility will be state-of-the-art DRAM memory chips. Wafers produced at the Avezzano facility will be transported to TI's 35-year-old assembly operation 35 miles to the south, in Rieti.

Atari's Tramiel wins 'worst boss' award

Managers and executives at all levels often prominently display the awards they have earned on the walls and in the display cabinets in their offices. But the award Jack Tramiel recieved last month is not likely to found anywhere on the Atari premises. That's because the boss of the video game and personal computer maker was named California's worst boss of 1988.

"It was unanimous," according to Greg Critzer, editor of *California Magazine*, which bestowed the award on Tramiel. To emphasise the point, the magazine printed a drawing of Tramiel with the caption "Work is Hell ... And Jack Tramiel is one of the bosses who make it seem that way".

For the past several years, the magazine has published its 'Ogre Index' which rates company bosses on a five-point scale. The categories are: penny-pinching, slave-driving, screaming, badgering and being hard to read.

Tramiel rated in only two categories, penny-pinching and slave-driving. But according to Critzer, during the survey of hundreds of people in various major Californian industries: "There wasn't one phone call we made where his name didn't come up first."

H-P to build $US100 million chip facility

Hewlett-Packard, which dazzled the industry in the late seventies and early eighties by putting record numbers of transistors onto microprocessors and other chips, is making a new strong committment to its chip-making prowess.

The Palo Alto company said it will build a $US100 million state-of-the-art wafer fab facility at its Northwest IC Division in Corvallis, Oregon. The 200,000-square-foot facility will house H-P's ASIC Technology Access Centre which designs and makes most of H-P components.

First production is scheduled for some time in 1990.

The Serviceman

A Convention, and a colour TV with a bad case of the bends!

This being a special issue of *EA*, I thought I'd finally take the opportunity to squeeze in a report on my visit to last year's very successful 13th National TESA/TETIA Convention. But there's also an interesting story about my experiences with a Philips K9 colour TV which came in with an extremely bad case of 'the bends'.

Sometimes these stories might give you the impression that we TV technicians never do anything besides fixing televisions and other domestic electronic equipment. This is not *quite* right(!), because apart from anything else we have to spend a lot of our spare time learning about new technology, and keeping abreast of new models and designs.

Mostly, this learning process means slogging through dry-as-dust manuals and text books. But just occasionally learning becomes fun, or at least enjoyable!

Every two years the Television & Electronic Services Association (TESA) joins with its sister organisation The Electronic Technicians Institute of Australia (TETIA) to stage a week-long convention for people engaged in the electronics servicing industry. Members from all over Australia (and some from New Zealand) gather to discuss their problems and to listen to talks about new and future technology.

The Conventions are not all dreary lectures, because the daily programme includes technical tours to places of interest. And of course, the evenings are given over to pleasant socialising.

And so it was that last October, some sixty members gathered in Surfers Paradise for the 13th National TESA/TETIA Convention.

The Convention began on Monday morning with a talk by a Chartered Accountant about business structures for small service organisations, and about the costing of jobs within those organisations. This last item was particularly interesting because of the practical examples given.

Many delegates present, when they substituted their own figures for those in the examples, found that they were really undercharging their customers. It was shown that we were only recovering *most* of our costs, not all of them. The bit that we weren't recovering made the difference between making 'just a living' and making a comfortable living.

Then the next speaker showed us how we could save hundreds of dollars a year on our phone bills, by using modern facsimile machines to speed up parts ordering and information gathering. The only thing that wasn't explained was how to get a fax machine to save money with!

Other talks on the first day covered the sources of finance for small businesses, and the uses of mini-computers in data handling and record keeping.

The day concluded with a delicious seafood dinner while cruising on the Surfers Paradise waterways aboard the showboat 'Island Queen'.

Much of Tuesday was taken up with technical lectures delivered by Rod Humphris, senior lecturer in Electronics at the Royal Melbourne Institute of Technology. RMIT has always been a strong supporter of TESA and TETIA, and over the years has provided a mountain of technical literature to back up talks by its senior instructors.

This year was no exception and we came away with papers on video recorder faults, surface-mount component technology and servicing, and digital frame stores, now becoming common in domestic equipment for picture-in-a-picture or super-freeze-frame.

Next day the party travelled to Brisbane to visit the studios of Brisbane TV Limited, BTQ7. This was the highlight

Servicing professional video equipment is a different kind of job to servicing domestic gear. Members of TETIA and TESA got a look at the real thing last year in the maintenance room of BTQ Channel 7, Brisbane. Peter Poulton, Operations Supervising Technician is seen here working on a camera control unit with Andrew Robertson, Acting Engineering Director.

of the Convention, although it began in some confusion and would have ended in disarray but for the quick-thinking of Public Relations Manager Gary Linaker's 'Girl Friday', Deborah Pacey.

Debby is more used to conducting school children, suburban Mums and pensioner groups around the studios. When faced with forty-odd technicians all asking complicated technical questions, she didn't try to bluff her way through but immediately called in Andrew Robertson and Peter Poulton, both senior technical specialists from the station's engineering staff, to help her.

As a result, we were able to ask the most detailed questions and we got the most detailed answers. The staff of BTQ7 went out of their way to make our visit instructive and enjoyable, and we now have a much better understanding of how a commercial television station conducts its business and puts its programmes to air.

The day concluded with dinner at Dreamworld and a visit to the IMAX cinema. This incredible movie experience has been described several times in *Electronics Australia*, but no description ever really conveys the full feeling of participation one gets from being there.

The final morning saw us back in the lecture theatre, with talks on new VHS recorder technology, compact disc servicing, cable TV and Master Antenna TV installations, servicing micro-wave ovens and some details of the new Sharp super-thin (LCD) TV display panels.

And to end the 13th Convention, we spent the afternoon with the now-traditional Question and Answer segment with manufacturers and parts suppliers. This part of the programme allows us to quiz participating manufacturers about their warranty and service policies and about spare parts supplies, prices and problems.

There is no doubt that manufacturers are being squeezed hard by the public on one side, demanding better and cheaper appliances, and by servicemen on the other, demanding more and cheaper parts and more and cheaper service information. Everyone has their own problems, I guess...

The Q and A session at the Convention uncovered a number of communications breakdowns, at both the manufacturer level and at the service shop level. We all came away with a better understanding of each other's problems, and a firm conviction that we'll do better in future.

The 13th (biennial) Convention represents 26 years of keeping up with technology, and the fact that TETIA and TESA have been able to keep the series going for so long shows the value placed on the Conventions by members of the groups.

TETIA and TESA are professional organisations, with strict admission requirements. TETIA members are all qualified technicians, but the organisation will also admit students of electronics while they are studying. TESA can only admit full time service companies. The objectives of both organisations are to provide a source of ethical guidance to members and the means by which members can improve their education and professional status.

The next Convention will be held in Auckland, New Zealand, in 1990. The New Zealand electronics industry has already promised its support and members of ETSA, the NZ equivalent of TESA, have promised Australian visitors a thoroughly enjoyable Convention.

If it's anything like the Queensland Convention, it will be a gathering not to be missed.

Case of the bends

And now back to the workbench, with another story to make one wonder why we ever bother to learn the art of servicing domestic electronics. There must be easier ways to earn a dollar!

As a TV serviceman, I see some of the queerest pictures imaginable. Most owners might see one or two funny faults in the lifetime of their set, but in my workshop, I see 'em all.

We technicians have developed a special language to describe the various faults and to us, the description often gives a clear indication of the site of the fault. On the other hand, customers have no access to our language and must find their own words to describe what they see. Although the story that follows is just a straightforward servicing problem, it started out as an enquiry about a most mysterious 'bent' picture.

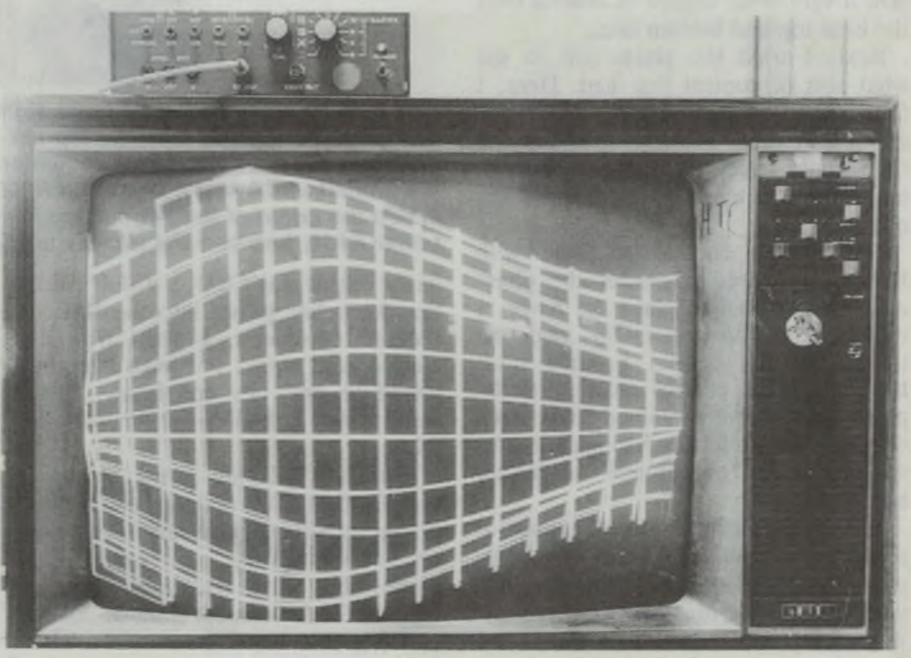
I couldn't make much sense of the description. 'Bent' might mean flagwaving, or the weaving verticals caused by hum bars, or it could be pincushion distortion. All I could do was to wait until I saw the problem with my own eyes.

Next morning, two charming young ladies drove up and between them carried into the shop an old Philips K9. They told me the picture had gone 'all funny' and when pressed for more detail, said that the picture was 'bent'.

The girls tried to explain, but couldn't think of any better description than 'bent'. So I put the set up on the bench and switched on. Thirty seconds later, I knew exactly what they meant.

In detail, the picture height was normal only in the centre of the screen. At the sides, the picture had collapsed down to about one third of the screen height.

It was an extreme example of what used to be called 'barrel distortion'. It gave faces a grotesque shape, with the nose stretched up the screen and framed with tiny squashed down ears. Big, long American cars looked like VW Beetles, fat in the middle and tapering down to



A re-creation of the fault described in this Serviceman story. This is a standard crosshatch pattern, with supposedly parallel horizontal lines.

nothing at either end.

It was the oddest distortion I have ever seen and I was quite interested in finding out what was causing it. (By the way, the girls were justified in being unable to describe the fault. I couldn't do much better!)

It was obviously caused by a malfunction in the North/South correction circuit, although it would take a lot more than the normal adjustment range to correct for this gross error.

The first thing to do, once the cabinet back was off, was to try the various adjustments that were available, to see which ones worked and which did not.

There are two controls in the K9's N/S correction circuitry. One is the phase coil, S598 and the other the amplitude trimpot, R602.

To begin with, I tried the trimpot and immediately found the first fault. As I turned the screwdriver in the pot, it went 'scrunch, scrunch' and then the centre of the pot fell right out. It was very obviously cooked, and would have to be replaced before I could get anywhere.

Fortunately, I have an old K9 chassis which I keep for parts and this still had the N/S trimpot on board. What's more, it was in perfect condition, so it was soon fitted to the faulty set and the tests continued.

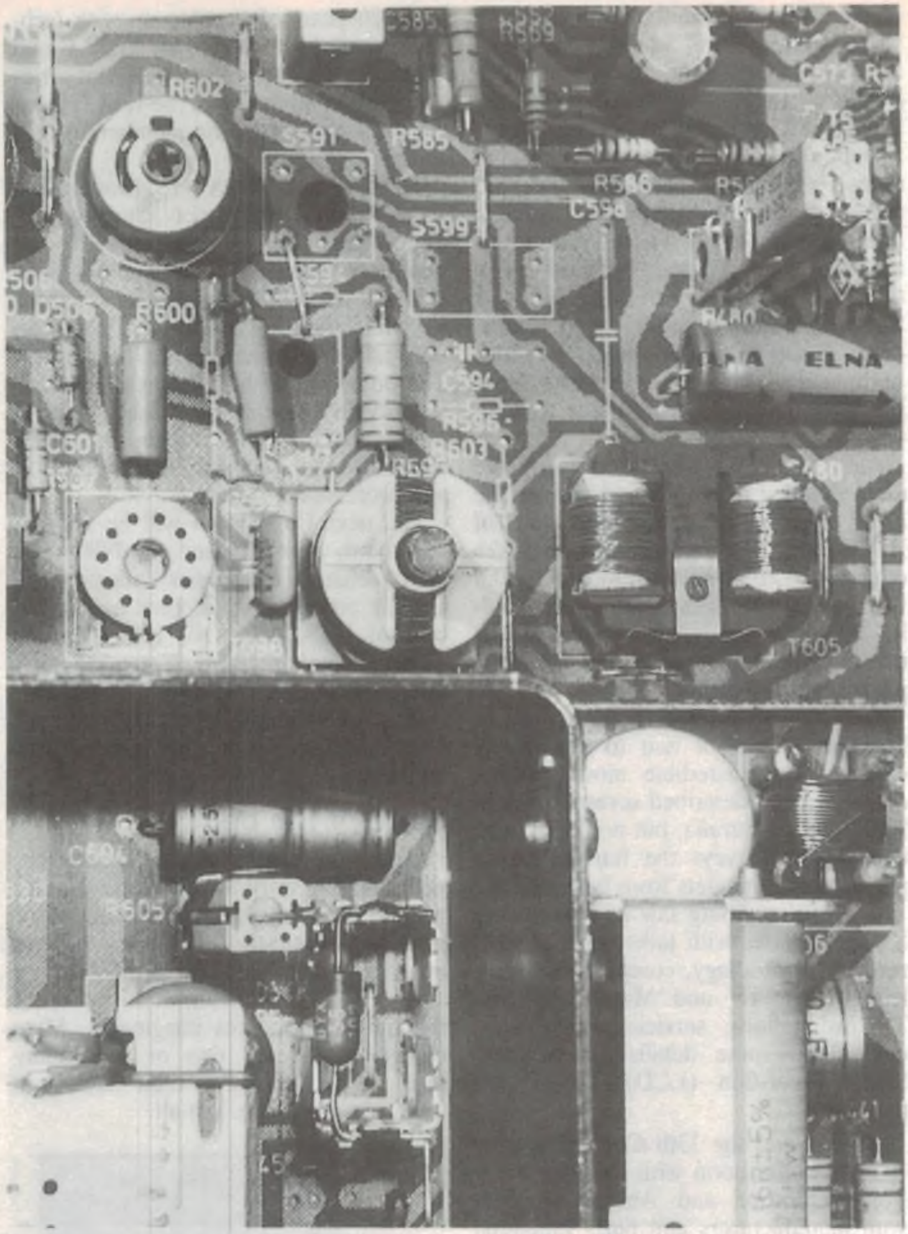
Unfortunately, the burned out pot was not the only trouble. The symptoms were still the same, although there was now a very small degree of control over the bent top and bottom lines.

Next, I tried the phase coil to see what sort of control that had. Here, I found that we had far, far too much control! A small adjustment of the coil core would sweep the bulge in the picture from one end of the screen to the other.

The limited control available with R602 disappeared whenever the phase coil was adjusted to place the bulge at either side of the screen. This made me think that the central position must have been the correct setting for the phase coil. But it remained to be seen why the correct setting had such a massive degree of 'overcontrol' on picture height.

The next check was on other passive components around that part of the circuit. These included a resistor in series with, and a capacitor across the N/S adjustment pot. These tested OK, so I moved on to more remote parts.

One component that stood out as a likely culprit was C604, a 470uF electro that feeds line pulses into the N/S correction transductor. I don't trust any electro, and would not have been surprised to find this one faulty. But it wasn't, and I had to go on to other parts.



This is the section of the K9 large signal board, in the vicinity of the fault described here. R602 is in the top left corner. S598 is in the centre of the picture, with the transductor T605 alongside. The diode and spring resistor mentioned in the story, D605 and R605, can be seen towards the bottom left, inside the curve of the large black heatsink. The broken track was directly under R600, between the trimpot and phase coil.

There's a 2.2 ohm spring resistor in series with a diode between one winding of the transductor and earth. The resistor had not sprung, as it would if the diode went short circuit, and in fact measured a little under 2 ohms. So that part was OK.

But the next test seemed to confound the issue. The diode tested low resistance both ways, as though it was short circuited. Which made me wonder why didn't the spring resistor open! The diode came out for a more accurate test, and of course, it was faultless.

In fact, there was a low resistance path between its anode and ground – through the transductor, back to the line output transformer at pin 2. This was another of those disappointing moments in TV servicing, where what seems to be an obvious fault turns out to be no such thing.

There were not many more components to be checked around this area of the board. A short series of 1 ohm resistors to ground all proved to be perfect, as did a resistor and capacitor in series with the yoke centre tap.

Finally, I tackled the small network of S580, C585 and R585, between the input side of the yoke and the bottom of the transductor. None of these was in any way faulty, which left only the yoke and the transductor to be tested.

I discounted the yoke as a problem, because an open or shorted winding would have delivered an asymmetrical picture. While damage to the core, the only other likely possibility, would have affected the horizontal scan as well as the vertical.

The easiest way to test the transductor was to replace it with the known good one from the spare board. The transfer was completed without trouble, and the first test showed no real improvement on the original.

One slight difference though, was that the centre horizontal line, which had been quite straight with the old transductor, was now bent upwards. Not nearly so much as the top and bottom lines were bent, but still enough to be noticeable.

The transductor is fitted with a small, moveable magnet to adjust for 'straight centre line', so I tried to make the adjustment. But as soon as my screwdriver touched the slot in the magnet, the whole end fell off the transductor.

This had an unexpected effect on the picture. The gross distortion disappeared, and the picture became more or less parallel from side to side. Except that the picture was only about four inches (alright, alright, 100mm!) high across the centre of the screen, and the height control had very little effect.

I removed the transductor and examined the pieces. It was apparent that the parts had once been glued together, but that the glue had broken away. I soon had the parts refixed with good old Araldite and the whole assembly back in the set.

It all made no difference though. The bulge in the centre was still as bad as ever and I was no nearer solving the problem.

The time had come to use the oscilloscope, seeing that my multimeter could not find the fault. The trouble seemed to be not responsive to any DC tests, so it had to be an AC problem and the scope should show this up.

The first trace for this part of the circuit shown in the service manual is the familiar 'bow tie' pattern at the output from the yoke. It is given as 190 volts peak to peak, and in the set I found a waveform of approximately this value. But it was grossly distorted, and bore little resemblance to the neat bow tie I was looking for.

The next waveform is No 19, shown as an 8 volt parabolic wave at the centre tap of the vertical yoke. In fact, I found nothing like this. It was more like the distressed bow tie seen earlier, at point 18.

The only other waveforms around this area are numbers 7, 8 and 9. These are plain sawtooth patterns generated by the vertical scan current and are not specifically connected with the N/S correction. In any case, they seemed to be exactly as shown in the manual, so they offered little hope for a solution to the problem.

I went back to waveform 19, at pin 2 on the yoke plug. This was totally unlike that shown in the manual, and seemed like as good a place as any to look for faults.

I had already checked C593 and R595 which lead away from this yoke plug, but this time I was looking at the AC performance, not the DC characteristics. The distorted waveform appeared at each end of the capacitor, and again at each end of the resistor.

This didn't make any sense, because R595 was connected to R586 where I had already checked waveform 9, a 3.2V sawtooth. The only way a length of copper track could have a different waveform at each end would be if it was really two lengths of track.

The K9 circuit boards make use of many jumper links, and there was one of these in this track. I hoped that I might have found a dry joint at the link, but it and every other solder joint on the track were as sound as bells.

I couldn't see anything that might interupt the continuity of the track, yet there had to be something. So I got out the old multimeter again and began a continuity check. This immediately showed that there was something seriously wrong.

The track from pin 3 on the transductor was continuous all the way up to C601, but not to R602 or R595 – which are supposed to be connected to the same track. There was absolutely no sign of a break, even when I knew there had to be one.

With the sharp point of the meter probe, I scratched deeply into the coating that covers the tracks and there, just below R602, was the cause of all the trouble. After I had scratched off the paint, I could see a deep groove crossing the track.

It was wider at one end than at the other, and had obviously been there since the board was made. It had caused no trouble until the thin connection at the narrow end finally corroded (or fused) away.

Just to be certain, I put a jumper lead from pin 3 on the transductor to R602, and the sides of the picture immediately resumed their normal shape. Removing the jumper brought back the distorted picture. That was enough for me.

In 10 seconds I had soldered a bridge across the broken track and restored the picture to normal. I can't point to the spot on the circuit diagram where the break occurred, because of the way the schematic is drawn. It can only be shown on the board pattern. But it was there right enough, and it led me a merry dance until I found it.

Apart from replacing the burnt trimpot, this job consisted of soldering 10 millimetres of tinned copper wire onto a circuit board track. If the customer had the option of paying only for work done, this one would not be worth much. In fact, the customer pays me to find and fix, not just fix, so the job finishes up being worth the doing.

Finally, I believe the parabolic waveform shown at point 19 in the manual must be a misprint. I checked this after the set was repaired, and found it to be a 125 volt version of the bow tie waveform at point 18. It's nothing like the 8V parabola shown in the manual. In fact, the waveform as shown could lead one to chase faults that don't exist!

As I said at the beginning, why do we ever get involved? That's enough for now. I'll be back next month, a little older and a lot balder – see you then?

Fault of the Month

Kriesler 59-04

SYMPTOM: Intermittent small change of picture height, sometimes continuously, sometimes not for five minutes or more. Not responsive to vibration or hot/cold cycling.

CURE: R629 (150k 1/2W NTC) resistor faulty. This resistor is in the network supplying bias to the first vertical amplifier. The change in bias is too small to be read at the amplifier base but the effect can be measured across the resistor.

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

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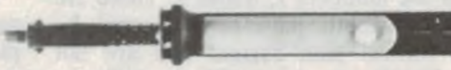

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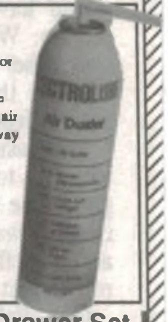

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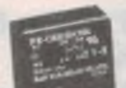

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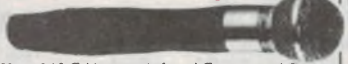

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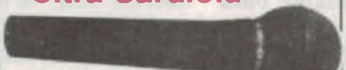

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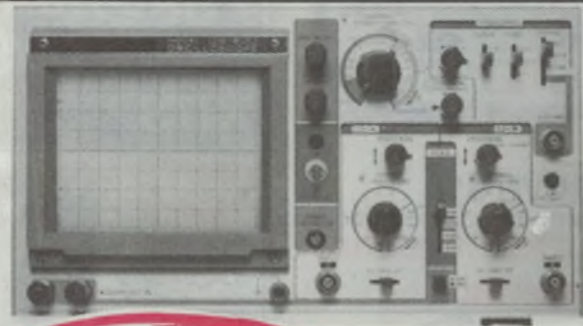

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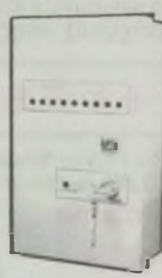
Our 1989 Model IRD now includes pulse count circuitry with a specific time delay between pulse sensing. Three pulses of IR radiation are required to trigger the detector. Providing the detectors are sensibly positioned false triggering is completely eliminated.

Features:

- **Lens simply 'snaps' to either wide angle (range 40ft) for normal use or Narrow angle (and 80ft plus) for corridor applications.**
- **Snazzy integral mounting bracket allows corner 90o mounting.**
- **12V DC Powered**
- **Built-in test lamp.**
- **Relay output SPST 30V 1a max.**
- **9-18V DC**

S 5301 Excellent value *at $79.00*

Multi Sector Burglar Alarm



Protect your Home or Business from Intruders with this "State of the Art" Burglar Alarm System

Over the last few years, House Break-Ins have increased dramatically. The recovery rate of stolen goods is very low. Now more than ever before, it makes extremely good sense to build and install this ingenious Multi-Sector System. This unique Alarm System incorporates the features of the more expensive commercial models - at a fraction of the price.

Features:

• 8 sectors can be monitored independently • Each input circuit is provided with an indicator LED and a sector On/Off switch • Individual sector isolation • Inputs accept both normally closed and normally open sensors • Two inputs provided with an entry delay • Alarm is disabled by frontpanel key switch • Internal trip warning buzzer • Unique circuit detects tampering • Automatic muting of the siren driver when under test • Fully variable exit delay • Will drive external horn speaker • Alarm output variable between 1 & 15 minutes • When triggered, gives a connection to external devices e.g. Bells, TV Camera etc • Switched output can be used to send a silent alarm • Full battery back up • Alarm will operate for approx. 2 days with mains disconnected • Supplied in an attractive functional security case.

(See EA Jan/Feb'85)

Kit (Less Battery Back Up) K 1900 $149.50

Back Up Battery 12V 1.2AH S 5065 $24.95

Passive Infra-Red Lite Guard Floodlight Control

How often have you thought there could be a prowler outside your door?

Install a Lite Guard & (once armed) any "guest" will be floodlit when detected by this highly sensitive Infra-Red Detector.

The Lite Guard detects a moving person or vehicle by comparing the background temperature with a rapid change of temperature across the detection beams. So when Lite Guard detects movement across the coverage area it will turn on the floodlight(s) for 1-20 minutes as preadjusted.

Security: Prowlers are startled by an unexpected blast of light.
Convenience: Lite Guard will detect your arrival & turn light on to welcome you home.
Energy Saving: Built-in photo cell deactivates unit in daylight.

S 5350 was $135.00 SPECIAL ONLY $99.00

Please note: Floodlamps & holders not supplied

More TOP VALUE SECURITY KITS on our 2nd DPS

Flat Key Cam Lock

Zinc alloy die cast housing with stainless steel cap. Key removable in either position. 2 solid brass keys supplied.

S 2550 WERE $4.95
NOW ONLY $4.00ea
S 2552 Spare Key Blanks $1.20 ea.

Telephone or Security Keyboard Switch

Matrix Type

Specifications: Contact Conductive rubber. Rating DC 24V 5mA. Contact Resistance 200 Ohms. Max. Withstand Voltage 250V AC. Bounce 5m sec. max.

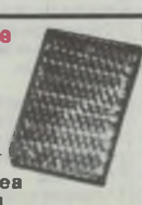
S 5380 WERE $9.90ea
10 up $8.90ea NOW ONLY $7.50ea

2 Amp Regulated Power Supply — Save!

Input Voltage: 240V AC -50Hz
Output Voltage: 12V DC +/-0.5V
Output Current: 2A DC
Dimensions: 84 x 68 x 200mm
Weight: 1.2kgs

M 9050 Normally $69.95
Now only $50.00

Solar Cell Module



.4V at 450mA
Great experiments Solar Module. Connect in parallel or series as you wish. Terminal strap enables easy interconnection to other cells.

A 0210 previously $5.98ea
NOW ONLY $5.00ea
10 Cells or more $4.00ea

★ ★ ★ ★ ★ ★ ★ ★ Transformer Bargains

M 2165 240V to 9,12,15,18,21, 24V @ 60VA (60W)
Normally **26.50** NOW **$19.00** 10 Up **$15.00ea**

M 2175 240V to 12,15,24,30V @ 120VA (120W)
Normally **$39.95** NOW **$30** 10 Up **$26.00ea**

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150MHz Frequency Counter

A frequency counter is invaluable for the accurate alignment and testing of many modern electronic circuits.

Specifications:
Frequency Range 10Hz - 150MHz
Gate Time 1 sec, 6 sec.
Accuracy +/- 1 count
Max. Input 20V P-P
Sensitivity:-
10Hz - 30MHz 25mV -100mV
10MHz - 150MHz 100mV - 300mV
Power requirement 9V DC @ 100mA
Use our 9V Plug Pack M 9004

Q 1520 **Value at $199.00**
Special $149.00 YOU SAVE $50

USEFUL, INTERESTING, PRACTICAL - FABULOUS KITS

Digital Multimeter *With Built-In Capacitance Meter*

All the normal ranges of current, resistance and voltage plus a convenient and simple to use capacitance meter in five ranges, plus transistor tester. Check the features of this top quality digital multimeter from the Labtech range.: • Continuity Test • Buzzer Sound: Less than 200 ohm • Capacitance: 5 Ranges 2000pF - 20uF • Transistor Tester

DC Voltage	.2, 2, 20, 200, 1000V
DC Current	200uA, 2mA, 20mA, 200mA, 2A, 10A
AC Voltage	.2, 2, 20, 200, 750V
AC Current	200uA, 2mA, 20mA, 200mA, 2A, 10A
Resistance	200, 2K, 20K, 200K, 2M, 20M

General: Display: 3 1/2 digit LCD, 0.5" height, with polarity and LO-BAT indication • Overrange Indication
Maximum Common Mode Voltage: 500V peak
Power: 9V alkaline or carbon-zinc battery.
Dimensions, Weight: 170mm x 87mm x 42mm, 350 grams
Specifications: Input Impedance: 10M on all ranges
Normal Mode Noise Rejection: 46db at 60Hz (1K unbalanced)
Common Mode Noise Rejection: 100db at 60Hz
Overload Protection: 1000V dc or peak on all ranges
Response Time: less than 1 Second.

Q 1085 USUALLY **$139.00**
SPECIAL PRICE $99.00

SAVE

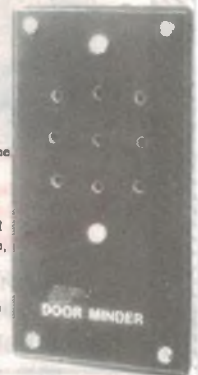
Audio Frequency Generator

In testing audio circuitry it is necessary to have an accurate audio signal source. It even allows you to test 455KHz IF stages!

Specifications: **SAVE $50**
Frequency Range 10Hz 1MHz
Accuracy +/- 3% +2Hz
Output Waveforms: Sine: 8V RMS
Square: 10V P-P
Output Attenuator: -20db, -40db and fine adjust.
Q1540 was $249.00 NOW $199

Door Minder

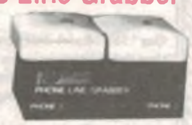
(See SC Feb'88)
Will sense a door opening in a large or small room and will sound a two-tone chime. Does not have to be anywhere near the doorway as it detects pressure change. Ideal for use in shops, office, doctors surgeries, Chemists etc.



K1915 was $45.00
NOW $39.00
SAVE $6.00

Telephone Line Grabber

(See Silicon Chip Mar'88)



The telephone Line Grabber prevents interruption from one extension to another. When one extension is being used it automatically mutes the other extension(s). Gives you complete security. Also great for use with modems. One unit required for each extension.

K 1415 **TOP VALUE $19.95**

✻ ✻ ✻ ✻ LIGHT UP YOUR LIFE! ✻ ✻ ✻ ✻

We have lots of specials we couldn't fit. Come in and look around and make sure you have our NEW 1989 Catalogue

Up To Now Similar Lamps Sold For $1,000 And More **NEW FOR '89**

Plasma Lamp Display

Fantastic pulsating high voltage Plasma discharge continually changes shape and direction. Mode selectable to either fingertip control or sound activated e.g. from voice or sound system. Provides endless fascination as it sizzles and arcs. Supplied complete with AC Mains Adaptor.

Price Breakthrough for '89
A 0120 $199.00 NOW PRICE SLASHED TO $150

Beat Triggered Strobe (See AEM July'85)

Add More Life To Your Next Party
Flashes in time to your music, or as normal strobe. Exclusively customised by Altronics into our H 0480 Instrument Case. Includes silk screened panel.

K 5790 $79.95 NOW $75.00
For Increased Power Two Tube Option
K 5795 $16.50 NOW $15.00

Line Filter and Conditioner (See EA July '88)

Smooth power for stereo, TV & computers. Altronics customised version housed in strong Jiffy Box. Nickel sprayed for EMI shielding.

K 6040 **was $39.50**
NOW ONLY $35.00

Led Light: *The House Number*

(See Silicon Chip Oct'88)

Identify your House
The LED light makes your house easily recognisable at night by illuminating your house number. Great for people visiting, easy for taxis and emergency services to locate you at night.
Operates off low voltage plug pack • Automatic operation • Works only at night • Automatic switch off after 4-5 hrs.
Altronic Kit comes complete. 64 LEDs supplied.

K1960 was $59.95 **NOW $55.00**

Machined Pin Sockets

Gold Plated Sockets
For applications demanding 100% long life contact reliability.

All 30% OFF!

			Now
P 0530	8 Pin	$1.10	.79
P 0532	14 Pin	$1.45	$1.00
P 0534	16 Pin	$1.65	$1.15
P 0536	18 Pin	$1.80	$1.25
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DC Electronic Fuse

(See EA Nov'87)
Simply clips across the DC Fuse holder. Offers protection adjustable from 0-10A in 2 ranges.

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.
• Housed in a rugged Jiffy Box.

A must for prototyping and service work.
No Electronic workshop should be without one.

K 2535 **GREAT VALUE AT $39.50**

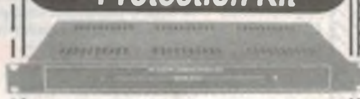
Active Direct Injection Box

(See EA Oct '87)
Converts high impedance unbalanced inputs to low impedance balanced outputs. Dozens of studio/PA uses.

Features:
• Sturdy diecast box
• Black tough indust. powder coat finish
• Professionally screen printed.
• Earth isolate switch.
• +5db pad.
• Phantom powering plus internal 9V bat.

K 5550 **$45.00 NOW $39.00**

Loudspeaker Protection Kit



Protect your valuable loudspeaker system. This easy to construct kit, provides both DC and overpower protection for your valuable Hi-Fi speakers.
Self-powered unit disconnects the speakers within 1/10th of a second of a fault occuring yet in no way effects the sound quality.
1 unit rack box includes quality silk screened front panel.

K 5050 WAS $125.00 NOW $99.00
SAVE $26.00

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Construction project:

Low cost 2-sector House Alarm

Still looking for a cheap, easy to install house alarm? This new design from Altronics offers all the features normally required to protect the average home, in a small box that can be mounted out of the way in a cupboard or closet.

by PETER HARRIS

There have been various designs for burglar alarms published before, both in *EA* and elsewhere, but in our opinion many of these represented 'overkill' for what is probably the most common application of such alarms: protecting the typical family home. Some of the earlier designs seem to have been designed more with the idea of protecting a small factory or office building, and accordingly both the cost and constructional complexity are relatively high.

When we set out to design the present alarm, the goal was to produce a unit which would provide all of the operational features required to protect the average family home, but for the best possible price. It also had to be designed for easy construction.

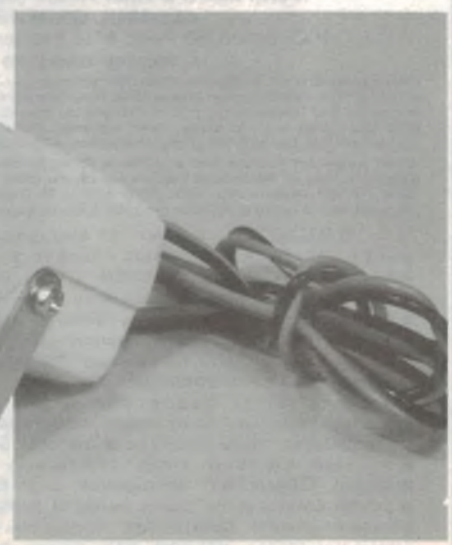
We had to have battery backup, instant PANIC button, instant and delayed inputs, remote mounted key switch, latched relay output (as well as alarm duration output) and soft warning prior to main alarm, just to mention a few!

The resulting design meets these requirements quite well, I'm happy to say. The complete control unit (including backup battery) fits inside a low-cost jiffy box measuring 198 x 114 x 63mm – considerably smaller than most previous units, and a good deal cheaper than the complex metal cabinet used for some.

The control unit itself can be mounted away from the 'action' by mounting the key switch near the front door (or anywhere for that matter). Connections to the key switch and flashing LED only need four wires from the control unit, so a length of two-pair 'telephone' cable will do the job perfectly!

In addition to the features mentioned above, the design provides two separate relay contact outputs. One set is 'on' for the duration of the alarm, the other is only reset when the alarm is reset – i.e., it acts like a telltale.

The momentary relay can be used to power external bells, sirens, telephone dialers, lights, or whatever. The contacts are normally 'dry', that is they are voltage free; but the PCB has been designed so that the relay can supply ei-



The finished alarm unit in its case, as it looks if you build in the keyswitch and LEDs. The piezo siren is at right.

ther positive 12 volts or can switch to 0 volts.

The soft warning alarm feature is necessary to prevent (hopefully) embarrassment at 2am when all is quiet! The noise maker in this case is a mini piezoelectric 12V siren, which is VERY loud when driven at full voltage. In the soft alarm case the alarm is driven at a lower voltage.

A 'panic button' feature was considered necessary by some people, so we have included it. To make this really effective it operates instantly at any time, even if the alarm is turned off!

Incidentally the design work for this alarm unit was carried out in the R&D department of Altronics, in Perth. This means that the design and PCB pattern are protected by copyright, and cannot be reproduced by other firms for commercial use. However complete kits for the project will be available from Altronics by the time you read this article. The kit identification number is K-1910.

Circuit description

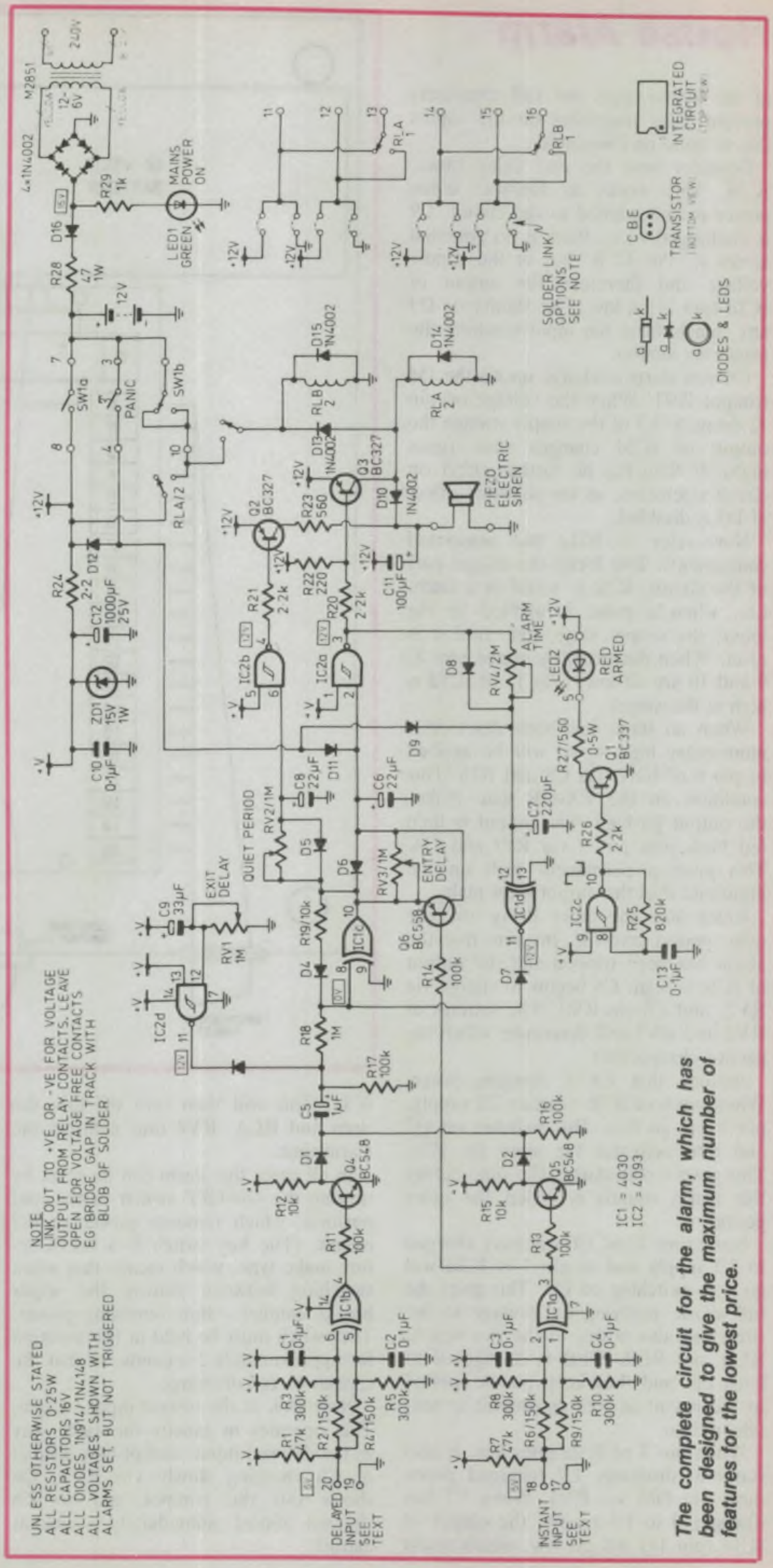
When you look at either circuit schematic or the PCB for the first time it all seems rather complex, but the circuit description can be broken down into several sections to make it easier to follow. We will start at the input section of the circuit, on the left, and work to the right.

INPUT SECTION: The two inputs work in exactly the same way, so the description will be for one input only (IC1b). IC1 is a quad 2-input exclusive OR gate. This means that when both inputs are at the logic/voltage level the output will be low. In this case, both inputs have to be the same for the alarm to trigger, as Q4 inverts the signal.

Normally with the input terminated with a 47k resistor, the junction of the two 150k series input resistors is held at half the supply voltage. This means that pins 6 and 5 will be held at two-thirds and one-third of the supply voltage respectively. Thus the output of IC1b (pin 4) will be high. This holds the collector of Q4 low and hence there is no input to the alarm circuit proper.

Now consider if one of the inputs was disconnected. Pin 6 will rise to almost the full supply voltage, while pin 5 will be at two-thirds supply. Both these two levels are considered logic '1' by the EX-OR gate, so the output will be low, which is inverted to trigger the alarm.

If, on the other hand, the input is shorted, pin 5 will go to 0 volts and pin 6 will go down to one-third of the supply. This corresponds to two logic '0's, and thus the output will be low. In each



The complete circuit for the alarm, which has been designed to give the maximum number of features for the lowest price.

House Alarm

of the above cases the 1uF capacitors prevent false triggering on the inputs due to noise on long lines.

Consider now the exit delay timer, IC2d. This works as follows. When power is first applied to the circuit, C9 is discharged – i.e., there is no potential across it. Pin 12 is thus at the supply voltage and therefore the output of IC2d (pin 11) is low. This shunts via D3 any signals from the input reaching the triggering section.

C9 now starts to charge up via the 1M trimpot RV1. When the voltage on pin 12 drops to 1/3 of the supply voltage the output of IC2d changes state (goes high). It then has no further effect on circuit operation, as the shunting effect of D3 is disabled.

Now refer to IC1c and associated components. This forms the trigger part of the circuit. IC1c is wired as a latch, i.e., when a pulse is applied to the input, the output stays high until it is reset. When the circuit is armed pins 8, 9 and 10 are all low. (Pin 11 of IC1d is high at this stage).

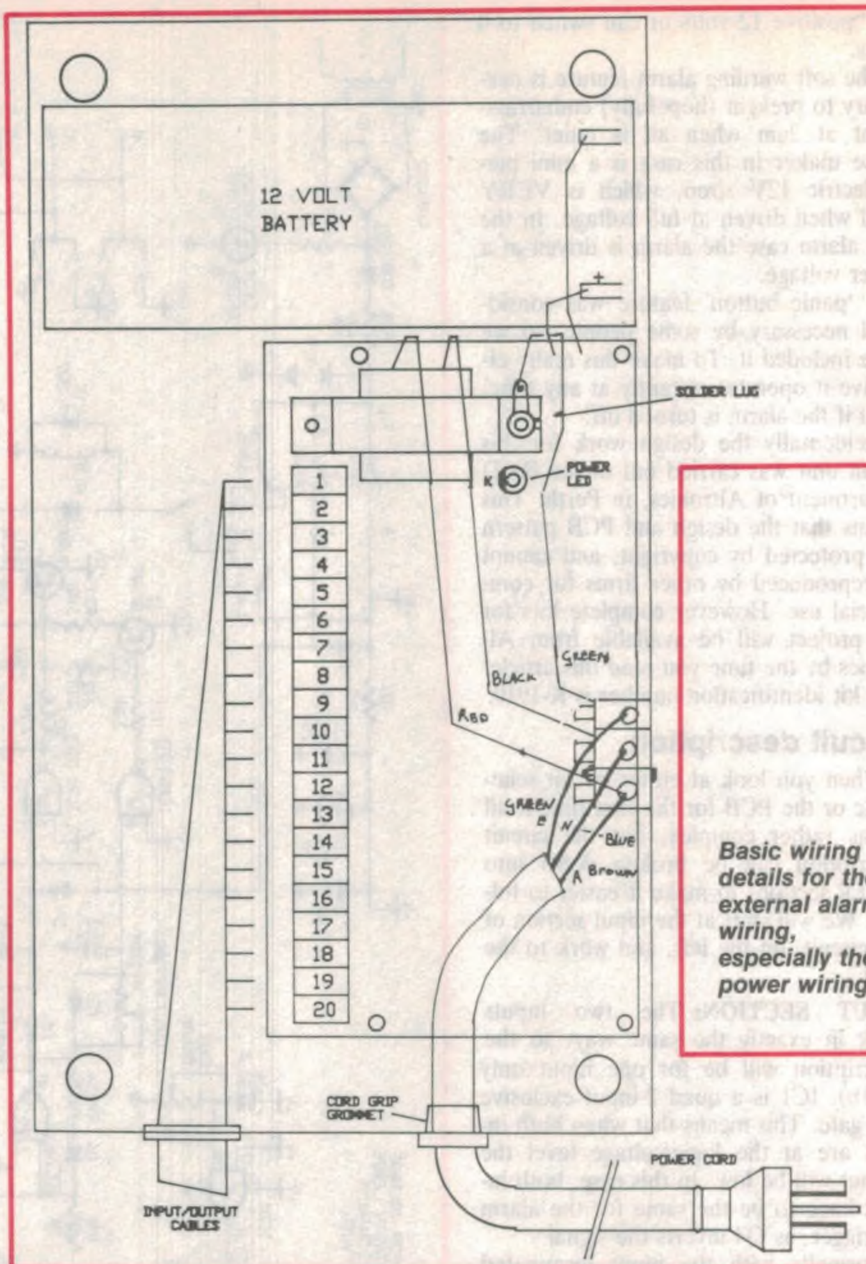
When an input has been detected a momentary high signal will be applied to pin 8 of IC1c, via C5 and R18. This condition on the EX-OR gate makes the output go high. The output is then fed back into pin 8 via R19 and D4. This gives a permanent high on the input and thus the output stays high.

Enter now the entry delay and the quiet period controls. Imagine that the alarm has been tripped and the output of IC1c is high. C8 begins to charge via RV2, and C6 via RV3. The settings of RV2 and RV3 will determine which capacitor charges first.

Assume that C8 is charging faster. When pin 6 of IC2b reaches 2/3 supply, pin 4 will go low. This switches on Q2 and thus activates the siren via R23. This gives a soft alarm. The time before this alarm sounds is called the quiet period.

Some time later, C6 will have charged to 2/3 supply and so pin 3 of IC2a will go low, switching on Q3. This gives the full alarm, applying full voltage to the siren and also power to the two relays, RLA and RLB. RLB is configured to latch on, and thus keep power applied to the circuit as well as provide a 'tell-tale' output.

When pin 3 of IC2a goes low, it also starts to discharge C7 (charged previously via D8) via RV4. When C7 has discharged to 1/3 supply, the output of IC1d (pin 11) will go low, which resets IC1c. This will then turn off Q3, the siren and RLA. RV4 thus controls the alarm time.



Basic wiring details for the external alarm wiring, especially the power wiring.

In all cases the alarm can be reset by turning the ON/OFF switch to the mid position, which removes power to the circuit. (The key switch is a break-before-make type, which means that when switching between throws the wiper breaks contact – thus removing power. The switch must be held in this position for approximately 2 seconds, so that the capacitors can discharge.

Now look at the instant input section. This operates in exactly the same way as the delayed input, except that instead of C6 charging slowly via RV3, Q6 shorts out the trimpot and so C6 charges almost immediately - instant alarm!

OUTPUT SECTION: This comprises Q2, Q3, the siren and relays A and B.

When the alarm has been triggered (on the delayed input) pin 4 of IC2b will go low. This turns on Q2, which feeds the siren via R23. This limits the current to the siren so it will only sound quietly. After a short period pin 3 of IC2a will go low. This turns on Q3, which gives full voltage to the siren (via D10), and also turns on both relays.

D13 stops current flowing back into the circuit when the alarm has timed out. D14 and D15 protect Q3 from back EMF from the relay coils, when the current is turned off.

The spare contacts on the relays (RLA/1 and RLB/1) are brought out to the terminals to be used for powering or switching other loads. By placing suitable solder blobs on the voltage terminals of the relays, you can power an external siren, strobe, telephone dialer etc. But note that the more load you put on the battery, the shorter the period it will power the system. See the accompanying diagrams for details of the connections.

The remaining sections to discuss are the panic alarm, the LED flasher and the power supply.

The panic alarm function was tricky to implement, because it had to operate even if the alarm was off. This was accomplished by wiring the panic button in so that when it is pressed power is applied to the circuit via D12. C6 and C7 are also charged (via D11 and D9) to simulate the alarm as if it was just triggered by the instant input. When the alarm sounds power is latched onto the circuit by relay B, as discussed earlier.

The LED flasher is a simple CMOS oscillator using IC2c and driving Q1, which in turn drives the LED. The oscillator works as follows. Initially C13 is discharged so pin 10 of IC2c is high. C13 then starts to charge via R25. When the voltage on the capacitor reaches 2/3 supply the output of IC2c goes low. C13 then starts to discharge, until the voltage reaches 1/3 supply whence pin 10 goes high again to repeat the sequence. C13 could be decreased in value for a faster flash rate, or increased for a slower flash rate.

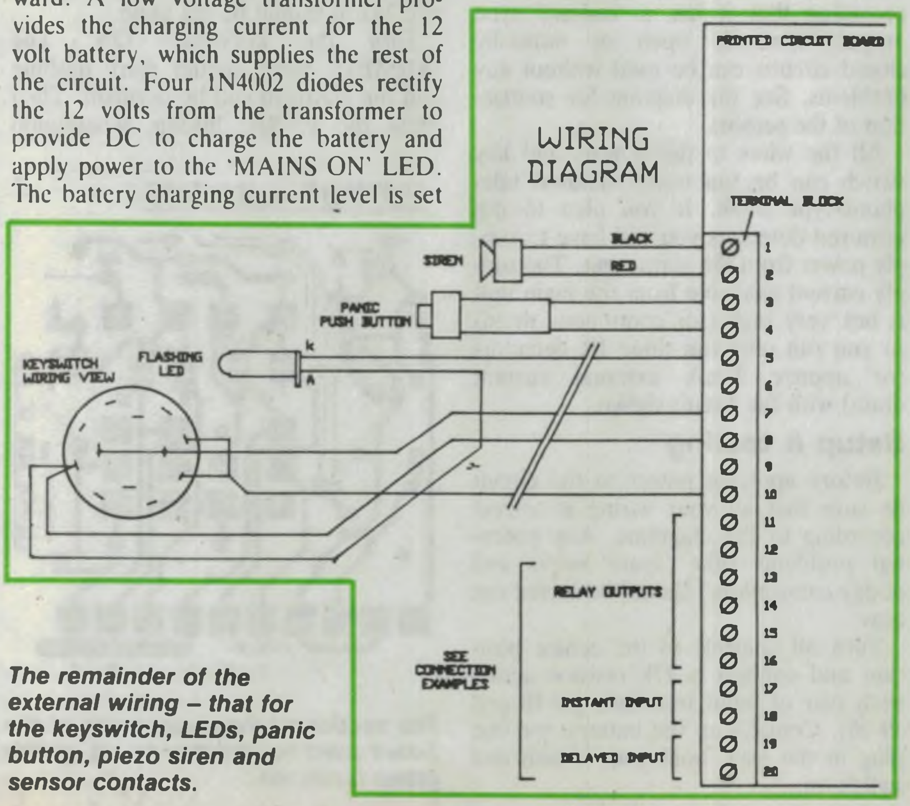
The power supply is fairly straightforward. A low voltage transformer provides the charging current for the 12 volt battery, which supplies the rest of the circuit. Four 1N4002 diodes rectify the 12 volts from the transformer to provide DC to charge the battery and apply power to the 'MAINS ON' LED. The battery charging current level is set by R28. R24 and C12 de-couple the power supply to provide a clean supply for the rest of the circuit. ZD1 protects against any large spikes that may come through the mains, and also to stop the battery from overcharging.

OUTPUT TYPE	LINK OUT	OUTPUT TERMINALS
1, 2 (N/O)	-----	1,2 (4,5 FOR UNLATCHED OUTPUT)
1, 3 (N/C)	-----	1,3 (4,6)
+ N/O 1, − 3	2,8 (6,10)	1,3 (4,6) SIREN, STROBE ECT
+ N/C 1, − 3	3,7 (6,9)	1,2 (4,5)
+, − N/O	7,3 (10,5)	1,2 (4,5)
+, − N/C	8,2 (10,5)	1,3 (4,6)

How to wire the links and output terminals for various functions.

Construction

The first thing you should do before anything else is to check that you have all the parts to do the job. Do a trial assembly, to make sure everything fits and you have all the hardware to mount the battery, the PCB, the wire and, of course, to see where you are going to mount everything.



The remainder of the external wiring – that for the keyswitch, LEDs, panic button, piezo siren and sensor contacts.

The first assembly job is the PCB. Start by looking carefully at the solder side of the PCB for bridged tracks. It is so easy for shorts to occur with these fine tracks.

Start by mounting the smaller components into the PCB. Mount most of the components flat against the surface of the PCB. Proceed then with the higher profile components, leaving the IC's until last. These can either be soldered in directly or mounted in a socket. If you are soldering them in use an earthed tip soldering iron and solder pins 7 and 14 first. Avoid touching the pins, as these devices are static sensitive.

Note that the terminals all clip together before soldering into the PCB. Mount the transformer onto the PCB using the 3mm bolts and nuts, not forgetting to put a solder lug under one of the bolts for the earth connection. Cut the secondary leads to length and then solder them onto the PC pins. Note that the centre-tap is not required, so just cut the blue wire back. That about covers it for the PCB.

Now comes installation into the box. Position the battery and the PCB into the box and mark the holes for the PCB, cable entry, key switch and LED's. Drill all the holes now, as doing it later might be difficult. Obviously, if you want to mount the keyswitch and the LED's separately from the box then the holes for these don't have to be drilled in the box.

Don't forget the power cord and the mains terminal block. Make sure you wire up the mains carefully, using the diagrams as a guide. Any mistakes here could prove to be dangerous or even fatal! The BROWN and BLUE wires go to the transformer's RED and BLACK

House Alarm

wires, while the GREEN wire goes to a solder lug mounted on the transformer.

The completed PCB can now be mounted in the box, using the long bolts and spacers. The bolt comes up through the bottom of the box, followed by the spacer, then the PCB, a shake-proof washer and then a nut. It is easiest to put all four bolts in the box at once.

PARTS LIST

1 mains lead
1 front panel sticker
1 jiffy box 198 x 114 x 63mm
1 12V transformer
1 PCB K1910
1 1.2A/Hr gell cell
1 piezo siren
2 relays 621DO12
1 momentary push button
1 4 pole 2 pos. key switch
4 6mm spacers
1 9mm rubber grommet
2 LED grommets
1 10mm cord grommet
2 14 pin IC sockets
1 2 way PCB term block
6 3 way PCB term block
1 3 way mains terminal block

Resistors

All 1/4W 5%
1 x 220R, 2 x 560R, 1 x 1K, 3 x 2K2, 3 x10K, 4 x 47K, 5 x 100K, 4 x 150K, 1 x 820K, 1 x 1M
1 2R2 1/2W
1 47R 1W
4 300K 1/4W MF
3 1M horiz. MNT trimpot
1 2M horiz. MNT trimpot

Capacitors

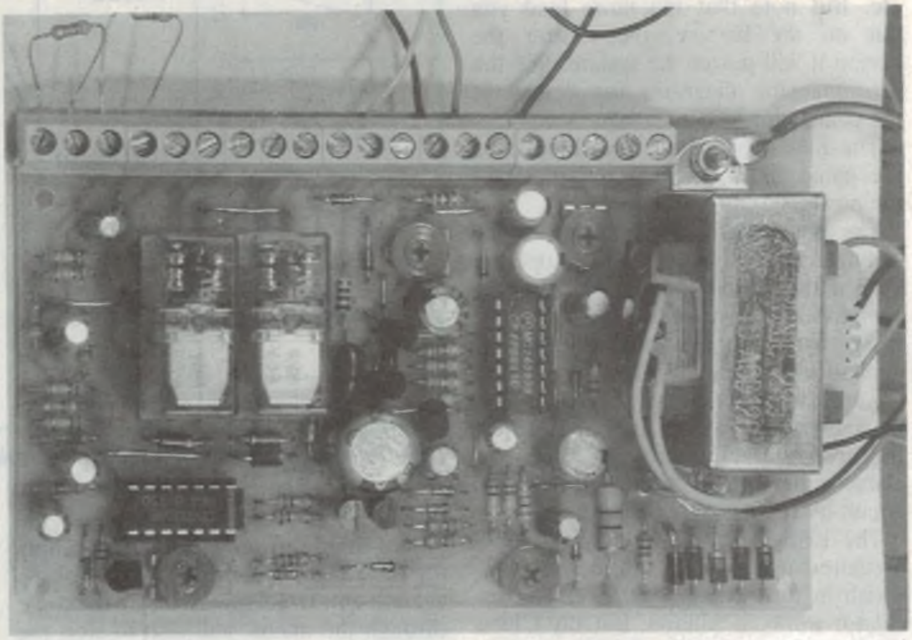
1 0.1uF greencap
6 1uF 16V RB
2 22uF 25V RB
1 33uF 25V RB
2 100uF 16V RB
1 220uF 16V RB
1 1000uF 25V RB

Semiconductors

10 1N914/1N4148 diodes
9 1N4002 diodes
1 red led 5mm
1 green led 5mm
1 15V 1W zener
2 BC 327
1 BC 337
2 BC 548
1 BC 558
1 4030 quad ex-or
1 4030 quad Schmitt nand

Miscellaneous

solder, L/D hookup wire (red, black, yellow), tinned copper, solder lug, nuts/bolts/washers



A close-up view of the alarm PCB, showing all of the components. Note the test resistors connected at the top left-hand corner.

The assembly can now be put aside and your attention turned to installation of the wiring and sensors. This will depend almost entirely on where you put the box and what sensors you use. You can use just about any type of sensor, providing that it has a 'contact' type output; normally open or normally closed circuits can be used without any problems. See the diagram for connection of the sensors.

All the wires to the sensors and key switch can be run using standard telephone-type cable. If you plan to use infra-red detectors you will have to supply power from the alarm unit. The supply current available from the main unit is not very high (for continuous drain) so you can only run three IR detectors (or approx 90mA external current drain) with the circuit shown.

Setup & testing

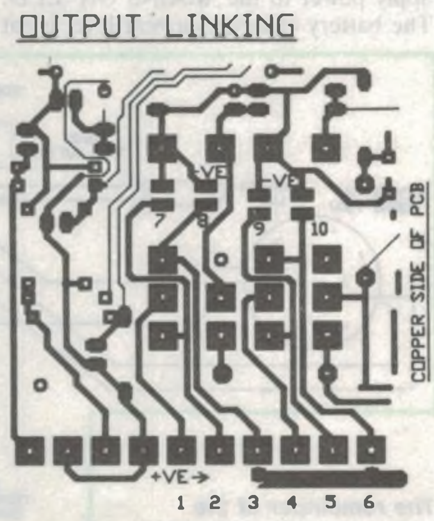
Before applying power to the circuit be sure that all your wiring is correct according to the diagrams. Any potential problems (like 'spare' wires and dodgy connections) should be sorted out now.

Turn all controls to the centre position and connect a 47k resistor across each pair of input terminals (17-18 and 19-20). Connect up the battery, put the plug in the wall, hold your breath and switch on...

No smoke? OK, the 'MAINS ON' LED should be on and the 'ARMED' LED should also be on.

That was phase one. Now you can proceed to check a few voltages. Check the terminal voltage of the battery – it should be around 13 volts. Check the supply voltages on the two IC's (pin 7 and 14), it should be the same.

Turn the keyswitch ON. The 'ARMED' LED should start flashing and the alarm should be dormant. Then press the PANIC button, whereupon



The section of the copper side of the board used for linking, to set up the alarm functions.

both relays should click in and the siren should sound. Turn the keyswitch to mid position for a second to reset the alarm. Then turn the keyswitch OFF and try the PANIC again. The same thing should happen. If you are willing to let the alarm time out, then the alarm should reset and turn itself off.

Try shorting out the instant input. This should have the same effect as the PANIC button (when the alarm has been set). Reset the alarm and try the delayed input. There will be a delay before any sound (set by the quiet period) then the soft warning will come on and finally the main alarm. This total delay is set by the entry delay trimpot. Note that if you set the entry delay shorter than the quiet period, there will not be any soft alarm.

Faultfinding

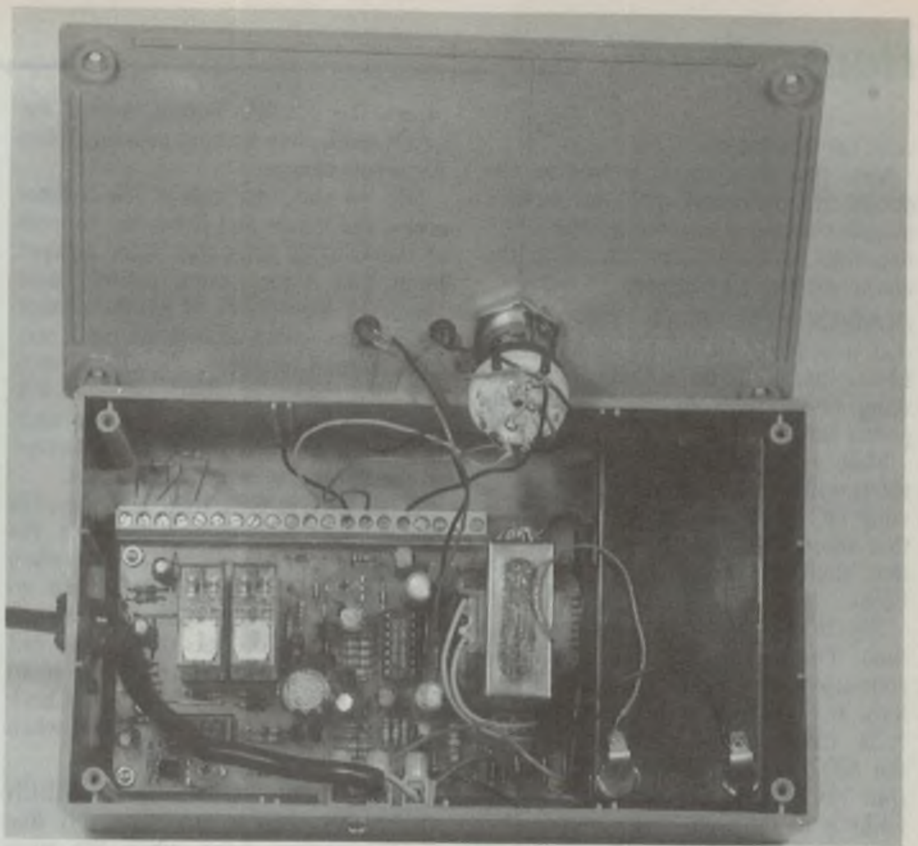
If things haven't gone smoothly as we've just described, pause before you scream "This ?&@%* thing is faulty!" and throw it against the wall. Just remember that 90% of all project problems come from either bad soldering or incorrect wiring!

Go over the PCB and the wiring very carefully, and you might just find the problem. If this reveals nothing, then you have to determine *exactly* what is happening. This will help to pinpoint the problem area.

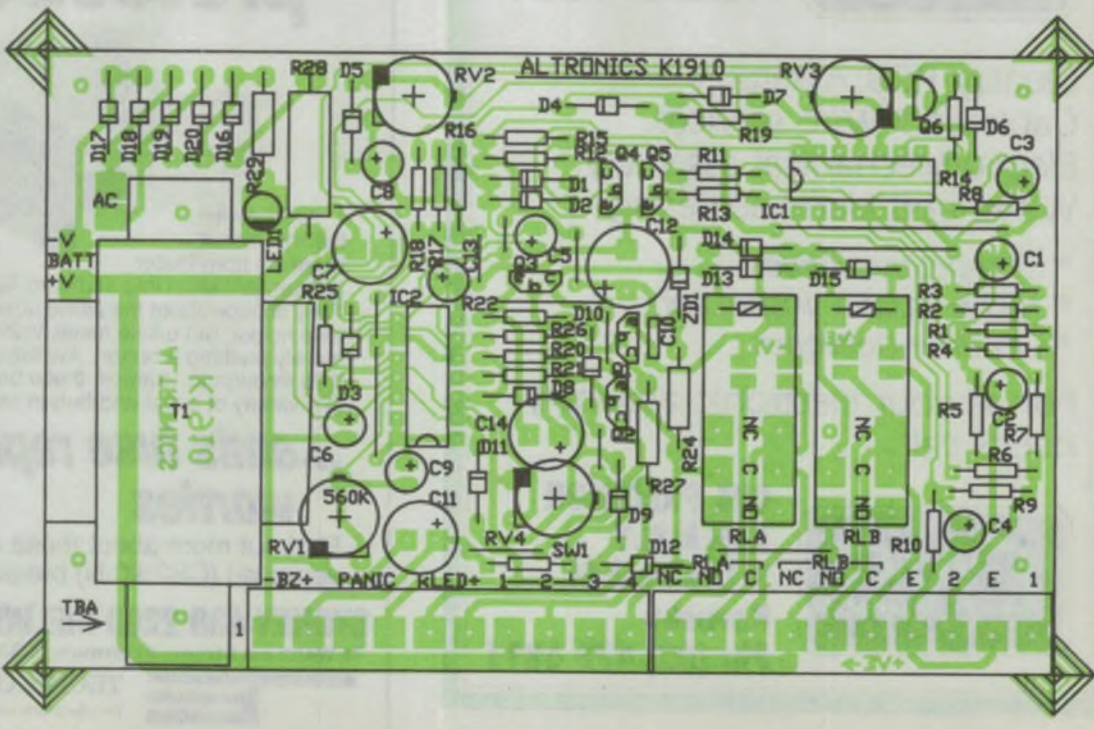
I will give a few examples of possible problem areas. The trick with faultfinding is to be methodical. Check everything stage by stage. Start with the supply voltages and then follow the signal through the circuit, with the aid of the circuit diagram and the earlier part of this article.

All the transistors in the circuit work like switches. When there is zero volts between base and emitter, the transistor will be off and there will be 12 volts between collector and emitter. When the voltage between base and emitter reaches about 0.6 volts the transistor will turn on and the collector-emitter voltage will fall to near zero.

The output from the CMOS gates will be either high or low - i.e., 12 volts or 0



A general view inside the alarm unit case, showing the PCB, keyswitch, 12V gel battery and LED wiring.



The PCB overlay diagram, showing the location and orientation of all of the minor parts. Watch the polarity of the ICs, diodes and electrolytic capacitors.

volts (or close to it).

Note that all voltages shown on the circuit are measured with the meter's negative probe connected to the negative side of the battery, and with the alarm set, but not triggered.

COMPLETELY DEAD: This means that absolutely nothing works – no LEDs, no siren, no nothing. The first thing to is check in this case is the power supply.

Make sure you have 12 volts AC from the transformer. Make sure you have 15 volts DC at the anode of D16. Check that when you turn the keyswitch ON that there is voltage applied to the PCB.

Try to get one thing working at a time. The actual fault description may comprise several different faults. Have a look at the LED flasher circuit around IC2c. Check for 12 volts on pin 9 (of the 4093), check to see if the output (pin 10) is pulsing, check to see if the LED is in the right way around! It is easy to find the fault by process of elimination.

INPUTS DON'T RESPOND: That means the PANIC button works, the LEDs work, but nothing happens when the inputs change.

OK, in this case put a 47k resistor across the inputs and check the outputs of the EX-OR gates (pin 4 for delayed input, pin 3 for instant input); these should be high (12V). If not then check the resistor values around the input section. Note: The outputs should go low if you disconnect or short out the 47k resistor. Check that it is the *anode* ends of D1 and D2 that you have connected to the outputs of the EX-OR gates.

If all that is OK, then it is possible that the exit timer is not timing out. Pin 11 of IC2d (4093) should be low when first switched on, but should then go high after a period of time. The less the resistance of RV1, the shorter the exit time. Check that pin 11 of IC1d (4030) is high (this is the reset signal). Check too that pin 10 of IC1c goes high when the cathode of D1 goes high.

EVERYTHING WORKS UNTIL SIREN GOES ON: This is most probably due to the battery dying when the siren draws current, indicating a flat battery.

Sometimes these batteries won't take a charge if they have been dormant for some time. This can be cured by charging at a high voltage (30 to 40 volts), but with the current limited to 100mA. If you have a current limited power supply, then set the current limit to 100mA and then wind up the voltage to maximum. Put the battery on and leave it until the voltage comes down to 15 volts.

If you don't have a power supply then leave it connected to the circuit for 24 to 48 hours, which will hopefully rectify the problem.

IF ALL OF THE ABOVE FAILS: Go and have a drink, calm down and then re-read the article again from start to finish. With a bit of luck, you'll spot something you've missed, and be able to track down the cause of the problem.

If this still doesn't happen, make as many measurements as possible, and write these down carefully along with a description of what is happening (or not happening). Then send this information to us via the Reader Information Service (accompanied by $4.50), and we'll try to work out what has happened so we can advise how to fix it.

Construction Project:

Automotive Brake Lamp Monitor

Here's the project that won first prize in the Newcomer section of our recent Grand Aussie Hobby Electronics Contest. Low in cost and easy to build, it warns you if your vehicle's brake lamps aren't working as they should – hopefully before another motorist rams into your rear end!

by PETER BOYLE

This project monitors the operation of a vehicle's brake lamps and can alert the driver should a fault occur. It can detect when one brake lamp bulb burns out – or when the whole lot fail to operate. Protection can also be extended to include a trailer or caravan under tow.

The project is easy to install and inexpensive to build, and should work with any car or trailer combination.

Note that although the monitor is connected into the vehicle's brake lamp wiring, it is wired in *parallel* with the brake lights and the operation of these lamps is in no way dependent on its operation. So fitting the project to your vehicle can only improve the safety – there's no risk of the opposite occurring, assuming it's correctly installed.

Listed below are examples of what themonitor does:

1. Brake lamps working correctly – When the brake pedal is depressed, the dash-mounted indicator light will illuminate steadily. When the brake pedal is released the indicator light goes out – signalling the driver that the brake lamps are working correctly.

2. Brake lamp bulb has burnt out – When the brake pedal is depressed the indicator light will illuminate steadily as above. When the brake pedal is released, however, the light does not go out, but locks on and pulsates – so as to caution the driver of a brake lamp fault.

3. When an electrical connector or wire goes open-circuit – The fault will be indicated by the pulsating indicator light as in example No 2.

4. If there is an intermittent fault, i.e., a loose wire – The monitor will switch between the fault and good test mode in response to the occurrence of the fault. It will do this because the monitor continues to test the brake lamp circuit even when the device is tripped in to the fault mode.

5. When a brake lamp fuse blows – A blown fuse will be more readily apparent, as the indicator light will not illuminate at all.

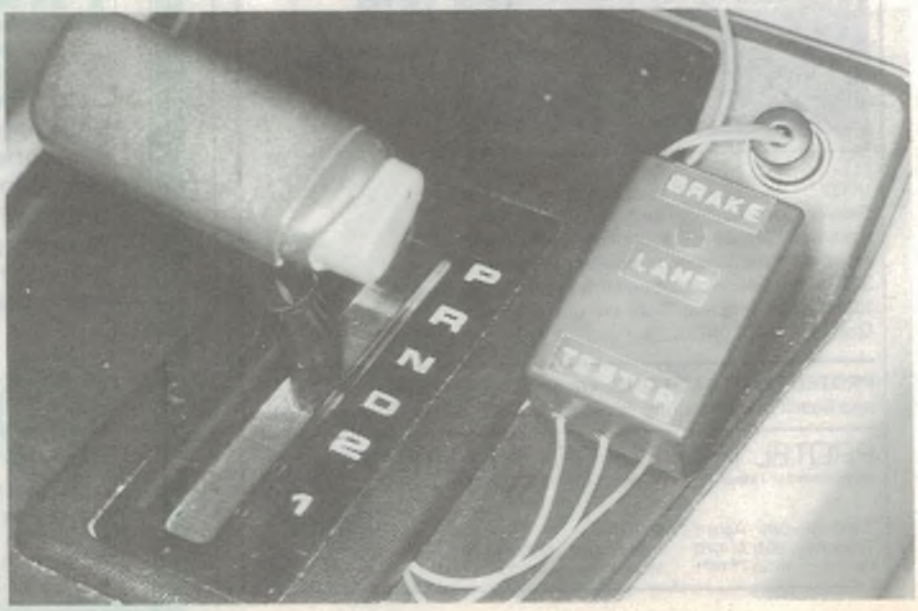
Incidentally a kit of parts for this project will be available from Dick Smith Electronics, which sponsored the Grand Aussie Hobby Electronics Contest.

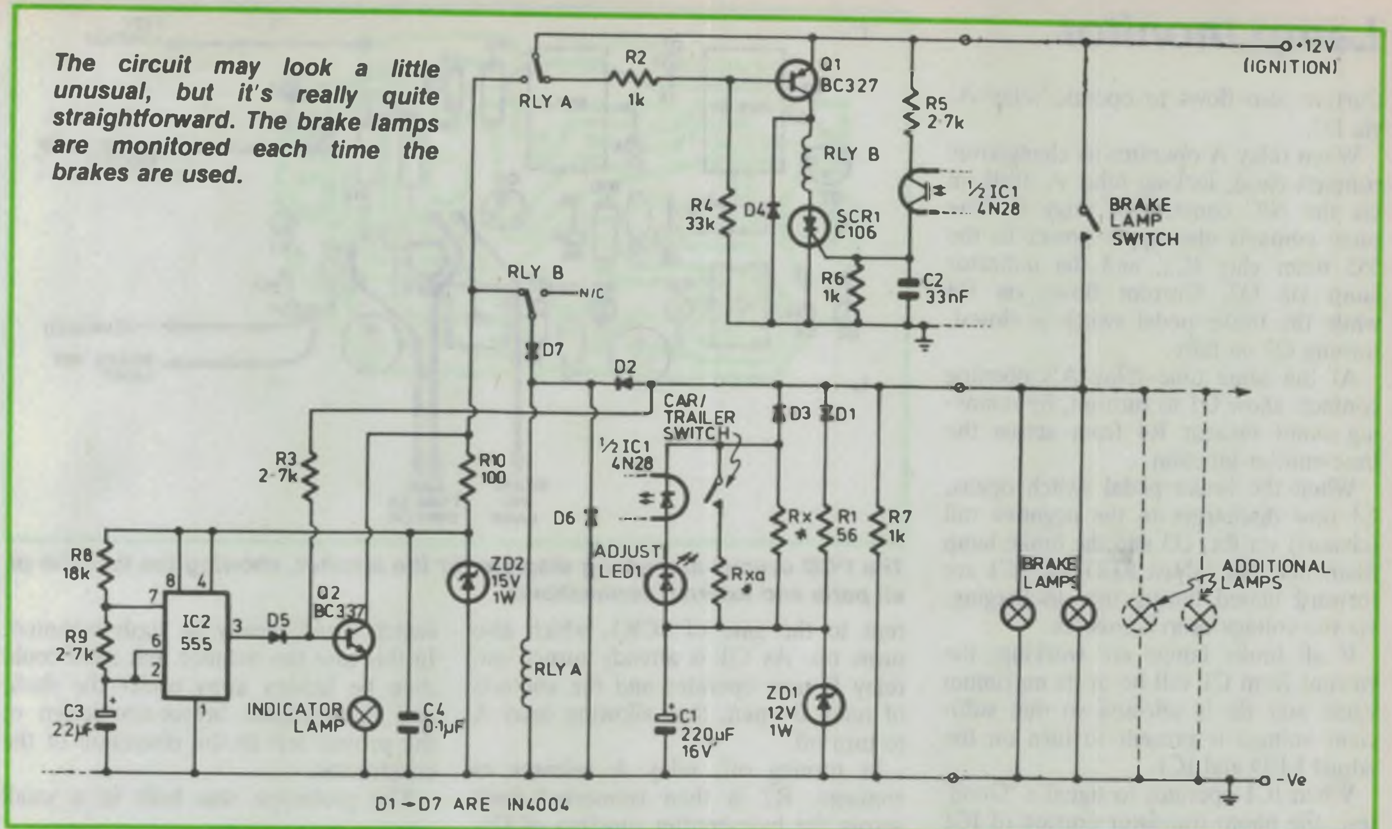
How it works

The principle of operation is based entirely upon Ohm's law. Essentially the brake lamp monitor measures the resistance and the continuity of the brake lamps and the associated wiring.

The resistance measurement is made by discharging an electrolytic capacitor (C1) through the brake light circuit, at the moment the normal brake light switch opens. This means that the test is made while the lamp filaments are still white-hot, so the positive temperature coefficent of resistance, which the lamp filaments exhibit, is used to maximum advantage.

Brake lamps are wired in parallel, so





The circuit may look a little unusual, but it's really quite straightforward. The brake lamps are monitored each time the brakes are used.

in effect when all the lamps are working the resistance of the brake lamp circuit will be its lowest. Therefore when C1 discharges, maximum current will flow into this circuit and a proportional voltage will appear across resistor Rx, which is also in series.

When C1 discharges it applies a forward bias to the 'adjust' LED and the infrared emitting diode of optocoupler IC1. The value of Rx is so selected that the maximum current flow will turn on the LED and IC1. When IC1 turns on (the moment after the brake pedal is released) this signal is interpreted as a 'good test' by the brake lamp monitor.

When one or more lamps go 'open', the resistance in the brake lamp circuit will be higher, and less current will flow when C1 discharges. Less voltage will now be present across Rx, and if the value of Rx is properly selected neither the LED nor IC1 will turn on. In this instance the monitor will receive a 'Bad test' and the circuit will lock into the fault mode.

The purpose of the 'adjust' LED in series with the infrared diode portion of IC1 is to make it easy to select the correct value of Rx. Very fine adjustment of the 'Detect' circuitry is possible with the aid of this LED, without the need for other test instruments. The series LED also serves to raise the potential needed to operate IC1.

Viewed in dim light, the adjust LED can be seen to operate when the brake pedal is released (in sync with IC1) and this indicates a 'good' test. When a brake lamp bulb is removed from the circuit, the adjust LED should not be seen to operate and this is a 'bad' test of the fault trip circuit.

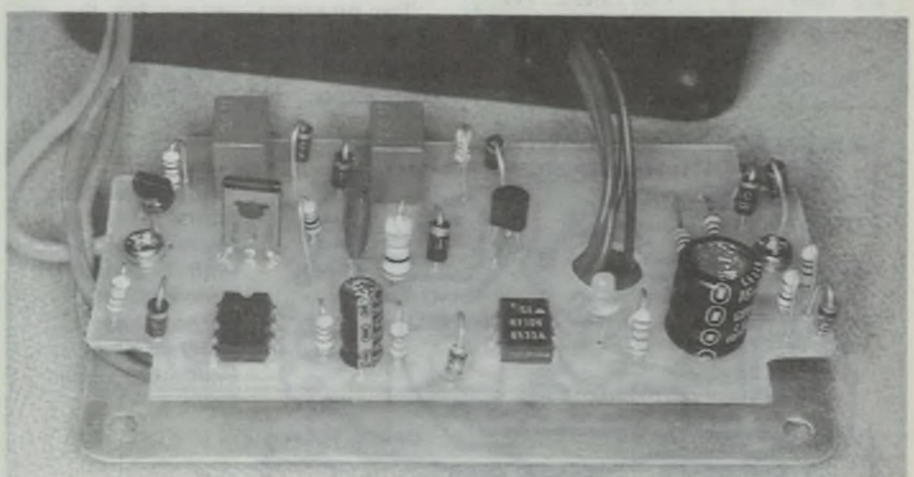
Increasing the value of Rx makes the adjust LED appear brighter. Decreasing the value of Rx makes the operation of the LED appear fainter, and this increases the sensitivity of the device.

I have found that the value of Rx is not particularly critical and the correct value of resistor(s) is not difficult to find. Note that the 'car/car + trailer' switch SW1 is to allow the value of Rx to be set for the appropriate values when the car is used alone, or fitted with a trailer and additional brake lamps.

Table 1 shows the approximate values for Rx corresponding to various combinations of brake lamps.

In more detail

When the brake pedal is applied the brake light switch closes and current flows to operate the brake lamps. Current also flows to charge C1 via D1 and R1. ZD1 regulates the charge on C1.



Close-up of the author's prototype, mounted on the lid of the zippy box. The PCB pattern published overleaf is very similar.

Lamp monitor

Current also flows to operate relay A, via D2.

When relay A operates its changeover contacts close, locking relay A itself on via the N/C contacts of relay B. The same contacts also apply power to the 555 timer chip IC2, and the indicator lamp via Q2. Current flows via R3 while the brake pedal switch is closed, turning Q2 on fully.

At the same time relay A's opening contacts allow Q1 to turn on, by removing shunt resistor R4 from across the base-emitter junction.

When the brake pedal switch opens, C1 now discharges to the negative rail (chassis) via Rx, D3 and the brake lamp filaments. The adjust LED and IC1 are forward biased during this discharging, via the voltage drop across Rx.

If all brake lamps are working, the current from C1 will be at its maximum value and Rx is selected so that sufficient voltage is present to turn on the adjust LED and IC1.

When IC1 operates to signal a 'Good' test, the photo transistor portion of IC1 will turn on. This transistor applies current to the gate of SCR1, which also turns on. As Q1 is already turned on, relay B now operates and the contacts of relay B open, thus allowing relay A to turn off.

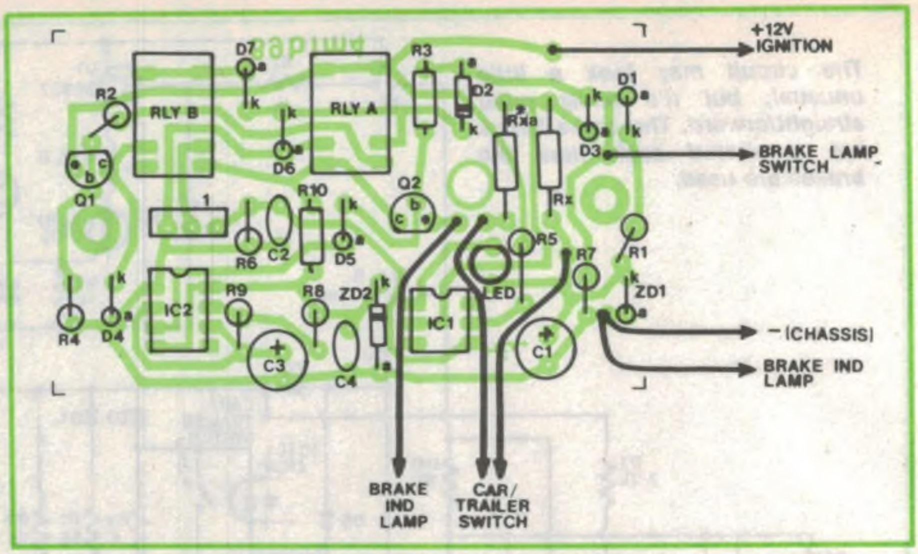
In turning off, relay A releases its contacts. R2 is then connected back across the base-emitter junction of Q1, turning it off again. This also causes relay B to release, and turns off SCR1 as well. At the same time the positive supply is removed from IC2, Q2 and the indicator light.

If a brake lamp bulb burns out, or a similar problem exists, the adjust LED and IC1 will not turn on when C1 discharges. So after the brake pedal is released, SCR1 and relay B are not tripped on, so a 'Bad' test is indicated to the driver by the indicator light, which will lock on and pulsate to signal a brake lamp fault.

Construction

The prototype pictured has the car/car + trailer switch SW1 and the indicatorlight mounted on the project case for convenience, although the lamp and switch could ideally be dash mounted. In this case the monitor unit itself could then be hidden away under the dash, and the ultimate layout-size-design of the project left to the discretion of the constructor.

The prototype was built in a small



The PCB overlay and wiring diagram for the monitor, showing the location of all parts and external connections.

TABLE 1

Brake lamp combination	Value of Rx,Rxa
2 x 21W	1.8Ω, –
4 x 21W	1.8//1.8Ω, –
2 x 21W + 2 x 18W*	1.8Ω, 2.7Ω
4 x 21W + 2 x 18W*	1.8//1.8Ω,2. 7Ω

* On trailer

PARTS LIST

1 Zippy box, 83 x 54 x 28mm
1 PC board, 80 x 48mm, code 89/blm3
2 SPDT relay, 12V PCB mounting
1 SPST switch – slider or toggle
1 Brake indicator lamp and bezel (optional)

Semiconductors

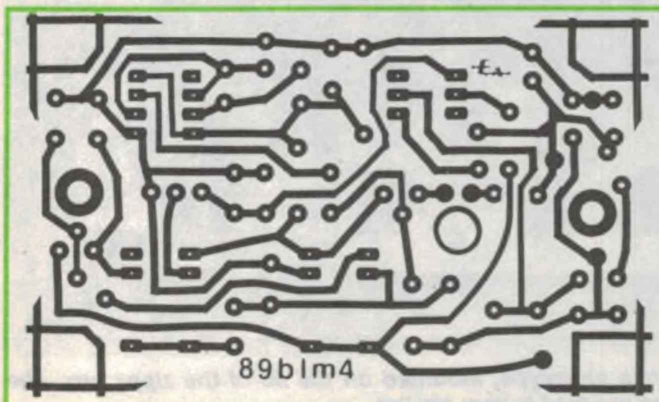
7 1N4004 or similar diode
1 12V 1W zener diode
1 15V 1W zener diode
1 C106D SCR
1 BC327 transistor
1 BC337 transistor
1 4N28 optocoupler
1 555 timer IC

Resistors

All 5% 1/4W: 1 x 56 ohms, 1 x 100 ohms, 3 x 1k, 3 x 2.7k, 1 x 18k, 1 x 33k.
(Rx and Rxa selected from Table 1)

Capacitors

1 33nF metallised polyester
1 0.1uF metallised polyester
1 22uF 16VW PCB type electro
1 220uF 16VW PCB type electro



The PCB pattern, actual size for those wishing to etch their own. Note that all corners are notched to fit inside the zippy box.

UB5 'zippy' box, measuring 83 x 54 x 28mm. All of the parts except for the indicator lamps and switch SW1 are mounted on a small PC board, measuring 80 x 48mm overall (and now coded 89/blm3).

A full-size pattern for the PCB artwork is reproduced here, for those who wish to make their own. A wiring overlay diagram is also provided, along with a close-up picture of the assembled PCB, to guide you in wiring it up.

Assembling the parts on the PCB is quite straightforward, despite its small size. As usual, it's a good idea to mount the resistors and capacitors first; note that most of these are mounted on end, as are all of the diodes.

When you mount the diodes, make sure you fit these the correct way around. The same applies to the electrolytics, the two transistors, the SCR, the adjust LED and of course the two ICs. There's no real option with the two relays, which can only be fitted the one way around!

The assembled PCB mounts inside the lid of the zippy box, supported by two machine screws and 6mm long spacers. The wires for the connections to the vehicle wiring are brought out at one end of the PCB, while those for the brake lamp indicator and the car/car + trailer switch SW1 are taken via the hole near the centre.

When the unit is finished, check everything over carefully before connecting it into the vehicle. A car or truck battery can supply a great deal of current in the event of a fault – enough to vapourise a diode or transistor!

Installation

The monitor has only three connections to the vehicle's wiring, and these are:

1. The 12V positive line from the ignition switch, which can usually be picked up from a point such as the back of the accessory socket.

2. A connection to the brake lamps side of the brake lamp switch, which is usually located in the cabin, above and in mechanical contact with the brake pedal itself.

3. The negative/chassis side of the vehicle's 12V battery. This can again be picked up from the accessory socket, or by fitting a solder lug underneath a convenient self-tapping screw mounted into the vehicle metalwork.

The only adjustments which may need to be made when the monitor is installed in the vehicle are to fine-tune the value(s) of Rx, for optimum operation.

Basically the correct value for Rx is where the 'adjust' LED illuminates when the brake pedal is released, with all of the car's brake lamps intact and connected into circuit. If one of the brake lamps is removed, however, the LED should not illuminate. (Note that the LED will need to be viewed in dim light, to check this.)

Increase the value of Rx to make the LED illuminate more brightly or reliably, or reduce it if the LED continues to illuminate when a lamp is removed.

You'll only need to worry about switch SW1 and the additional shunt resistor Rxa if you have a trailer which is connected to your car or truck on occasion. The value of Rxa is again selected so that the adjust LED illuminates when the brake pedal is released, with all brake lamps for both car and trailer in circuit, but doesn't illuminate when one lamp is removed.

Note that Rx itself is used to set the circuit for the car's own brake lamps, while Rxa is used to compensate for the additional lamps used on the trailer. Once Rx is set for the car, don't change its value to allow for the trailer lamps.

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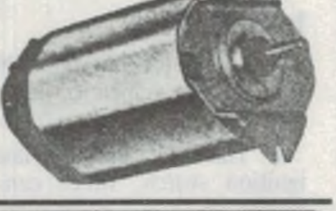

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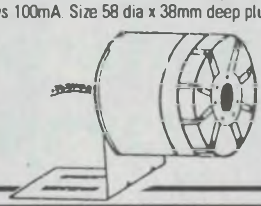

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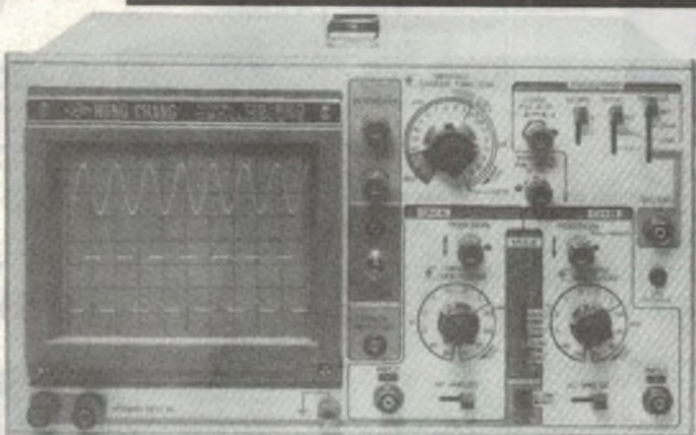

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Ref: Silicon Chip Feb. '89

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 490(H) x 303(W) x 290(D)mm. FOR FURTHER INFORMATION SEE OUR 1989 CATALOGUE - AVAILABLE NOW!

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KIT'S COLUMN

Hi Guys!

Well, the catalogue's been out for a month now and judging by how busy we have been you like it!

Please keep up the mail orders. While we are getting lots of mail the boss leaves me alone. (There's nothing the boss likes more than looking at the mail in the morning. I mean it!)

Anyway, we got back from Melbourne O.K. He hasn't been back since. As a matter-of-fact he's been at work a fair bit lately. Must'nt have had any better offers . . .

Nylon Knickers. You wouldn't believe this, but the other day the boss came in with a box FULL of cotton undergarments. Knickers to be precise. You should have seen them! He must have bought them from a Famine Relief Opportunity shop! He handed them out to all of us in kits, mail orders and the warehouse. ALL the ladies in the place got two pairs. (At least he didn't insist on fitting them on us).

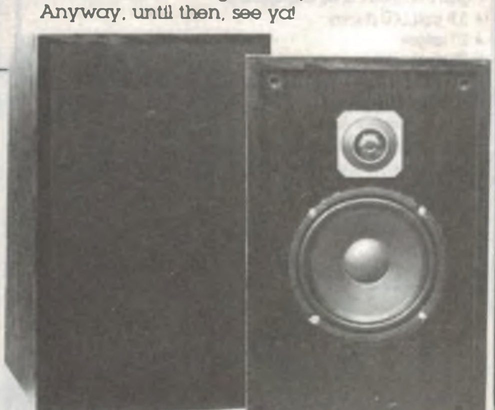
He had been reading a report in the Sydney Daily Mirror (Feb 8, 1989) which claimed that nylon knickers could generate up to 20,000 volts! All he could think about was the micro-zaps that we could give to his microchips. Thankfully most of the ladies told him where to stick his knickers. If they were going to get company 'Reg Grundies' they had to be silk and RED. That slowed him down.

He is now seen spraying anti-static everywhere. Not a stray volt to be seen. I still get a charge out of working here though!

NEW KITS. April is a real car buff month. There's the Auxiliary Brake Light Flasher (ref: Silicon Chip April). It will drive a rear parcel shelf mounted brake light and cause it to flash when you hit the anchor. Great at $17.95 - but it doesn't include the light! And the two Electronics Australia kits for April. One is a Brake Lamp Monitor. This gadget warns you if your brake lights have blown. Only $24.95 - cheaper than getting booked! And the other project turns your multimeter into a tacho/dwell (whatever that means) meter. Helps keep your car in tune. (I wonder if it works on old boyfriends?) See our ads for more info!

Finally, I'm sorry to say it but this will be my last column for a while. The boss has decided to use this space to flog more products. (I really think he doesn't like being told on).

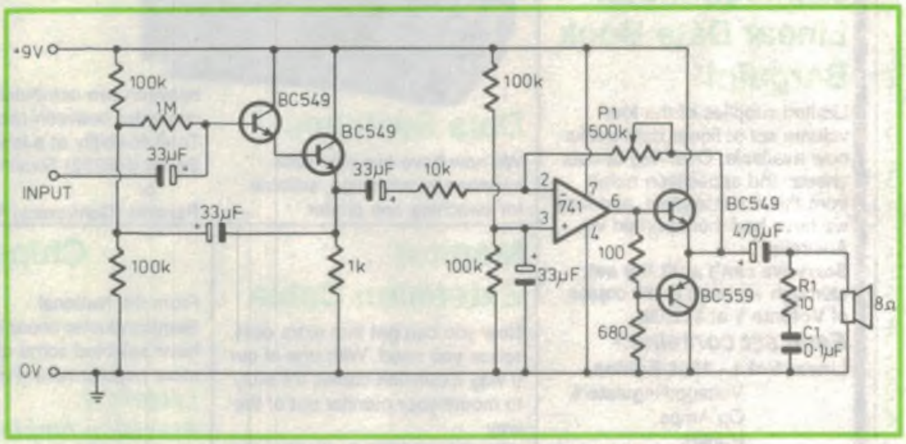
Anyway, until then, see ya!



Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible, the circuits have not been built or tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide construction details.

High impedance amplifier



This simple circuit will produce approximately one watt of power when connected to a 9V power source. The advantage of this circuit is that it uses a bootstrapped Darlington pair to boost the input impedance to about 20M ohms, making it ideal for high impedance signal sources. A volume control is provided on the main section of the amplifier by way of the inverting op amp and RV1.

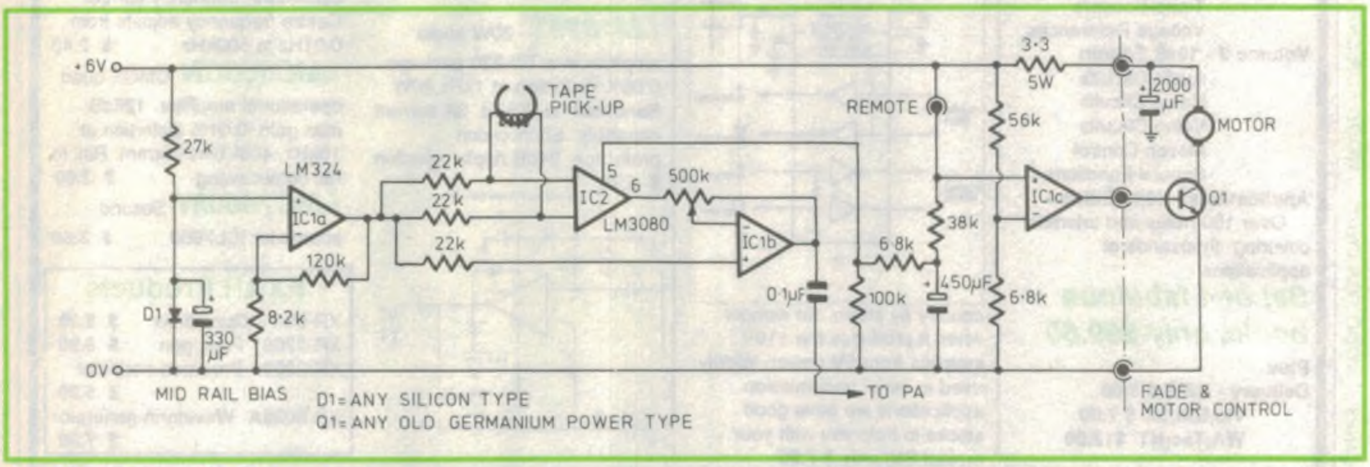
Unlike many designs, this allows the input impedance to remain constant at 20M, regardless of the setting of the volume control.

The circuit components are all cheap, easy to find parts, and shouldn't cost more than about $4 to buy, (excluding speaker). The output transistors are BC549 types, requiring the user to keep the volume at a level below distortion to ensure the current level through the transistors doesn't exceed 100mA.

The output section has a Zobel network, consisting of R1 and C1. This is to reduce oscillation at high gain. The output section itself is quite simple, consisting of an op amp driving a complementary pair. Construction is not critical, although lead lengths at the input should be kept as short as possible due to the high input impedance.

Darren Yates,
Frenchs Forest, NSW.

$25



Tape fader

A special tape player was required to play incidental music over a PA system before and after our weekly meetings. Available players were unsatisfactory, requiring obtrusive manual fade out, accompanied with a crashing switch off, or an abrupt remote pause leaving the running tape motor roaring into the PA during the speaker's address.

Because of this, an old tape player was modified by removing its electronics and fitting the circuit shown. The circuit was developed on a breadboard, and works well. The machine is switched off by the remote switch, which causes the music to die away gently without distortion over a 10 second interval, after which the motor stops. At the conclusion of the speaker's address, the player is switched back on, which first restarts the motor then causes the music to resume without any wow.

The main difficulty was eliminating the motor generated noise, which no amount of bypassing with capacitance could completely eliminate. An earth loop was partly to blame, so Q1, the 2000uF capacitor and the 3.3 ohm resistor were exiled to a small board mounted on the motor. All earths were run to the one point as well.

However, this did not completely solve the problem, which was traced to motor noise finding its way onto the power supply lines. Originally, the op amp inputs were biased to mid rail with a voltage divider, but the motor noise, despite filtering was sufficient to be obtrusive after passing through the amplifier network of IC1. IC2 was not affected due to its CMMR.

The biasing was changed to the 27k resistor and diode D1, bypassed with the 330uF capacitor. The voltage across D1 is amplified by IC1a to give a ripple free 3V, which is then applied to the three 22k resistors.

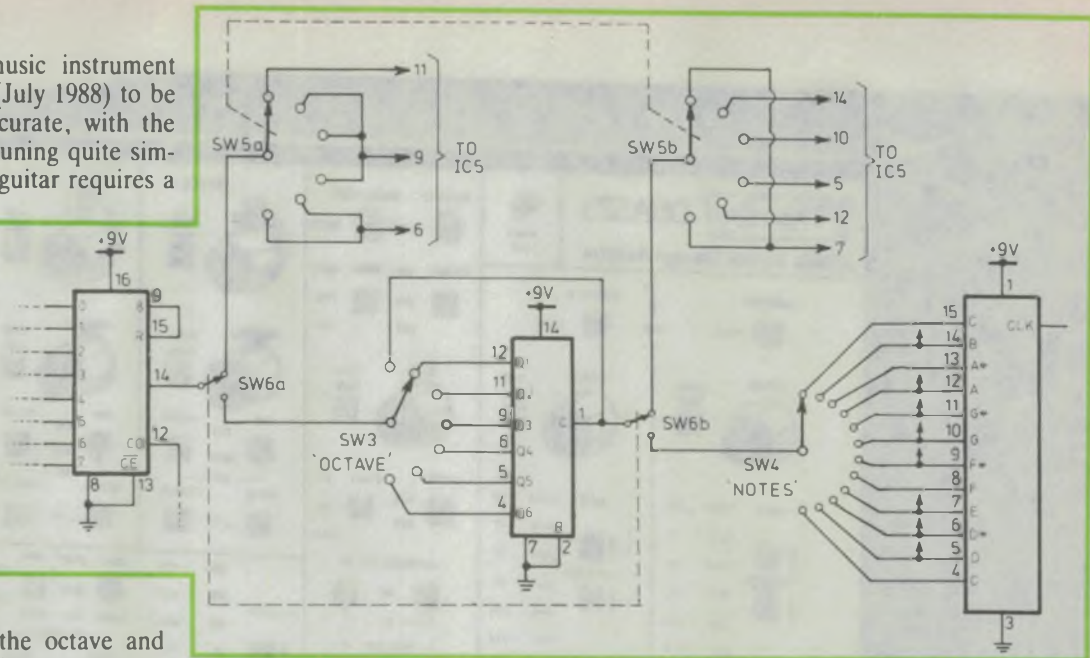
The end result is virtual silence, except for a small amount of hiss which no one has noticed anyway.

Jim Morphet,
Rosebud, Vic.

$40

Guitar tuner

I have found the music instrument tuner presented in *EA* (July 1988) to be both innovative and accurate, with the rotating LEDs making tuning quite simple. However, tuning a guitar requires a fair bit of twiddling of the octave and note switches, so I decided to add two extra switches to select the standard E, A, D, G, B, and E notes required in guitar tuning.



The modifications are as follows: Cut the track from pin 14 of IC3, and cut the track between the common terminals of SW3 and SW4. Connect a DPDT switch (SW5) so that one common goes to pin 14 of IC3, and the other common goes to pin 1 of IC4. Next connect SW5 as shown on the circuit diagram so that one position of the switch puts the circuit back to original, and the other connects SW6 into circuit.

The bridges shown on SW6 should be connected, then wires taken from the switch terminals to connect to IC5. These wires are best connected to SW4, rather than at the actual IC pins. The numbers represent the IC pin number for IC5 that the wire must connect to. Finally, mark SW5 as selecting either instrument or guitar, and mark SW6 as E, A, D, G, B, E.

R.W. Kemp,
Loxton, SA.

$25

Dreamed up a great idea?

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.

Joystick auto-fire

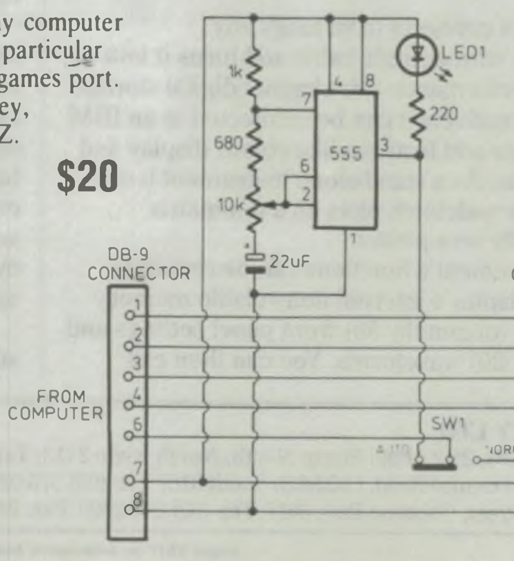
This simple device is a variable speed joystick auto-fire. The basic circuit consists of a 555 timer configured as an oscillator, producing a square wave of between 2 to 24Hz, depending on the setting of the 10k potentiometer. The LED has been included to indicate the speed of the oscillator, and operates with SW1 in either position.

Construction is simple with the components being mounted on stripboard, and then fitted into a plastic case with the LED, potentiometer and switch mounted on the front panel.

The completed circuit can be connected to the computer by fitting a 9 pin D connector to each end of the circuit and connecting the whole assembly in series with the joystick. The circuit is for Commodore 64 type computers, the Vic 20 and any computer that uses this particular format for its games port.

Aaron Spinley,
Auckland NZ.

$20



Pin	Function
1	UP
2	DOWN
3	LEFT
4	RIGHT
5	—
6	FIRE
7	+5V
8	GND
9	—

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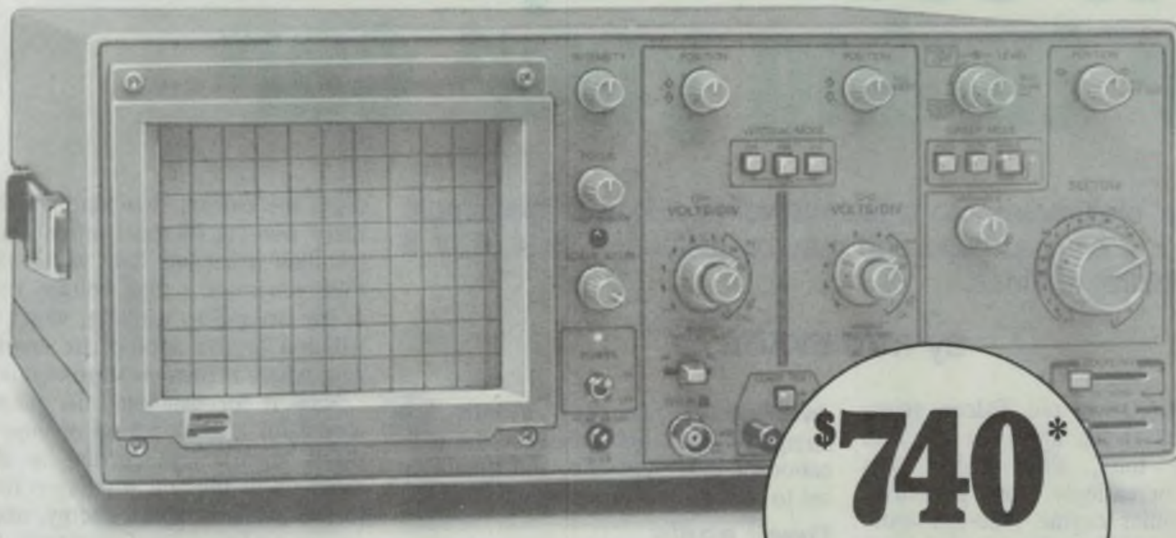

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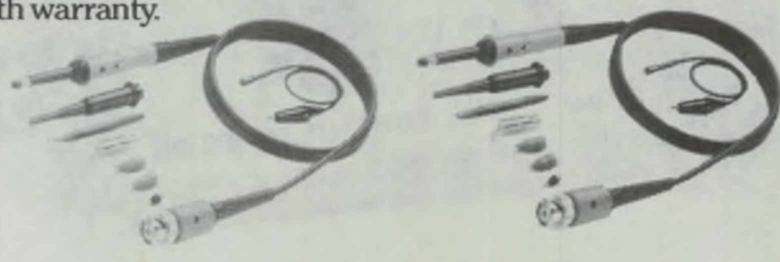

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Construction project:

Low cost Adaptor for tuning your car

Turn your multimeter into a tacho/dwell meter with this simple adaptor. It's easy to build and may be calibrated for 4, 6 or 8 cylinder petrol engines.

By ROB EVANS

When the trusty old Falcon (circa 1971) stalled at the lights for the fifth consecutive time, this project was becoming increasingly more attractive. Clearly, regular engine tune-ups avoid this kind of embarrassment and save on fuel costs. However, it is no longer sufficient to cross the local mechanic's oil stained palm with silver for this service – large notes are required!

Fortunately, the problem has been virtually eliminated for cars built in the last few years, by the use of fully electronic ignition systems. These eliminate the mechanically driven contact breaker (points) of the traditional Kettering arrangement, which tend to become burnt, pitted and out of adjustment in a short time.

But in reality, a very large proportion of vehicles on the road still use the basic Kettering system. Most four wheel drives for example retain this system, in (ironically) the interests of reliability. This is because when you are 'out bush' the basic system may be repaired by 'a piece of fencing wire and a beer can', whereas a dedicated semiconductor is a little more difficult to find. So for many motorists, regular engine tune-ups and the expense involved are a fact of life.

The alternative to booking your car in for an expensive service however, is to gather together a few basic tools, a tacho/dwell meter, and do it yourself. A tacho/dwell meter is quite a simple instrument, which provides a readout of the important electrical parameters for engine tuning.

The tacho (tachometer) function of such an instrument will provide a readout of engine revs, which should be known for adjustments such as ignition timing and carburettor tuning. The dwell (angle) reading is a little less straightforward, but is basically an indication of the points gap, and should be set to the manufacturer's specifications.

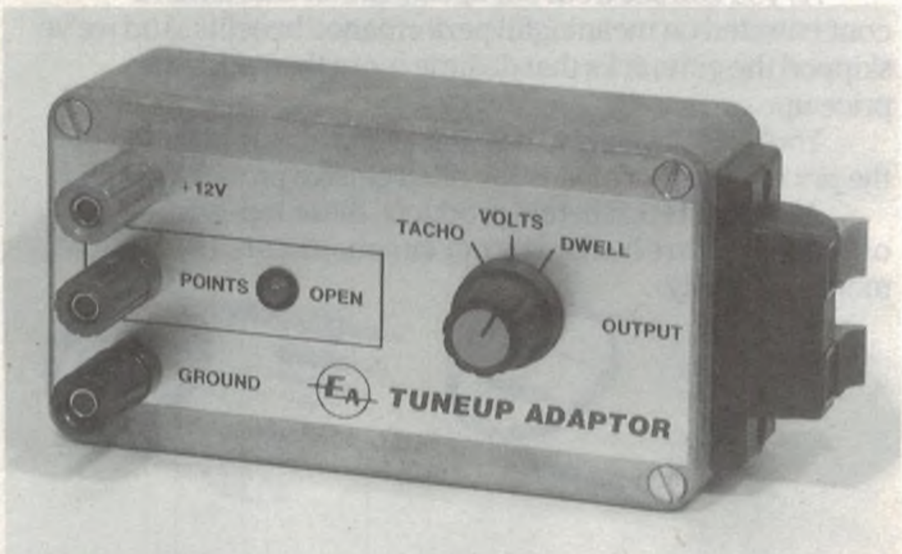
Dwell angle

This slightly odd expression is exclusive to the automotive industry, and is defined as the angle through which the distributor shaft rotates while the points are closed. That is, in electronics terms it's a measure of the points' duty cycle. The importance of this figure may be seen by studying the electrical relationship between the points and the ignition coil.

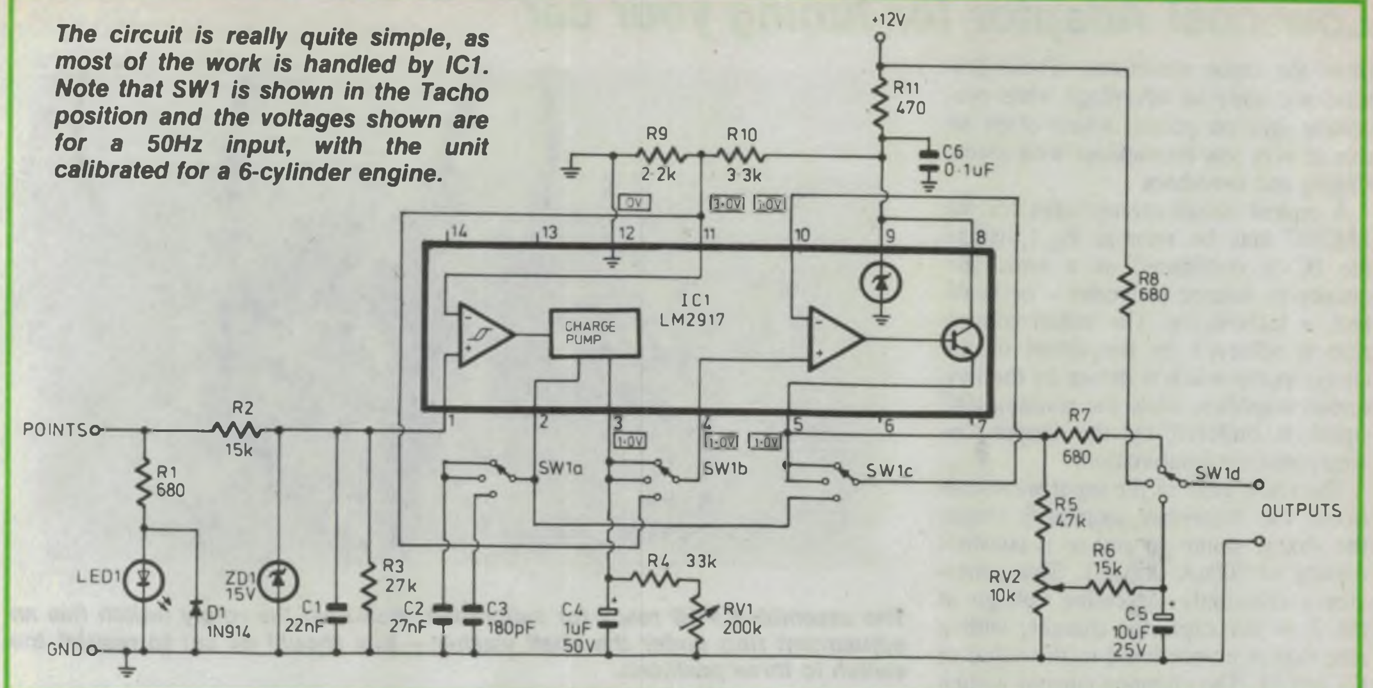
The standard (Kettering) ignition system uses a lobe on the distributor shaft to force the normally closed points open at regular intervals, which in turn interrupts the current flow through the primary winding of the ignition coil. The resultant collapsing field within the coil then generates a high voltage transient in the secondary winding, which is distributed to the appropriate spark plug gap, where it fires the air/fuel mixture.

Now if for example, the points are closed for a short period of time (small dwell angle), less current is able to build up in the coil winding – resulting in less available spark energy, and poor engine performance. Conversely, a large dwell angle means that less time is available (when the points are open) for the collapsing field to dissipate its energy. The interruption of this natural decay tends to cause severe arcing and pitting of the points and again, poor performance.

So the dwell angle, which is set by adjusting the points gap, is fundamental to the correct operation of an ignition system. In fact when attempting an engine tune-up, establishing the correct points gap or dwell angle should always be the first step.



The unit may be permanently installed into the engine bay and hard-wired to the ignition system, or used as a portable test instrument with flying connector leads.



The circuit is really quite simple, as most of the work is handled by IC1. Note that SW1 is shown in the Tacho position and the voltages shown are for a 50Hz input, with the unit calibrated for a 6-cylinder engine.

Design and features

A number of tacho/dwell meters have been described in the past. These ranged from designs with a couple of IC's driving a moving coil meter, to fully blown units with elaborate signal processing and digital displays. Unfortunately, the cost of the display (be it digital or analog) has driven the price of these units up to an unacceptably high level, negating one of the prime advantages of doing-it-yourself.

However, the ubiquitous multimeter offers a very convenient solution to the problem. If a tacho/dwell circuit is arranged to simply convert the ignition signals to an appropriate DC voltage, the multimeter may connected to the output as a final readout. So this is the basis of the EA Tuneup Adaptor, and by using this method we have been able to keep the cost of the unit to a very low level. In fact, the case is the most expensive item in the parts list.

Another slightly unusual aspect of the Tuneup Adaptor is the addition of an indicator LED (and dropping resistor), which is wired across the points connections. This simple addition presents an insignificant load to the ignition circuit, yet is quite handy for emergency situations where the action of the points must be known – but more of this later.

When using the Tuneup Adaptor, a single rotary switch chooses between the tacho and dwell operation, with the middle 'volts' position selecting the +12V rail. This setting is useful for assessing the condition of the vehicle's battery and charging circuit.

The basic concept of this design is for the unit to be permanently installed in the vehicle's engine compartment, and the multimeter attached when the occasion calls for a tune-up. While this makes the operation very simple, there is no real reason why the Tuneup Adaptor cannot be used as a portable instrument and plugged in at will.

The actual circuitry of the Tuneup Adaptor could have been arranged in many different ways, for there is no shortage of suitable circuits. But in the interests of simplicity and reliability, we settled on a single chip solution based around the popular LM2917 frequency to voltage converter.

The LM2917

This function block from National Semiconductors is able to perform frequency to voltage conversions with only a few external components. It offers a wide linear output swing, an internal voltage regulator, variable input reference and high output current capability. Also, this rugged chip is widely available at quite a reasonable price, and is ideally suited to tachometer applications such as the EA Tuneup Adaptor.

The actual circuit of the LM2917 uses a neat frequency doubling technique to achieve a low level of ripple in the DC output signal, and a hysteresis amplifier input stage to ensure reliable triggering

SPECIFICATIONS

General

- May be calibrated for 4, 6 or 8 cylinder engines
- Suits any multimeter with impedance greater than 20k/V
- Compatible with electronic ignition systems

Tacho mode

Range: zero to 6000 RPM
Accuracy: +/-1.5% from 400 RPM to 6000 RPM
Response time: approx 15ms per 100 RPM

Dwell mode

Range: zero to 100 degrees
Accuracy: +/-2% from 10 degrees to 80 degrees
Response time: approx 50ms per 10 degrees

Low cost Adaptor for tuning your car

from the input waveform. These features are quite an advantage when processing ignition pulses, which often arrive at very low frequencies with severe ringing and overshoot.

A typical circuit arrangement for the LM2917 may be seen in Fig.1, where the IC is configured as a basic frequency to voltage converter – or in effect, a tachometer. The actual conversion is achieved by the action of the charge pump which is driven by the hysteresis amplifier, while the resulting DC signal is buffered by the output op-amp/transistor combination.

The rising edge of the input waveform (from the hysteresis amplifier) causes the charge pump to source a constant current of 200uA into C1. This generates a constantly increasing voltage at pin 2 as the capacitor charges, with a rate that is proportional to the value of C1 and I1. The charging current is then terminated by an internal comparator when the voltage at pin 2 has reached 3/4 Vcc.

Similarly, the falling edge of the input waveform causes the charge pump to *sink* a constant 200uA into pin 2, thereby discharging C1 until the voltage falls to the lower preset level of 1/4 Vcc. The resulting waveform at pin 2 is a square wave with defined rise and fall times, moving between 3/4 Vcc and 1/4 Vcc.

During both of these charging and discharging periods, the same amount of current is sourced from pin 3. That is, whenever C1 is charging or discharging, another 200uA current source is enabled which in turn charges C2.

So in effect, a current pulse is delivered to C2 on each transition of the drive waveform, or at double the input frequency. However, between these periods C2 is discharged at a rate as set by R1, causing the voltage to settle at a point where the levels of charging and discharging are in equilibrium.

Since the current pulses are of a fixed period (as set by C1 and I1) the time between each pulse, and the resulting integrated voltage at pin 3, will vary in sympathy with the input frequency. Also, this output voltage will not be affected by the duty cycle of the input waveform, since its *average* duty cycle is always constant and will only vary with the input frequency.

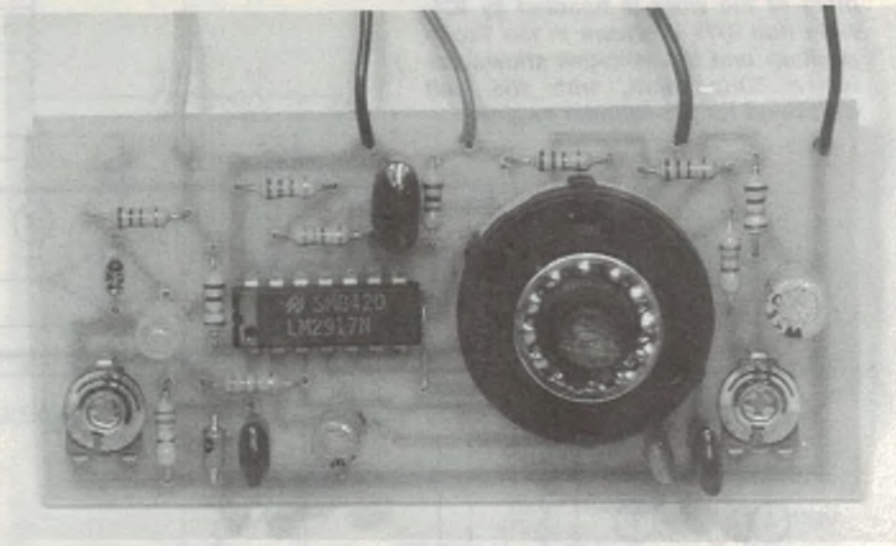
The resulting voltage is finally linked to the output buffer stage via pin 4 of the LM2917. In this case the op-amp is connected as a non-inverting buffer stage, with the output transistor included within the negative feedback loop. This enables the output to accurately sink load currents of up to 50mA.

As may be seen in Fig.1, the power supply for the LM2917 is stabilised by an internal zener diode at pin 9, which is supplied by the dropping resistor Rz. The zener diode will hold the internal voltage of the chip to about 7.5 volts over a wide range of source voltages, maintaining the accuracy and stability of the circuit.

The actual signal received from the points of a traditional (Kettering) ignition system is extremely 'dirty'. It has an undefined leading edge due to the uneven contact surfaces of the points, and severe ringing on the trailing edge due to the dissipation of stored coil energy. This can cause serious problems for some circuits.

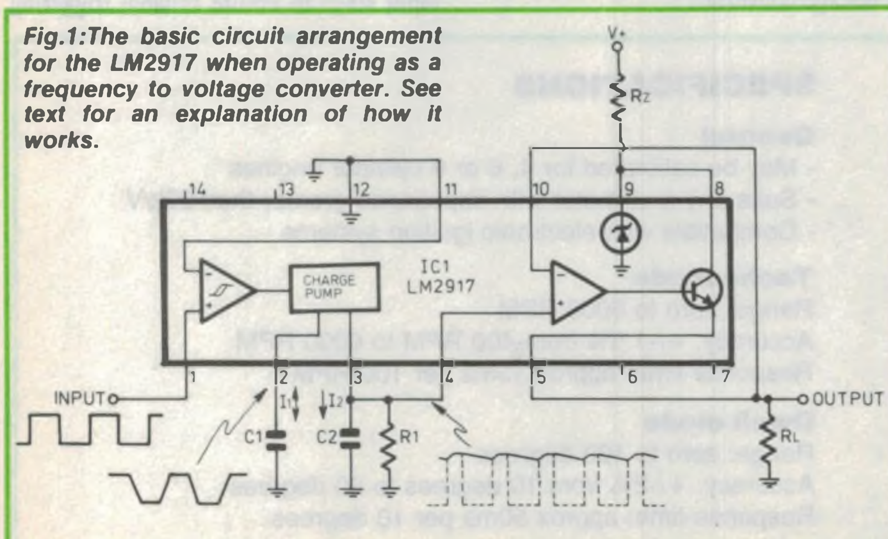
The fixed pulse width required by a tachometer is often generated by triggering a simple monostable stage, and integrating the result as mentioned above. However, this style of tachometer will tend to misread rather badly in realistic signal conditions, due to continual re-triggering of the monostable. However, the charge pump arrangement will maintain readings until conditions are so bad that the engine may not even be capable of running.

To understand this, consider an input waveform with a very ragged leading edge for example. In this case the current source at pin 2 may momentarily switch out of the appropriate charge (source) mode and into discharge (sink)



The assembled PCB ready for calibration. Note that the rotary switch has an adjustment ring under the shaft washer – this should be set to restrict the switch to three positions.

Fig.1: The basic circuit arrangement for the LM2917 when operating as a frequency to voltage converter. See text for an explanation of how it works.



mode. This only causes a 'glitch' on the leading edge of the waveform at pin 2, and finally a matching 'hole' in the coincident charging pulse at pin 3. The end result is a slightly low reading at the output.

In fact, in a practical situation this error tends to be balanced out by the ringing associated with the trailing edge of such an input waveform. This causes a few extra narrow pulses to be generated after the 'trailing edge' charge pulse, which in turn causes a slightly higher output reading.

So there we have the LM2917. It's really quite an elegant solution to the problem of tachometer circuit design. When compared to alternative arrangements, such as generating the fixed pulse width from a monostable, the LM2917 shines in terms of reliability and accuracy.

Measuring dwell

While the LM2917 is ideally suited to tachometer applications, a few circuit changes are necessary for it to operate as a dwell meter.

Contrary to the requirements of a tachometer circuit, a dwell meter must sense only the duty cycle or pulse width of the input signal. In this case, all that we need is a stage to 'square up' the input wave form to a fixed amplitude, and integrate or filter the result. This will produce a DC level that is independent of frequency, yet sensitive to changes in pulse width or in automotive terms, the dwell angle.

To achieve this end, one of the main features of the LM2917, the charge pump, must effectively be disabled. Since the capacitor at pin 2 is charged and discharged at a fixed rate, any reduction in its value will cause a proportional increase in the rise and fall times of the waveform at this point.

So by selecting a capacitor with a very low value, the charge pump becomes a simple squaring stage. The resulting square-wave has a rapid rise and fall time, and may be applied directly to the output stage. However in this situation, the negative feedback around the output op-amp is removed, causing further squaring of the signal and an output swing of the full supply rail.

This produces a 'tidy' low impedance version of the input waveform, which may then be filtered by an RC network to provide a voltage representing the dwell angle.

The circuit

The actual circuit for the EA tuneup adaptor is basically the arrangement as shown in Fig.1, but with added input protection, calibration facilities, and switching for the dwell angle and voltage functions. The function selector switch SW1 is shown in the 'tacho' position.

To prevent excessive voltage transients from damaging the input stage of the LM2917, zener diode ZD1 in conjunction with R2 limits the voltage excursions at pin 1 to between +15V and -0.6V (ZD1 forward biased). R2 also forms an attenuator with R3 and provides input filtering with C1, which reduces any signals above about 500Hz. The ringing produced by the collapsing field of an ignition coil tends to be in the 5kHz to 10kHz region.

The other feature of the input circuitry is the addition of LED1 and its dropping resistor R1. The LED will illuminate when forward biased via R1 and the primary winding of the ignition coil, when the points are open. Also, the LED is protected from any stray reverse voltages by D1.

For typical signals from the points of an ignition circuit, the most reliable switching point for the input amplifier was found to be about 3 volts. This is set by the voltage divider R9 and R10, which biases the negative input of the amplifier (at pin 11) to this level.

The first section of the function switch SW1a selects the appropriate capacitor for the tacho and dwell operations, while the charge pump's output across C4 is controlled by R4 and RV1, the overall tacho calibration.

In the tacho mode, SW1b couples this DC level to the output op-amp's positive input at pin 4. This amplifier/transistor combination is set to unity gain by the negative feedback path completed by SW1c.

In the dwell mode however, the square-wave signal at pin 2 is applied to the inverting input of the output stage via SW1c, while the non-inverting input is switched to the voltage reference at R9 and R10 by SW1b. This stage then effectively becomes an inverting comparator, and provides suitably polarised output at pin 5.

Finally, the output signal is taken to SW1d via an isolating resistor (R7) for the tacho position, or the dwell function's calibration resistors (R5 and RV2) and integrating network (R6 and C5). This section of SW1 alternates the output to the multimeter between the final tacho and dwell signals, and the voltage position which is simply the +12V supply rail via the isolating resistor.

Construction

Assembling the EA tuneup adaptor is quite straightforward. All of the components including the function switch and indicator LED mount on one small

The internals of the Tuneup Adaptor. Note that the lugs of the output connector may need to be bent down, so as to avoid fouling the PCB.

Low cost Adaptor for tuning your car

PCB, measuring 85mm x 40mm. This mounts on the lid of a standard 122mm x 67mm x 40mm diecast aluminium case, although an equivalent (but less rugged) plastic box could be used. However, there is no guarantee that a plastic box will withstand the high temperatures and vibration which may be encountered in an engine compartment. Naturally, it would be fine for portable operation rather than a permanent installation.

Begin the construction by checking the printed circuit board (PCB) for any etching anomalies. Then mount the lower profile components, while paying particular attention to the orientation of polarised components, as shown in the component overlay diagram.

Next, mount the rotary selector switch, with the flattened section of the shaft facing in the appropriate direction for the knob pointer to match the front panel artwork. The LED should be mounted at a height where the lens will just protrude through the front panel.

Before mounting the assembly to the front panel, the banana sockets and the output connector should be wired to the PCB, and the unit tested and calibrated while the components are exposed.

Calibration

The tuneup adaptor may be set up for four, six and eight cylinder engines without changing any components – it's simply a matter of adjusting the two trimpots, RV1 and RV2, which calibrate the tacho and dwell readings respectively. The actual reading required for a given number of cylinders may be calculated from a couple basic facts about motor ignition systems.

Firstly, it takes two complete revolutions of the main engine shaft to fire all of the cylinders, since the distributor (which activates the points) is geared to run at half of the engine speed. Therefore, we have two sparks per revolution (SPR) for a four cylinder engine, 3SPR for six cylinders and 4SPR for eight cylinders.

So if a six cylinder engine is operating at 1000 revolutions per minute (RPM), we can expect 16.66 (1000/60) revolutions per second resulting in 50 (16.66 x 3) sparks per second. By working backwards, we find that the same spark rate corresponds to 1500RPM for a four cylinder engine, and 750RPM for eight cylinders.

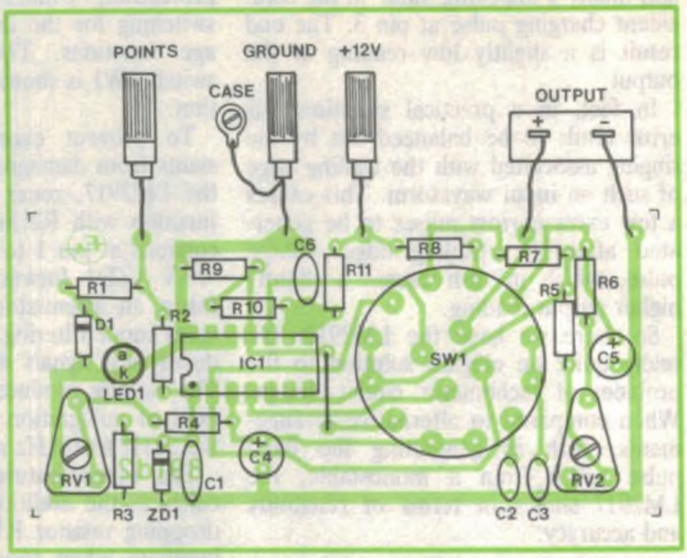
This 50 sparks per second figure is quite convenient for calibrating the tacho mode of the Tuneup Adaptor, since a stable 50Hz source is readily available from the 240V mains supply, via the secondary winding of a transformer. The secondary voltage should be between about 3V RMS and 10V RMS, and applied directly to the unit between the 'points' and 'ground' connections.

After that, it's simply a matter of connecting a multimeter to the output, and adjusting RV1 for a reading of 1.0V for a six cylinder engine, 1.5V for four cylinders and 0.75V for an eight. Also, by using the above information the spark rates for some of the more exotic engine configurations, such as three or five cylinders may be calculated.

The other fact relating to ignition systems is really just an extension of the first. Since all of the engine cylinders must fire within one rotation of the distributor shaft, the points of a six cylinder engine for example must open at each 60 degrees of rotation. Similarly, the distributor for a four cylinder engine will open the points every 90 degrees, while the eight cylinder version operates every 45 degrees.

Now, since dwell is a measure of the angle through which the points are closed within these periods, the above figures will represent the maximum dwell reading for each engine. That is, when the points are closed for the whole cycle.

So to calibrate the dwell mode of the Tuneup Adaptor, we need to simulate this condition, and adjust the output for the appropriate maximum reading. Fortunately, this is simply a matter of ensuring that the 'points' connection is at ground potential by leaving the input open circuit, and adjust RV2 for the correct reading. This is 0.6V (60 degrees), 0.9V (90 degrees) and 0.45V (45 degrees) for six, four and eight cylinder engines respectively.



The component overlay and wiring diagram. Double check the orientation of the semiconductors and other polarised components, before applying the power.

Installation and use

Now that the unit has been calibrated, it may be fully assembled and mounted in the engine compartment. The best mounting position is on a solid section of the bodywork in the vicinity of the distributor, but not too close to any high temperature areas such as the exhaust manifold.

Ideally, the lower section of the box should be attached to the body with a couple of large self tapping screws – or nuts bolts and star washers. While this holds the box physically in place, it may also provide the electrical ground return path via the metal bodywork. In this case the 'ground' connection on the unit need not be used.

After that, wires may be run to the points connection on the distributor or coil, and the +12V ignition circuit. Note that in the case of a transistor assisted ignition (TAI), the 'points' wire should be attached to the low voltage connection of the distributor, rather than the coil. This is because the signal at the coil is controlled by the internal switching transistor of the TAI, and does not reflect the duty cycle of the points.

In a TAI system the points only act as a trigger to its internal circuitry, which in turn delivers a fixed ignition firing pulse to the coil. So while dwell angle at the points is not critical, it is still worth checking since a very high or low

Recreate your very own

'Spark': an old-time Induction Coil – 1

Induction coils were an essential part of early radio transmitters, right from the days of Hertz and Marconi. Here's the first of two articles which show how to build one for yourself. Use it to re-create early radio equipment, or just to have fun experimenting safely with high voltage AC!

by PETER R. JENSEN, VK2AQJ

When in 1896 the youthful Marconi had demonstrated his new wireless contrivance to the elderly head of the British Post Office, Mr W. Preece, and had received his enthusiastic assistance in presenting his work to the public and to the Navy, there were some that said that he had invented nothing new.

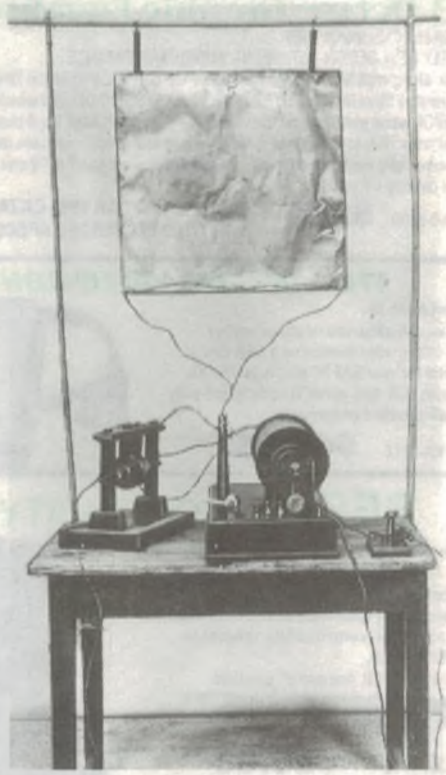
Not that Marconi ever suggested that everything that he had used was his own invention: he certainly claimed that what he had done with a number of pre-existing inventions was novel. When seen in conjunction with an actual demonstration of wireless telegraphy, this was enough to convince many that what he had achieved was quite different to the work of Oliver Lodge, who had come close to demonstrating transmission and reception a full two years previously. However it did not stop a number of vitriolic critics from deriding the young Italian inventor and sneering at what was claimed to be the theft of work of earlier experimenters.

In due course, despite these savage criticsms, Marconi was to go on to make a temperamental novelty into the workable system that we now call 'radio', although for many years and in England still, it was called by its first name, 'wireless'.

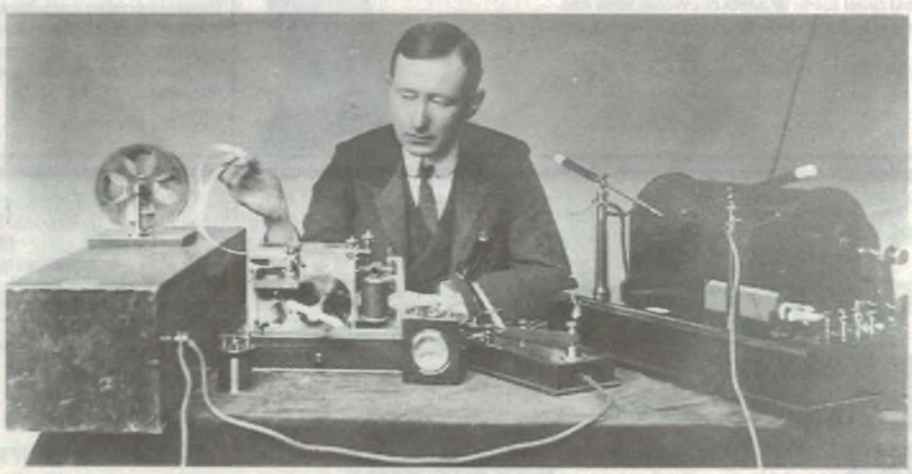
Of the pre-existing electrical devices which Marconi was to employ, perhaps the most important was the *induction coil* which, at that time, was generally known as a *Ruhmkorff coil*. It was this device that produced the high voltage which was necessary to achieve a powerful spark that lay at the heart of Marconi's transmitter and also that of Hertz, whose classic experiments had been conducted in 1887.

As can be seen in the accompanying illustration of the apparatus used by Hertz, the induction coil was just as important an element as it was later to be in the Marconi wireless. However, even when used by Hertz in his crucial experiments, the induction coil was an old device. Its inventors were the two French physists, Antoine Masson and Louis Breguet, who made the first model in 1841.

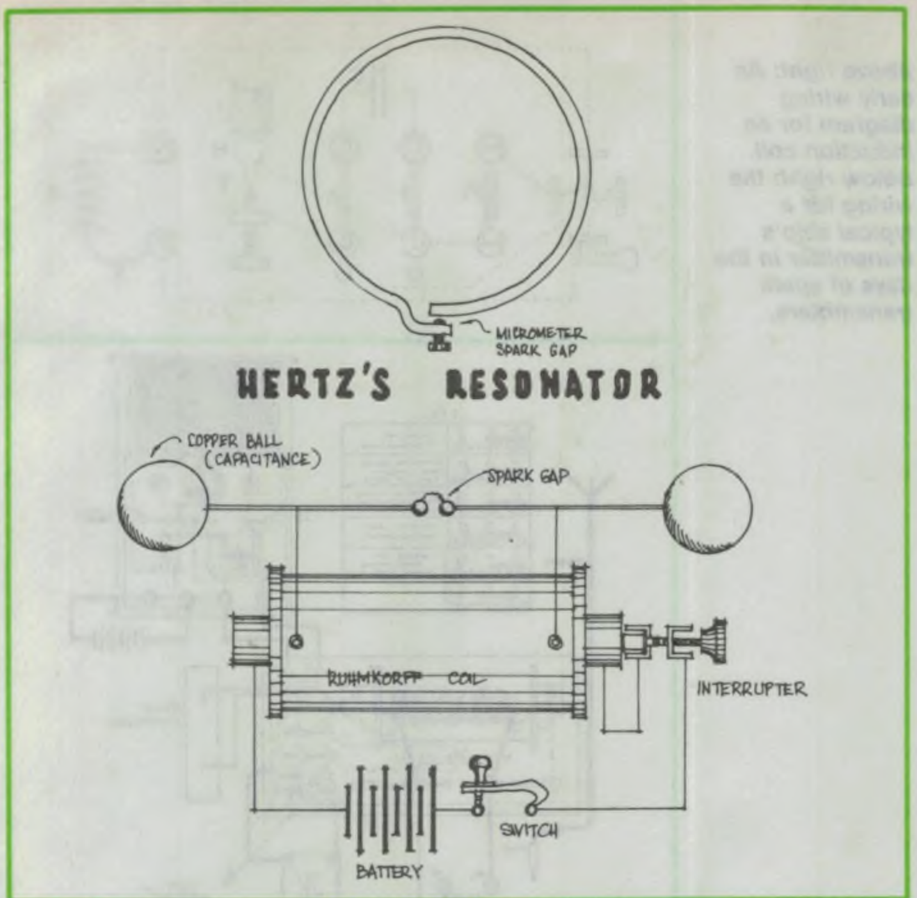
However it was later significantly improved by the German instrument maker Heinrich Daniel Ruhmkorff, who had been born in 1803 and lived in Paris until his death in 1877. By that time Ruhmkorff's apparatus was so well known that for many years after it bore his name. Indeed it was sufficiently familiar to the French scientific community that it was included in the well



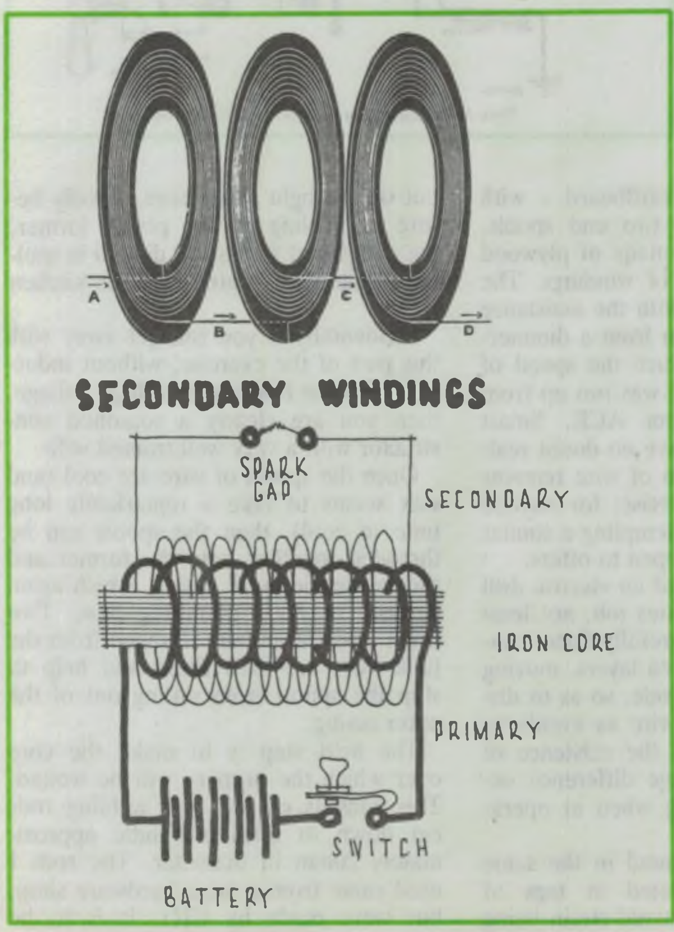
Marconi's first wireless (spark) transmitter, with an induction coil playing a key role in the centre of the table.



Wireless pioneer Guglielmo Marconi pictured in 1911 with some of his equipment. Note the induction coil at right.



Above: Heinrich Hertz's resonator (receiving loop) and oscillator – which was a simple spark transmitter, again based on an induction coil.



Left: The basic electrical circuit of an induction coil (below), with a sketch showing the way the multiple secondary windings are arranged.

known early science fiction epic *Twenty Thousand Leagues under the Sea*, written by Jules Verne in 1870.

At one stage of the story, as the enigmatic Captain Nemo, the Commander of the strange submarine is describing its wonders to Professor Aronnax and his companions, he says, "I use Bunsen's elements, not Ruhmkorff's – they would not have been powerful enough". A subtle and correct observation, of which Marconi was far later to discover the truth, when finally he abandoned the induction coil in favour of alternating current and high power transformers to drive his trans-Atlantic telegraphic service.

For anyone with an interest in antique wireless and its reproduction, the induction coil represents quite the most daunting tasks of construction.

In principle, an induction coil is simplicity itself: A primary coil is wound on a core of soft iron and this in turn is surrounded by a very large number of turns of thin wire to form a secondary. A direct current is passed through the primary coil and also through an interrupter (a magnetically controlled switch). This current is turned on and off at a rapid rate of perhaps 25 to 50 times a second. As the current is turned off, the collapsing magnetic field in the core produces a very strong pulse of high voltage in the secondary, and thus a large spark can be produced across a spark gap.

That may sound simple enough, and the diagram shows this even more clearly. However in reality the device is not so easy to construct. Because very high voltages were produced – up to 500,000 volts was not uncommon – the secondary winding was wound in a most unusual manner to avoid internal flashovers and self-destruction. In Fleming's book of 1916, *An elementary manual of Radiotelegraphy and Radiotelephony*, the form of construction of the winding is as described as follows.

"The secondary circuit is wound in a very large number of flat coils or sections, several hundred such coils being sometimes employed. These are prepared by winding the silk-covered copper wire between paper discs in a flat spiral, as a sailor winds up a spare rope. These are then slipped onto the ebonite tube enclosing the primary coil and the ends of the coils are then jointed together."

"To enable this to be done the coil sections are wound in double flat layers with a disc of paraffined paper between, the beginning and end of the wire thus being at the outside and the two layers

Induction coil

so wound that the windings follow on in the same direction. There is then no difficulty in making the joints between the various flat coils composing the secondary circuit..."

"...The object of this mode of winding is to secure that no two points on the secondary wire, which are at great differences of potential, come near to each other. The whole of the very numerous flat coils forming the secondary circuit are compressed together between the two thick ebonite cheeks and it is usual to immerse the whole finished secondary coil in very hot paraffin wax to exclude air and insulate it thoroughly."

That description, coupled with the accompanying diagram from the same book, should be enough to dissuade the most enthusiastic constructor! Certainly over a protracted period the author was discouraged from attempting to build this most fundamental of wireless instruments.

At an earlier stage and as described in *EA* in April 1986, an induction coil was built which looked authentic enough but, hidden inside, was a modern ignition coil from a motor vehicle. It gave off a fairly satisfactory spark for demonstration purposes and the Scouts found it all quite quaint and interesting.

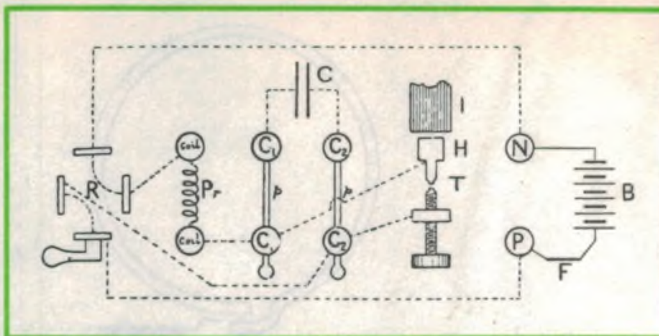
However the thought lingered that a full scale induction coil was essential to any realistic reproduction of an early Wireless Station and this article and the one that follows tell how the goal was ultimately achieved.

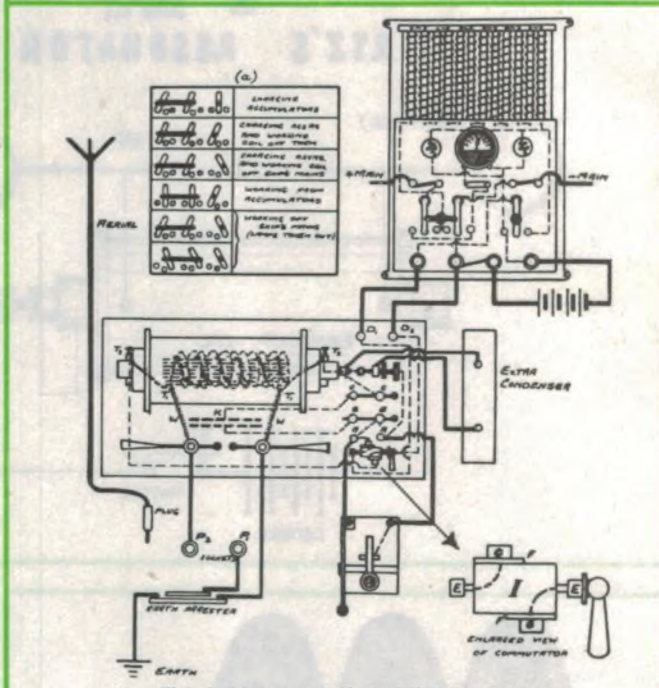
The starting point for the construction was the purchase of eight coils of fine cotton covered wire from ACE Radio, who have moved from their home of many years at Marrickville to Manly Vale. The end paper on the reels describes the wire as 0.1219mm in diameter, with the letters T.N.A. The covering to the wire is coloured blue. It was made by 'Fine Wires Ltd.' of Nottingham, England and how long ACE have had it one cannot imagine. However any similar cotton covered wire of the same gauge would no doubt be just as successful.

The next step was to wind the secondary coils, and for the purpose seven sub-coils were made up on separate spools. These were designed to fit over a section of plastic plumbing pipe, to allow subsequent insertion of the primary winding and the core of soft iron rods.

As indicated in the diagram and photographs, these spools were made

Above right: An early wiring diagram for an induction coil. Below right: the wiring for a typical ship's transmitter in the days of spark transmitters.





Plain Aerial Emergency Transmitting Gear Connections.

up from very heavy cardboard – with the exception of the two end spools, which had one cheek made of plywood to stiffen the bundle of windings. The windings were made with the assistance of an electric drill, run from a dimmer-type controller to reduce the speed of rotation, and each coil was run up from a drum of wire from ACE. Smart mathematicians will have no doubt realized that a spare drum of wire remains at the end of the exercise: for anyone who is interested in attempting a similar project, the author is open to offers.

Even with the help of an electric drill this is a long and tedious job; not least because it has to be carefully done, running the wire on in even layers, moving it slowly from side to side, so as to distribute the layers of wire as evenly as possible and to avoid the existence of points of major voltage difference occurring in the winding when in operation.

All the coils are wound in the same direction and terminated in tags of heavier duty wire, to avoid strain being put on the light gauge wire. Finally before assembling on the plastic former, the completed spools are dipped in molten candle wax, heated over the kitchen stove.

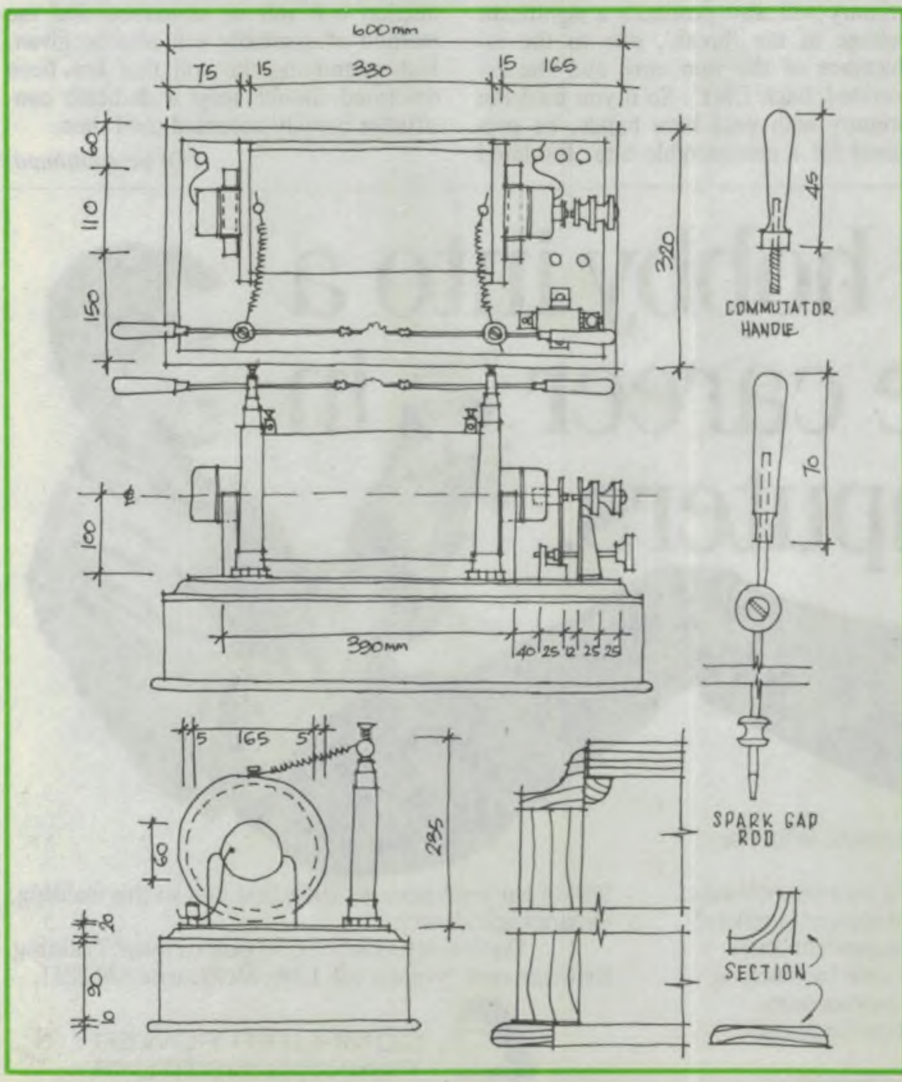
Incidentally if you can get away with this part of the exercise, without inducing a divorce rather than a high voltage, then you are clearly a seasoned constructor with a very well trained wife.

Once the spools of wire are cool (and wax seems to take a remarkably long time to cool), then the spools can be threaded together onto the former and slid inside the outer casing, which again consists of PVC plumbing pipe. Two small brass terminals, salvaged from the junk box, are then fitted and help to stop the spools from sliding out of the outer casing.

The next step is to make the core over which the primary will be wound. This consists of soft iron welding rods cut down to form a bundle approximately 20mm in diameter. The rods I used came from a large hardware shop, but were made by CIG. It is to be

Right: A closeup shot of the author's secondary windings, after waxing.

Below: The author's mechanical plans for his induction coil, as described in these articles.



noted that the rods, which were approximately 3mm in diameter, were plain and without flux covering.

The bundle of rods is slid down inside a further plastic tube, courtesy of the local plumbing suppliers, until a snug fit is achieved. Finally the ends of the bundle are smeared with a generous amount of epoxy resin, to hold it together and form a stable unit. Once the epoxy is dry, the ends of the bundle are ground flush. I did this with a carborundum disk on the trusty electric drill.

In passing it should be noted that the whole of this project can be made with hand tools only, and the most elaborate of these is an electric drill.

Having assembled the core and its plastic covering, the next step is to construct the primary winding. This consists of three layers of 14 gauge (SWG) enamelled copper wire and involves approximately 300 turns. Masking tape is used to hold the winding at the start and end of each layer and when completed the whole assembly, including the plastic covered core of rods, should slide neatly inside the former for the secondary. Again this is all shown in the accompanying diagram and photographs.

At this stage it is probably as well to see if the beast will work. That is to say, will it produce a spark or not? After all the hard work needed to get this far, you may well need the boost to the morale that a nice fat spark alone can give!

Of course it is easy enough to test the

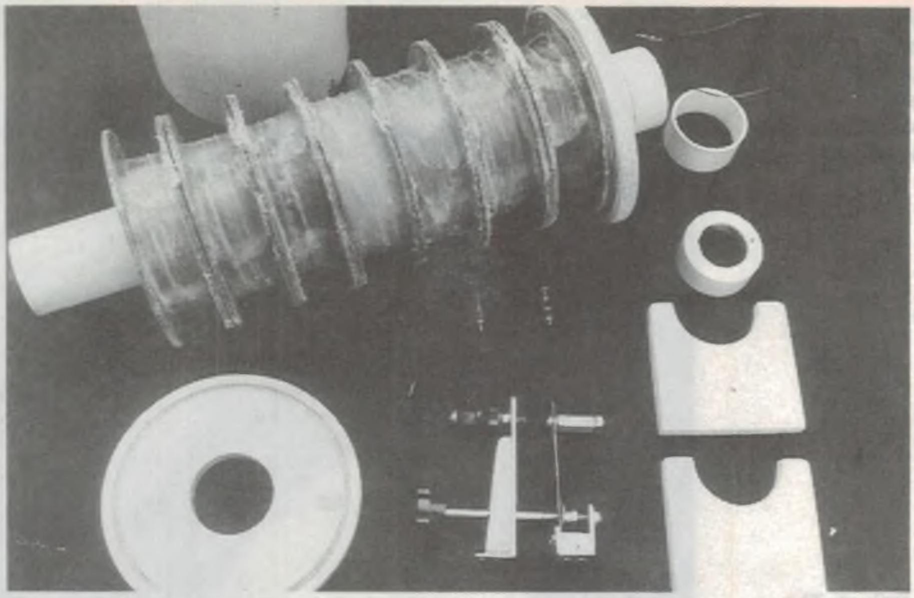
Induction coil

continuity of the windings. Any VOM or ohm meter will do, providing that it can read up to about 100,000 ohms. The primary is unlikely to give any problem and probably a test on the secondary spools was undertaken prior to dipping the windings in the liquid wax bath. However this is just about your last chance to see that all is well: after this, disassembly becomes rather tedious.

Incidentally the secondary of the induction coil in the diagram had a resistance of about 40,000 ohms and the primary less than one ohm.

To test for the spark, all that is needed is a supply of 12 volts, such as a car battery but it must be able to supply up to 5 or 6 amps, which is the static current of the primary winding described.

All that you have to do is bring the secondary windings from each end of the coil together with some hook up wire, leaving a gap of about 20 to 30mm, to form a temporary spark gap. Then, remembering that the voltage required to jump 25mm is about 50,000 volts and keeping one's hands and other parts of the body well away from the secondary, allow the current to run through the primary.



The major components of the author's induction coil, with the secondary at top and the interruptor at lower centre.

When the current is interrupted, a powerful spark should occur across the temporary spark gap. Incidentally the primary will also produces a significant voltage at the 'break', due to the inductance of the iron core and the associated 'back EMF'. So if you hold the primary with your bare hands, be prepared for a considerable bite. Insulated pliers might just be a good idea!

In the second of these articles the remaining major components of the induction coil will be described and the method of assembly will also be given. Just assembling the coil that has been described should keep a dedicate constructor happily occupied until then.

(To be continued)

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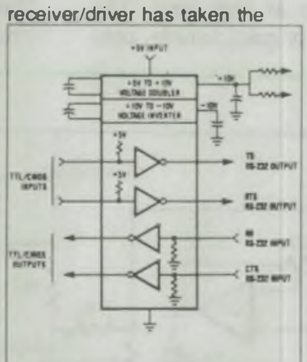

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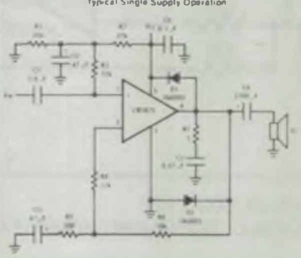

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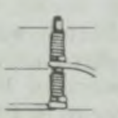

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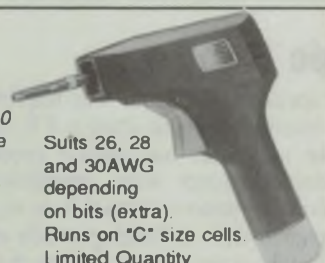

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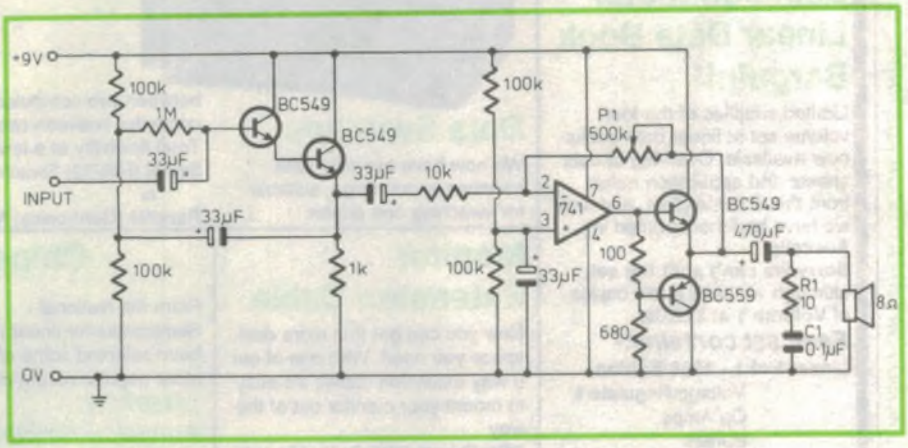
Circuit & Design Ideas

Interesting circuit ideas from readers and technical literature. While this material has been checked as far as possible, the circuits have not been built or tested by us. As a consequence, we cannot accept responsibility, enter into correspondence or provide construction details.

High impedance amplifier



This simple circuit will produce approximately one watt of power when connected to a 9V power source. The advantage of this circuit is that it uses a bootstrapped Darlington pair to boost the input impedance to about 20M ohms, making it ideal for high impedance signal sources. A volume control is provided on the main section of the amplifier by way of the inverting op amp and RV1.

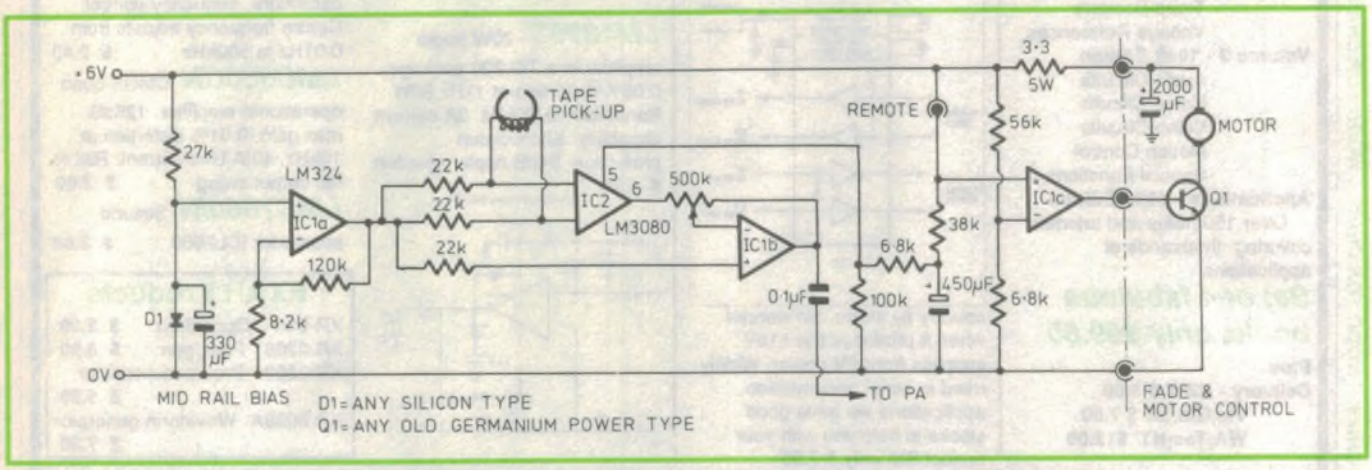
Unlike many designs, this allows the input impedance to remain constant at 20M, regardless of the setting of the volume control.

The circuit components are all cheap, easy to find parts, and shouldn't cost more than about $4 to buy, (excluding speaker). The output transistors are BC549 types, requiring the user to keep the volume at a level below distortion to ensure the current level through the transistors doesn't exceed 100mA.

The output section has a Zobel network, consisting of R1 and C1. This is to reduce oscillation at high gain. The output section itself is quite simple, consisting of an op amp driving a complementary pair. Construction is not critical, although lead lengths at the input should be kept as short as possible due to the high input impedance.

Darren Yates,
Frenchs Forest, NSW.

$25



Tape fader

A special tape player was required to play incidental music over a PA system before and after our weekly meetings. Available players were unsatisfactory, requiring obtrusive manual fade out, accompanied with a crashing switch off, or an abrupt remote pause leaving the running tape motor roaring into the PA during the speaker's address.

Because of this, an old tape player was modified by removing its electronics and fitting the circuit shown. The circuit was developed on a breadboard, and works well. The machine is switched off by the remote switch, which causes the music to die away gently without distortion over a 10 second interval, after which the motor stops. At the conclusion of the speaker's address, the player is switched back on, which first restarts the motor then causes the music to resume without any wow.

The main difficulty was eliminating the motor generated noise, which no amount of bypassing with capacitance could completely eliminate. An earth loop was partly to blame, so Q1, the 2000uF capacitor and the 3.3 ohm resistor were exiled to a small board mounted on the motor. All earths were run to the one point as well.

However, this did not completely solve the problem, which was traced to motor noise finding its way onto the power supply lines. Originally, the op amp inputs were biased to mid rail with a voltage divider, but the motor noise, despite filtering was sufficient to be obtrusive after passing through the amplifier network of IC1. IC2 was not affected due to its CMMR.

The biasing was changed to the 27k resistor and diode D1, bypassed with the 330uF capacitor. The voltage across D1 is amplified by IC1a to give a ripple free 3V, which is then applied to the three 22k resistors.

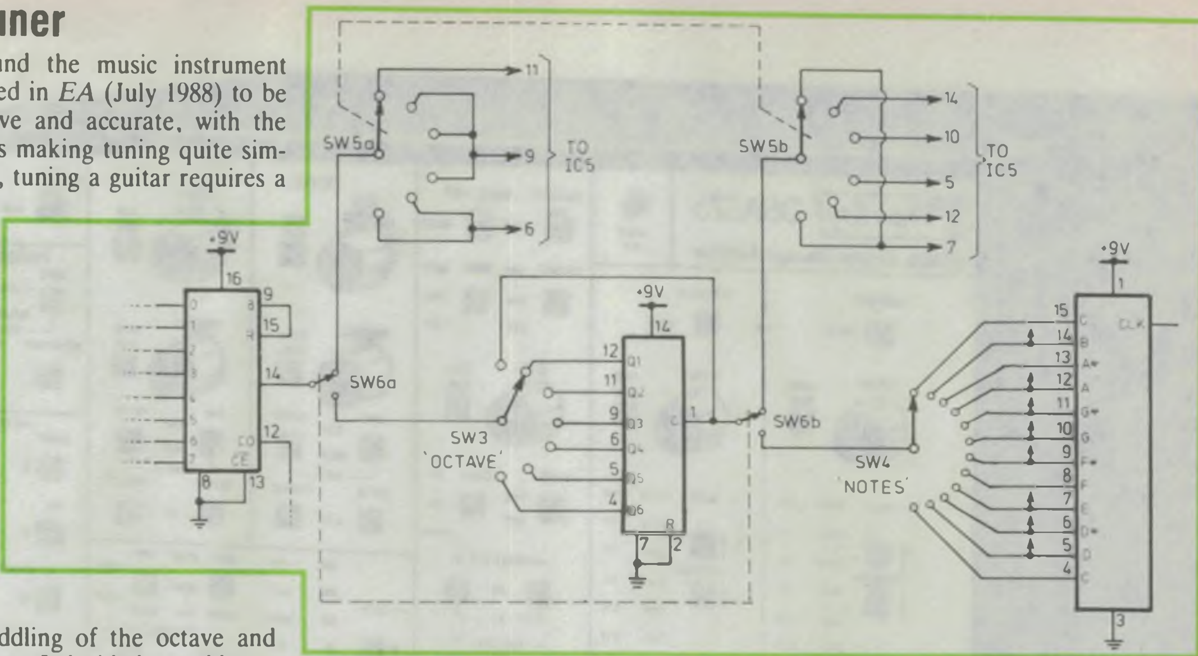
The end result is virtual silence, except for a small amount of hiss which no one has noticed anyway.

Jim Morphet,
Rosebud, Vic.

$40

Guitar tuner

I have found the music instrument tuner presented in *EA* (July 1988) to be both innovative and accurate, with the rotating LEDs making tuning quite simple. However, tuning a guitar requires a fair bit of twiddling of the octave and note switches, so I decided to add two extra switches to select the standard E, A, D, G, B, and E notes required in guitar tuning.



The modifications are as follows: Cut the track from pin 14 of IC3, and cut the track between the common terminals of SW3 and SW4. Connect a DPDT switch (SW5) so that one common goes to pin 14 of IC3, and the other common goes to pin 1 of IC4. Next connect SW5 as shown on the circuit diagram so that one position of the switch puts the circuit back to original, and the other connects SW6 into circuit.

The bridges shown on SW6 should be connected, then wires taken from the switch terminals to connect to IC5. These wires are best connected to SW4, rather than at the actual IC pins. The numbers represent the IC pin number for IC5 that the wire must connect to. Finally, mark SW5 as selecting either instrument or guitar, and mark SW6 as E, A, D, G, B, E.

R.W. Kemp,
Loxton, SA.

$25

Dreamed up a great idea?

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.

Joystick auto-fire

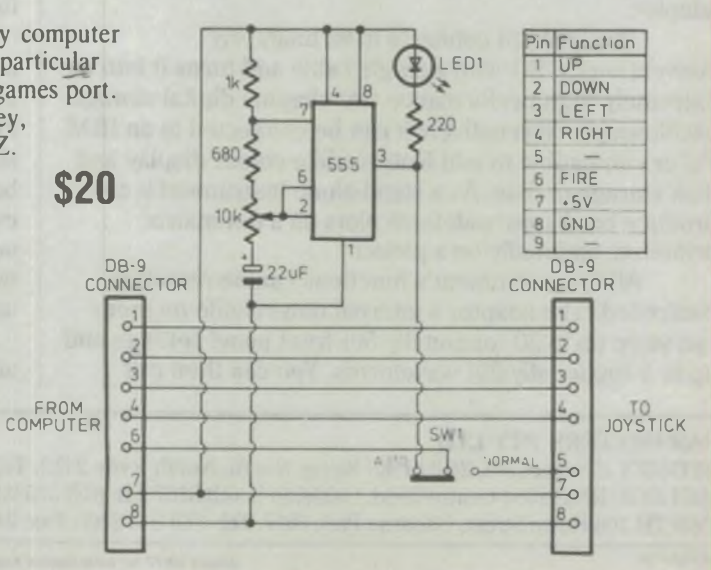
This simple device is a variable speed joystick auto-fire. The basic circuit consists of a 555 timer configured as an oscillator, producing a square wave of between 2 to 24Hz, depending on the setting of the 10k potentiometer. The LED has been included to indicate the speed of the oscillator, and operates with SW1 in either position.

Construction is simple with the components being mounted on stripboard, and then fitted into a plastic case with the LED, potentiometer and switch mounted on the front panel.

The completed circuit can be connected to the computer by fitting a 9 pin D connector to each end of the circuit and connecting the whole assembly in series with the joystick. The circuit is for Commodore 64 type computers, the Vic 20 and any computer that uses this particular format for its games port.

Aaron Spinley,
Auckland NZ.

$20



Pin	Function
1	UP
2	DOWN
3	LEFT
4	RIGHT
5	—
6	FIRE
7	+5V
8	GND
9	—

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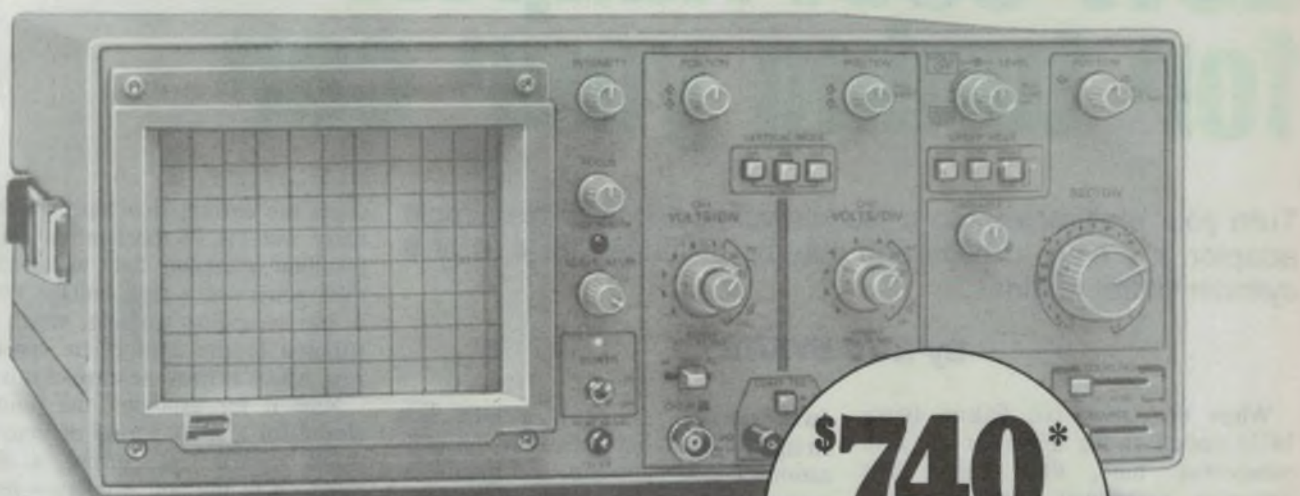

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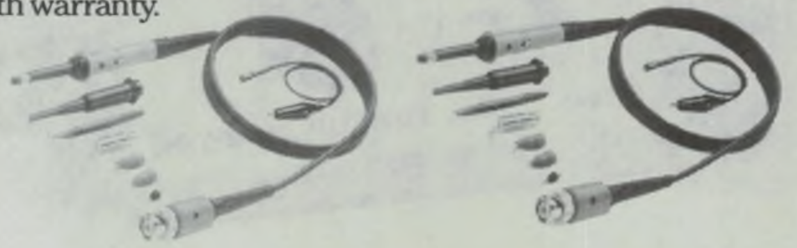

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Construction project:

Low cost Adaptor for tuning your car

Turn your multimeter into a tacho/dwell meter with this simple adaptor. It's easy to build and may be calibrated for 4, 6 or 8 cylinder petrol engines.

By ROB EVANS

When the trusty old Falcon (circa 1971) stalled at the lights for the fifth consecutive time, this project was becoming increasingly more attractive. Clearly, regular engine tune-ups avoid this kind of embarrassment and save on fuel costs. However, it is no longer sufficient to cross the local mechanic's oil stained palm with silver for this service – large notes are required!

Fortunately, the problem has been virtually eliminated for cars built in the last few years, by the use of fully electronic ignition systems. These eliminate the mechanically driven contact breaker (points) of the traditional Kettering arrangement, which tend to become burnt, pitted and out of adjustment in a short time.

But in reality, a very large proportion of vehicles on the road still use the basic Kettering system. Most four wheel drives for example retain this system, in (ironically) the interests of reliability. This is because when you are 'out bush' the basic system may be repaired by 'a piece of fencing wire and a beer can', whereas a dedicated semiconductor is a little more difficult to find. So for many motorists, regular engine tune-ups and the expense involved are a fact of life.

The alternative to booking your car in for an expensive service however, is to gather together a few basic tools, a tacho/dwell meter, and do it yourself. A tacho/dwell meter is quite a simple instrument, which provides a readout of the important electrical parameters for engine tuning.

The tacho (tachometer) function of such an instrument will provide a readout of engine revs, which should be known for adjustments such as ignition timing and carburettor tuning. The dwell (angle) reading is a little less straightforward, but is basically an indication of the points gap, and should be set to the manufacturer's specifications.

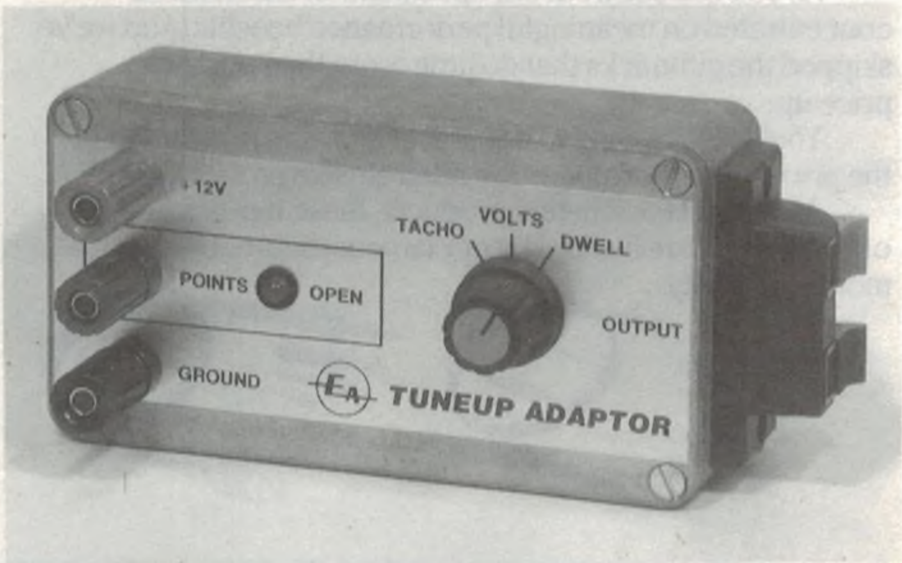
Dwell angle

This slightly odd expression is exclusive to the automotive industry, and is defined as the angle through which the distributor shaft rotates while the points are closed. That is, in electronics terms it's a measure of the points' duty cycle. The importance of this figure may be seen by studying the electrical relationship between the points and the ignition coil.

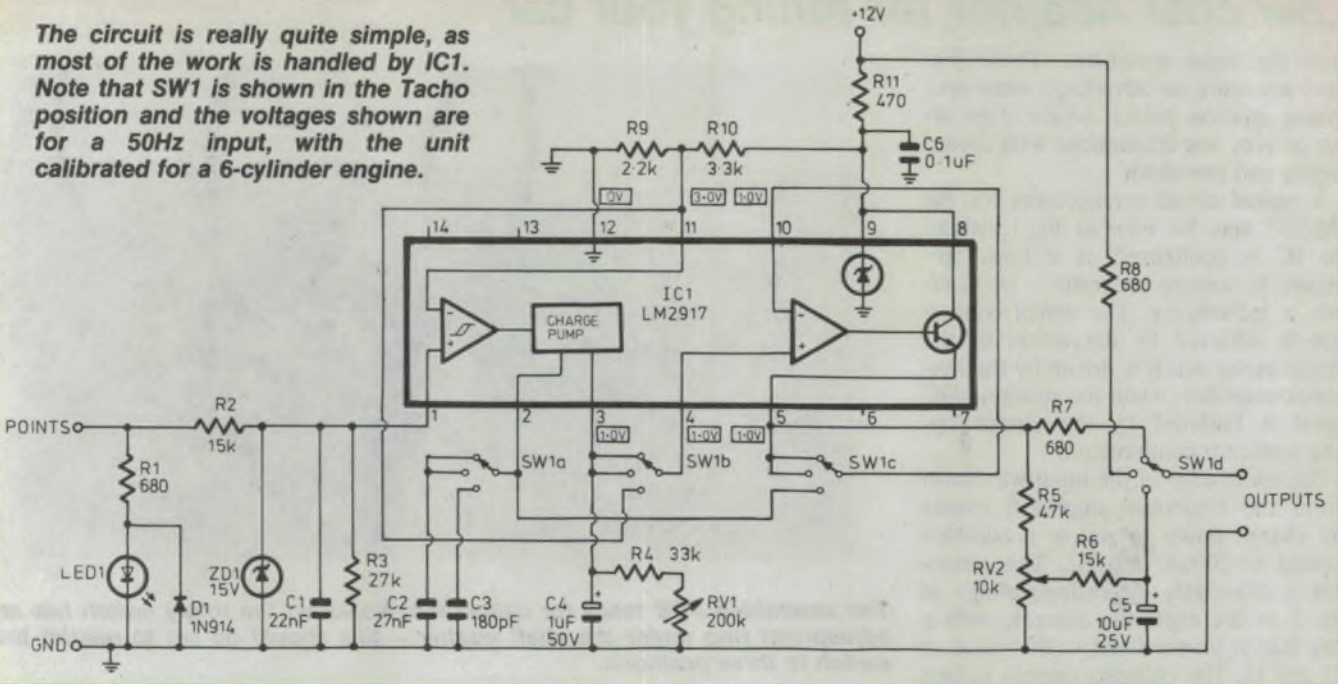
The standard (Kettering) ignition system uses a lobe on the distributor shaft to force the normally closed points open at regular intervals, which in turn interrupts the current flow through the primary winding of the ignition coil. The resultant collapsing field within the coil then generates a high voltage transient in the secondary winding, which is distributed to the appropriate spark plug gap, where it fires the air/fuel mixture.

Now if for example, the points are closed for a short period of time (small dwell angle), less current is able to build up in the coil winding – resulting in less available spark energy, and poor engine performance. Conversely, a large dwell angle means that less time is available (when the points are open) for the collapsing field to dissipate its energy. The interruption of this natural decay tends to cause severe arcing and pitting of the points and again, poor performance.

So the dwell angle, which is set by adjusting the points gap, is fundamental to the correct operation of an ignition system. In fact when attempting an engine tune-up, establishing the correct points gap or dwell angle should always be the first step.



The unit may be permanently installed into the engine bay and hard-wired to the ignition system, or used as a portable test instrument with flying connector leads.



The circuit is really quite simple, as most of the work is handled by IC1. Note that SW1 is shown in the Tacho position and the voltages shown are for a 50Hz input, with the unit calibrated for a 6-cylinder engine.

Design and features

A number of tacho/dwell meters have been described in the past. These ranged from designs with a couple of IC's driving a moving coil meter, to fully blown units with elaborate signal processing and digital displays. Unfortunately, the cost of the display (be it digital or analog) has driven the price of these units up to an unacceptably high level, negating one of the prime advantages of doing-it-yourself.

However, the ubiquitous multimeter offers a very convenient solution to the problem. If a tacho/dwell circuit is arranged to simply convert the ignition signals to an appropriate DC voltage, the multimeter may connected to the output as a final readout. So this is the basis of the EA Tuneup Adaptor, and by using this method we have been able to keep the cost of the unit to a very low level. In fact, the case is the most expensive item in the parts list.

Another slightly unusual aspect of the Tuneup Adaptor is the addition of an indicator LED (and dropping resistor), which is wired across the points connections. This simple addition presents an insignificant load to the ignition circuit, yet is quite handy for emergency situations where the action of the points must be known – but more of this later.

When using the Tuneup Adaptor, a single rotary switch chooses between the tacho and dwell operation, with the middle 'volts' position selecting the +12V rail. This setting is useful for assessing the condition of the vehicle's battery and charging circuit.

The basic concept of this design is for the unit to be permanently installed in the vehicle's engine compartment, and the multimeter attached when the occasion calls for a tune-up. While this makes the operation very simple, there is no real reason why the Tuneup Adaptor cannot be used as a portable instrument and plugged in at will.

The actual circuitry of the Tuneup Adaptor could have been arranged in many different ways, for there is no shortage of suitable circuits. But in the interests of simplicity and reliability, we settled on a single chip solution based around the popular LM2917 frequency to voltage converter.

The LM2917

This function block from National Semiconductors is able to perform frequency to voltage conversions with only a few external components. It offers a wide linear output swing, an internal voltage regulator, variable input reference and high output current capability. Also, this rugged chip is widely available at quite a reasonable price, and is ideally suited to tachometer applications such as the EA Tuneup Adaptor.

The actual circuit of the LM2917 uses a neat frequency doubling technique to achieve a low level of ripple in the DC output signal, and a hysteresis amplifier input stage to ensure reliable triggering

SPECIFICATIONS

General

- May be calibrated for 4, 6 or 8 cylinder engines
- Suits any multimeter with impedance greater than 20k/V
- Compatible with electronic ignition systems

Tacho mode

Range: zero to 6000 RPM
Accuracy: +/-1.5% from 400 RPM to 6000 RPM
Response time: approx 15ms per 100 RPM

Dwell mode

Range: zero to 100 degrees
Accuracy: +/-2% from 10 degrees to 80 degrees
Response time: approx 50ms per 10 degrees

Low cost Adaptor for tuning your car

from the input waveform. These features are quite an advantage when processing ignition pulses, which often arrive at very low frequencies with severe ringing and overshoot.

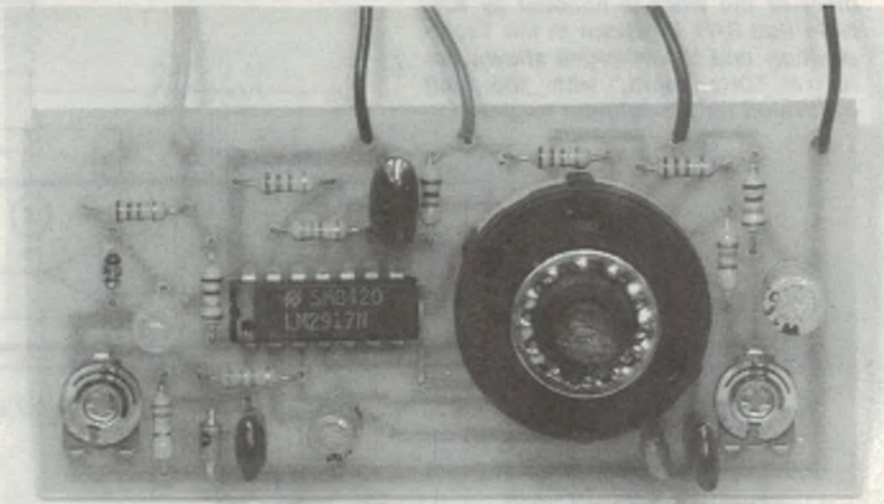
A typical circuit arrangement for the LM2917 may be seen in Fig.1, where the IC is configured as a basic frequency to voltage converter – or in effect, a tachometer. The actual conversion is achieved by the action of the charge pump which is driven by the hysteresis amplifier, while the resulting DC signal is buffered by the output op-amp/transistor combination.

The rising edge of the input waveform (from the hysteresis amplifier) causes the charge pump to source a constant current of 200uA into C1. This generates a constantly increasing voltage at pin 2 as the capacitor charges, with a rate that is proportional to the value of C1 and I1. The charging current is then terminated by an internal comparator when the voltage at pin 2 has reached 3/4 Vcc.

Similarly, the falling edge of the input waveform causes the charge pump to *sink* a constant 200uA into pin 2, thereby discharging C1 until the voltage falls to the lower preset level of 1/4 Vcc. The resulting waveform at pin 2 is a square wave with defined rise and fall times, moving between 3/4 Vcc and 1/4 Vcc.

During both of these charging and discharging periods, the same amount of current is sourced from pin 3. That is, whenever C1 is charging or discharging, another 200uA current source is enabled which in turn charges C2.

So in effect, a current pulse is delivered to C2 on each transition of the drive waveform, or at double the input frequency. However, between these periods C2 is discharged at a rate as set by R1, causing the voltage to settle at a point where the levels of charging and discharging are in equilibrium.



The assembled PCB ready for calibration. Note that the rotary switch has an adjustment ring under the shaft washer – this should be set to restrict the switch to three positions.

Since the current pulses are of a fixed period (as set by C1 and I1) the time between each pulse, and the resulting integrated voltage at pin 3, will vary in sympathy with the input frequency. Also, this output voltage will not be affected by the duty cycle of the input waveform, since its *average* duty cycle is always constant and will only vary with the input frequency.

The resulting voltage is finally linked to the output buffer stage via pin 4 of the LM2917. In this case the op-amp is connected as a non-inverting buffer stage, with the output transistor included within the negative feedback loop. This enables the output to accurately sink load currents of up to 50mA.

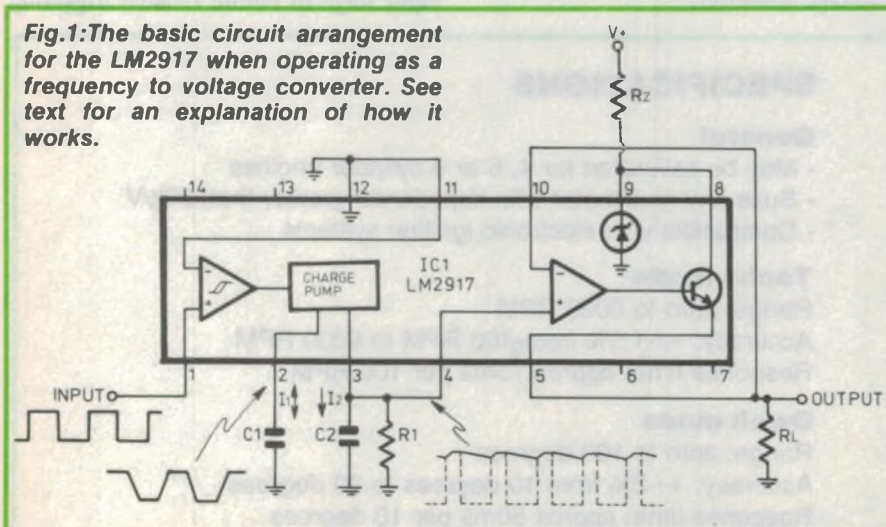
As may be seen in Fig.1, the power supply for the LM2917 is stabilised by an internal zener diode at pin 9, which is supplied by the dropping resistor Rz. The zener diode will hold the internal voltage of the chip to about 7.5 volts over a wide range of source voltages, maintaining the accuracy and stability of the circuit.

The actual signal received from the points of a traditional (Kettering) ignition system is extremely 'dirty'. It has an undefined leading edge due to the uneven contact surfaces of the points, and severe ringing on the trailing edge due to the dissipation of stored coil energy. This can cause serious problems for some circuits.

The fixed pulse width required by a tachometer is often generated by triggering a simple monostable stage, and integrating the result as mentioned above. However, this style of tachometer will tend to misread rather badly in realistic signal conditions, due to continual re-triggering of the monostable. However, the charge pump arrangement will maintain readings until conditions are so bad that the engine may not even be capable of running.

To understand this, consider an input waveform with a very ragged leading edge for example. In this case the current source at pin 2 may momentarily switch out of the appropriate charge (source) mode and into discharge (sink)

Fig.1:The basic circuit arrangement for the LM2917 when operating as a frequency to voltage converter. See text for an explanation of how it works.



mode. This only causes a 'glitch' on the leading edge of the waveform at pin 2, and finally a matching 'hole' in the coincident charging pulse at pin 3. The end result is a slightly low reading at the output.

In fact, in a practical situation this error tends to be balanced out by the ringing associated with the trailing edge of such an input waveform. This causes a few extra narrow pulses to be generated after the 'trailing edge' charge pulse, which in turn causes a slightly higher output reading.

So there we have the LM2917. It's really quite an elegant solution to the problem of tachometer circuit design. When compared to alternative arrangements, such as generating the fixed pulse width from a monostable, the LM2917 shines in terms of reliability and accuracy.

Measuring dwell

While the LM2917 is ideally suited to tachometer applications, a few circuit changes are necessary for it to operate as a dwell meter.

Contrary to the requirements of a tachometer circuit, a dwell meter must sense only the duty cycle or pulse width of the input signal. In this case, all that we need is a stage to 'square up' the input wave form to a fixed amplitude, and integrate or filter the result. This will produce a DC level that is independent of frequency, yet sensitive to changes in pulse width or in automotive terms, the dwell angle.

To achieve this end, one of the main features of the LM2917, the charge pump, must effectively be disabled. Since the capacitor at pin 2 is charged and discharged at a fixed rate, any reduction in its value will cause a proportional increase in the rise and fall times of the waveform at this point.

So by selecting a capacitor with a very low value, the charge pump becomes a simple squaring stage. The resulting square-wave has a rapid rise and fall time, and may be applied directly to the output stage. However in this situation, the negative feedback around the output op-amp is removed, causing further squaring of the signal and an output swing of the full supply rail.

This produces a 'tidy' low impedance version of the input waveform, which may then be filtered by an RC network to provide a voltage representing the dwell angle.

The circuit

The actual circuit for the EA tuneup adaptor is basically the arrangement as shown in Fig.1, but with added input protection, calibration facilities, and switching for the dwell angle and voltage functions. The function selector switch SW1 is shown in the 'tacho' position.

To prevent excessive voltage transients from damaging the input stage of the LM2917, zener diode ZD1 in conjunction with R2 limits the voltage excursions at pin 1 to between +15V and -0.6V (ZD1 forward biased). R2 also forms an attenuator with R3 and provides input filtering with C1, which reduces any signals above about 500Hz. The ringing produced by the collapsing field of an ignition coil tends to be in the 5kHz to 10kHz region.

The other feature of the input circuitry is the addition of LED1 and its dropping resistor R1. The LED will illuminate when forward biased via R1 and the primary winding of the ignition coil, when the points are open. Also, the LED is protected from any stray reverse voltages by D1.

For typical signals from the points of an ignition circuit, the most reliable switching point for the input amplifier was found to be about 3 volts. This is set by the voltage divider R9 and R10, which biases the negative input of the amplifier (at pin 11) to this level.

The first section of the function switch SW1a selects the appropriate capacitor for the tacho and dwell operations, while the charge pump's output across C4 is controlled by R4 and RV1, the overall tacho calibration.

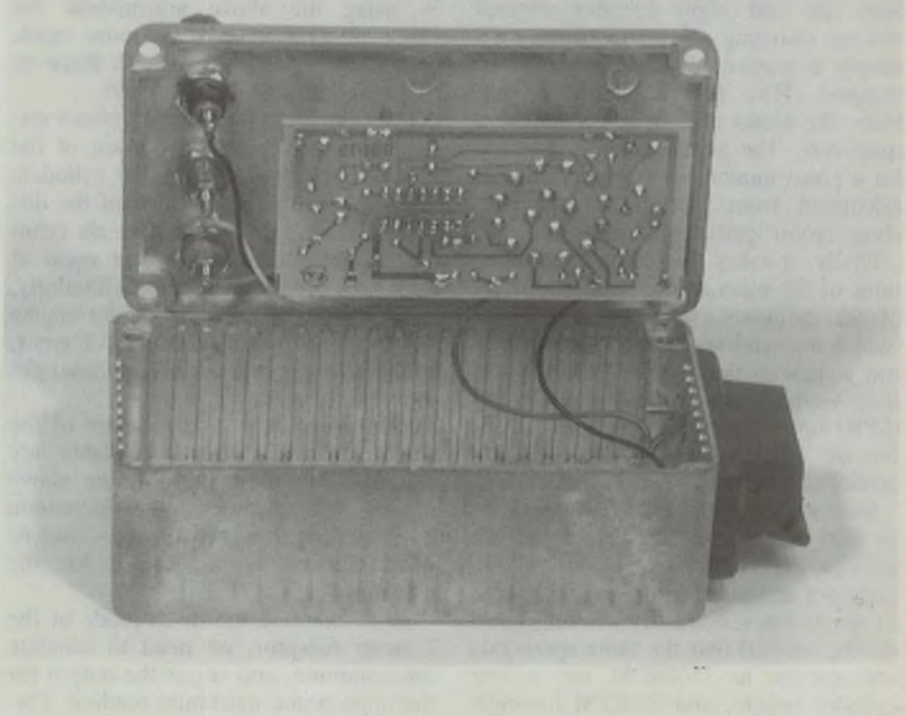
In the tacho mode, SW1b couples this DC level to the output op-amp's positive input at pin 4. This amplifier/transistor combination is set to unity gain by the negative feedback path completed by SW1c.

In the dwell mode however, the square-wave signal at pin 2 is applied to the inverting input of the output stage via SW1c, while the non-inverting input is switched to the voltage reference at R9 and R10 by SW1b. This stage then effectively becomes an inverting comparator, and provides suitably polarised output at pin 5.

Finally, the output signal is taken to SW1d via an isolating resistor (R7) for the tacho position, or the dwell function's calibration resistors (R5 and RV2) and integrating network (R6 and C5). This section of SW1 alternates the output to the multimeter between the final tacho and dwell signals, and the voltage position which is simply the +12V supply rail via the isolating resistor.

Construction

Assembling the EA tuneup adaptor is quite straightforward. All of the components including the function switch and indicator LED mount on one small



The internals of the Tuneup Adaptor. Note that the lugs of the output connector may need to be bent down, so as to avoid fouling the PCB.

Low cost Adaptor for tuning your car

PCB, measuring 85mm x 40mm. This mounts on the lid of a standard 122mm x 67mm x 40mm diecast aluminium case, although an equivalent (but less rugged) plastic box could be used. However, there is no guarantee that a plastic box will withstand the high temperatures and vibration which may be encountered in an engine compartment. Naturally, it would be fine for portable operation rather than a permanent installation.

Begin the construction by checking the printed circuit board (PCB) for any etching anomalies. Then mount the lower profile components, while paying particular attention to the orientation of polarised components, as shown in the component overlay diagram.

Next, mount the rotary selector switch, with the flattened section of the shaft facing in the appropriate direction for the knob pointer to match the front panel artwork. The LED should be mounted at a height where the lens will just protrude through the front panel.

Before mounting the assembly to the front panel, the banana sockets and the output connector should be wired to the PCB, and the unit tested and calibrated while the components are exposed.

Calibration

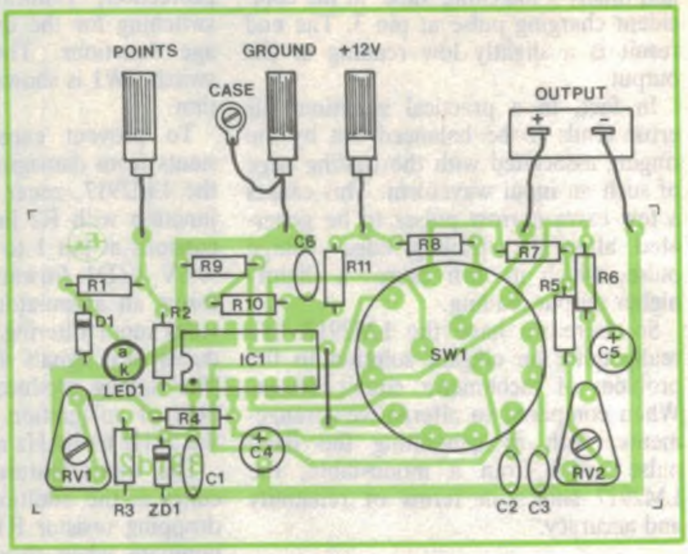
The tuneup adaptor may be set up for four, six and eight cylinder engines without changing any components – it's simply a matter of adjusting the two trimpots, RV1 and RV2, which calibrate the tacho and dwell readings respectively. The actual reading required for a given number of cylinders may be calculated from a couple basic facts about motor ignition systems.

Firstly, it takes two complete revolutions of the main engine shaft to fire all of the cylinders, since the distributor (which activates the points) is geared to run at half of the engine speed. Therefore, we have two sparks per revolution (SPR) for a four cylinder engine, 3SPR for six cylinders and 4SPR for eight cylinders.

So if a six cylinder engine is operating at 1000 revolutions per minute (RPM), we can expect 16.66 (1000/60) revolutions per second resulting in 50 (16.66 x 3) sparks per second. By working backwards, we find that the same spark rate corresponds to 1500RPM for a four cylinder engine, and 750RPM for eight cylinders.

This 50 sparks per second figure is quite convenient for calibrating the tacho mode of the Tuneup Adaptor, since a stable 50Hz source is readily available from the 240V mains supply, via the secondary winding of a transformer. The secondary voltage should be between about 3V RMS and 10V RMS, and applied directly to the unit between the 'points' and 'ground' connections.

The component overlay and wiring diagram. Double check the orientation of the semiconductors and other polarised components, before applying the power.



After that, it's simply a matter of connecting a multimeter to the output, and adjusting RV1 for a reading of 1.0V for a six cylinder engine, 1.5V for four cylinders and 0.75V for an eight. Also, by using the above information the spark rates for some of the more exotic engine configurations, such as three or five cylinders may be calculated.

The other fact relating to ignition systems is really just an extension of the first. Since all of the engine cylinders must fire within one rotation of the distributor shaft, the points of a six cylinder engine for example must open at each 60 degrees of rotation. Similarly, the distributor for a four cylinder engine will open the points every 90 degrees, while the eight cylinder version operates every 45 degrees.

Now, since dwell is a measure of the angle through which the points are closed within these periods, the above figures will represent the maximum dwell reading for each engine. That is, when the points are closed for the whole cycle.

So to calibrate the dwell mode of the Tuneup Adaptor, we need to simulate this condition, and adjust the output for the appropriate maximum reading. Fortunately, this is simply a matter of ensuring that the 'points' connection is at ground potential by leaving the input open circuit, and adjust RV2 for the correct reading. This is 0.6V (60 degrees), 0.9V (90 degrees) and 0.45V (45 degrees) for six, four and eight cylinder engines respectively.

Installation and use

Now that the unit has been calibrated, it may be fully assembled and mounted in the engine compartment. The best mounting position is on a solid section of the bodywork in the vicinity of the distributor, but not too close to any high temperature areas such as the exhaust manifold.

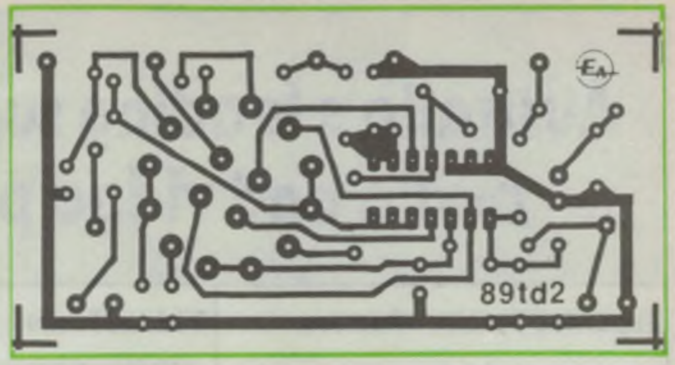
Ideally, the lower section of the box should be attached to the body with a couple of large self tapping screws – or nuts bolts and star washers. While this holds the box physically in place, it may also provide the electrical ground return path via the metal bodywork. In this case the 'ground' connection on the unit need not be used.

After that, wires may be run to the points connection on the distributor or coil, and the +12V ignition circuit. Note that in the case of a transistor assisted ignition (TAI), the 'points' wire should be attached to the low voltage connection of the distributor, rather than the coil. This is because the signal at the coil is controlled by the internal switching transistor of the TAI, and does not reflect the duty cycle of the points.

In a TAI system the points only act as a trigger to its internal circuitry, which in turn delivers a fixed ignition firing pulse to the coil. So while dwell angle at the points is not critical, it is still worth checking since a very high or low setting may prevent the TAI from operating. Also, if the TAI fails and must be bypassed, the engine will still run smoothly by virtue of the correct dwell angle.

The most convenient point to attach the +12V wire may be the battery (and ignition switch) side of the ballast resistor, if fitted. However if this is not convenient, a wire may have to be run to a 12V 'IGN' connection on the fuse box. Note that the Tuneup Adaptor must not be powered directly from the 12V circuit before the ignition switch, since the continual current drain (although low) will eventually flatten the vehicle's battery.

If however, the unit is not to be permanently mounted in the engine bay, suitable leads may be constructed with banana plugs on one end and 'croc' clips at the other. The Tuneup Adaptor may then be mounted in a low cost plastic box, and used as a portable device by simply attaching the clips to the appropriate test points when it's required.



The actual size artwork for the PCB.

PARTS LIST

- 1 PCB, 85mm x 40mm, code 89td2
- 1 diecast aluminium box, 122mm x 67mm x 40mm
- 3 binding posts
- 1 spring loaded speaker connector, 2-way
- 1 4-pole, 3-position PCB mount sealed rotary switch
- 1 knob

Resistors

All 1/4W, 5% unless noted:
1 x 470 ohm 1/2 watt, 3 x 680, 1 x 2.2k, 1 x 3.3k, 2 x 15k, 1 x 27k, 1 x 33k, 1 x 47k, 1 x 10k horizontal trimpot, 1 x 200k horizontal trimpot

Capacitors

- 1 180pF ceramic
- 1 22nF metallised polyester
- 1 27nF metallised polyester
- 1 0.1uF metallised polyester
- 1 1uF 50V PCB mount electrolytic
- 1 10uF 25V PCB mount electrolytic

Semiconductors

- 1 LM2917 frequency to voltage converter (14-pin version)
- 1 5mm red or amber LED
- 1 15V 1W zener diode
- 1 1N914 diode

Miscellaneous

Nuts and bolts, hookup wire, earthing lug.

But in normal circumstances, the most convenient way to use the Tuneup Adaptor is as a permanent installation, particularly since it must be recalibrated for use with a different number of engine cylinders. So when tune-up time comes around, it's simply a matter of inserting the multimeter probes into the spring loaded connectors, and taking readings on a 20VDC (or similar) range.

This is a convenient voltage range to use on a digital multimeter (DMM), since the thousands of RPM figure is separated from the hundreds by the display's decimal point. So 1200RPM for example will read 1.20 volts. Similarly, the dwell reading is not cluttered by the decimal point, which appears before the figure. So in this case 35 degrees of dwell will be displayed as 0.35 volts. Finally, the voltage reading will read directly, that is, 13.8 volts will read as 13.80 volts.

Of course the multimeter does not have to be a DMM style, despite its convenient display – any multimeter with an impedance above about 20k/V will do nicely. However, if a budding weekend mechanic doesn't have a multimeter it may be high time to make the investment. They are quite inexpensive, and have many other weekend uses besides automotive tinkering.

A workshop manual is another necessary item for successful engine tuning. This will supply figures for dwell angle, idling RPM, ignition timing and other useful information. In fact, if the Tuneup Adaptor, an appropriate manual and an ignition timing light are available, the engine may be given a complete tune with ease.

While the dwell and tacho functions of the Tuneup Adaptor are used primarily for engine tune-ups, the 'volts' position and points indicator LED are useful in other situations. The voltage facility may be used to assess the state of the battery and the charging circuit for example. Normally one would expect a healthy system to quickly stabilise at around 13.8V when the engine is running, and otherwise not drop below about 12V. Also, the indicator LED across the points should come in handy for more basic situations, such as static timing.

Static timing is used where a timing light is unavailable, such as in a remote area (out bush) after a break-down has forced new points to be installed, or the ignition timing altered. In this case the timing marks on the crankcase and main pulley are manually aligned with the ignition 'on', but without the engine running. Since the ignition fires when the points open, the LED should illuminate just as the timing marks pass in the normal direction of engine shaft rotation.

Further to this, the LED may be used as a points indicator whenever the engine is not running, and the ignition is 'on'. In the normal Kettering ignition, this combination presents a danger to the coil through excessive dissipation if the points are closed. That is, the continuous current through the primary winding may cause the coil to overheat, and eventually fail. With the Tuneup Adaptor, the solution is simple – make sure the LED is illuminated (points open) in this situation.

The LED is also handy for basic fault finding. If the engine will not run, yet the LED flashes on and off when the motor is cranked, chances are that the low voltage side of the ignition is fine. However if the LED stays illuminated, the points are probably broken or jammed open. And if the LED is inactive, the points could be welded together, or the coil and/or ballast resistor may be open circuit.

So all in all, the Tuneup Adaptor is quite a handy little automotive test instrument. Not only will it help keep your engine in tune, but it may help rescue you from being a stationary traffic hazard!

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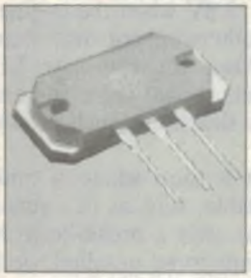

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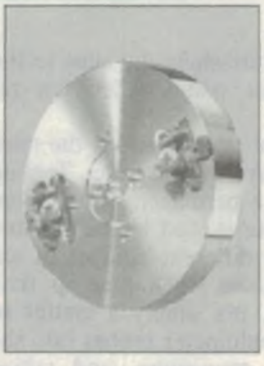

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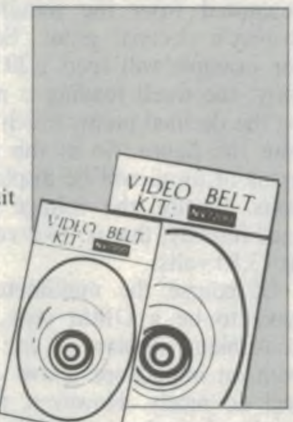

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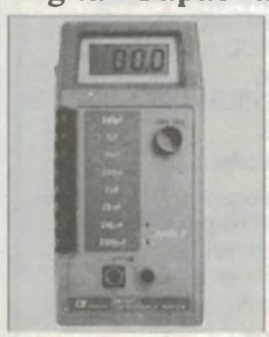

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Construction Project:

New Single-Channel UHF Remote Control Receiver

Here's an all-new version of a single channel remote control receiver/decoder that will match the transmitter presented in January 1989. It's smaller, more versatile than previous models, is very easy to construct and tune. Best of all, it costs less than $35.

by BRANCO JUSTIC and DOMENIC DECARIA

A single channel remote control system is always a very popular project, as the applications for such a system are numerous. We presented our revised single channel transmitter in *EA* January 1989, and now present the all new receiver/decoder to go with it.

Regular readers will no doubt have noticed our 16-channel system as well, described in the November 1988 February 1989 issues. But for those who don't want any more than a single channel remote control system, we offer this project.

The new design is an update (and a considerable one at that) on the system previously presented in EA January 1987, and is therefore compatible with it. However, the new system has more features, and is much smaller.

The aim was to produce a versatile system that is easy to construct and align, but retaining a low cost. The main features we have been able to build into the new receiver/decoder are small size, low current consumption (2mA when no relays are energised), two modes of operation, and two on-board relays. The first relay is called the *switch* relay, and is used to drive the load – for example, to supply power to a car burglar alarm.

The second relay is called the *indicator* relay, and is used to operate an external indicator, such as the blinkers on your car. This feature therefore provides a visual short-duration indication of the new status of the system.

Connections are also provided for a buzzer that operates in parallel with the indicator relay. This way the relay can drive an external indicator, and the buzzer can be integral with the receiver/decoder. The choice is yours.

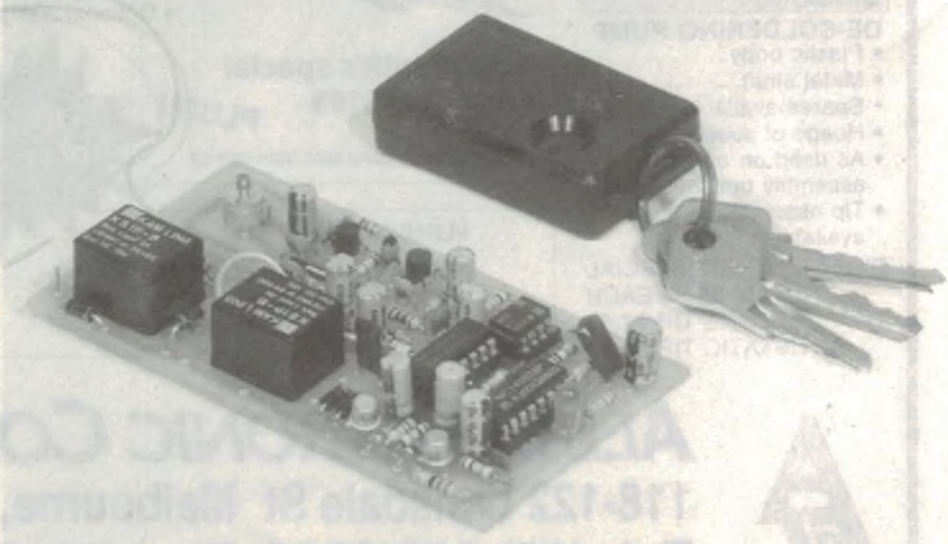
For example, in a remote controlled car burglar alarm, the blinkers could be operated by the indicator relay, and the alarm module by the switch relay. When you 'arm' the system, the blinkers would therefore come on for a certain interval to indicate the alarm is now set. When you 'disarm' the system, the blinkers will turn on for a shorter time. By changing the timing capacitors, you could arrange the times to give say, four flashes by the blinkers at 'arm' and one flash at 'disarm'. This might save you some embarrassment in the car-park!

The two modes of operation, selected with a wire link, are *pulse* and *toggle*. The pulse mode means the switch relay is energised only while the transmitter is activated, while toggle mode requires two transmitter pulses – one to turn the switch relay on, the other to turn it off.

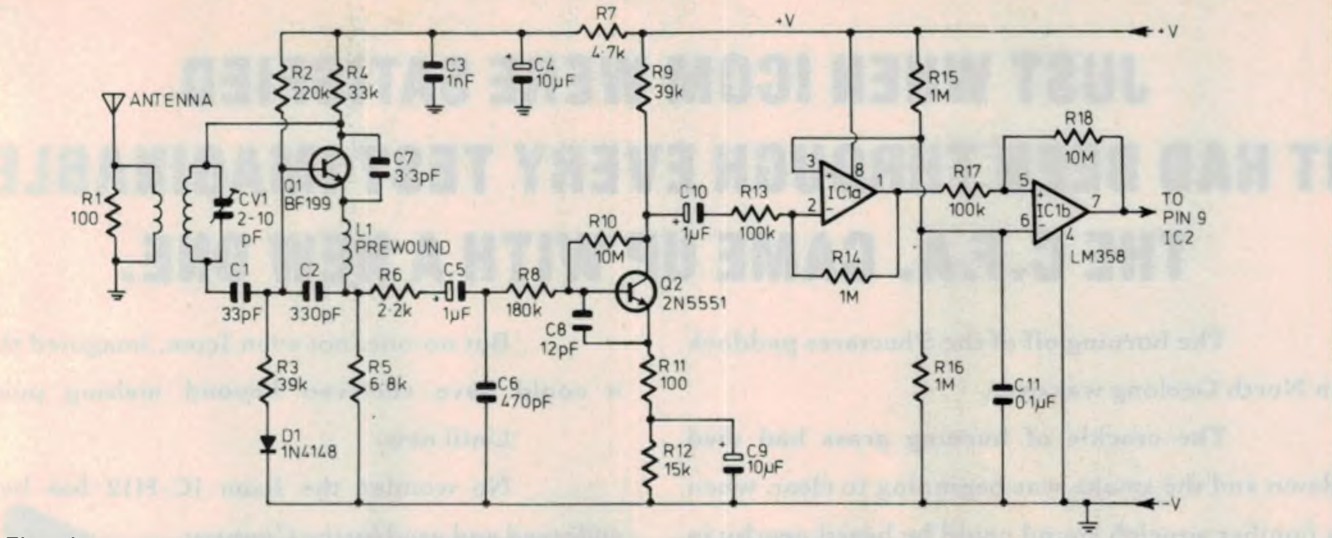
The indicator relay will work with both modes, although not quite as you might expect in pulse mode. In this mode, when you first activate the transmitter, the switch relay will operate for as long as the transmitter push-button is pressed, and the indicator relay will give the long duration indication.

When you release the push-button on the transmitter, the switch relay will turn off, but the indicator relay won't operate at all. The next time you press the transmitter push-button, the switch relay will, of course, come on again, but this time the indicator relay will pulse for the short duration time interval. This is handy if the switch relay is being used to toggle a load.

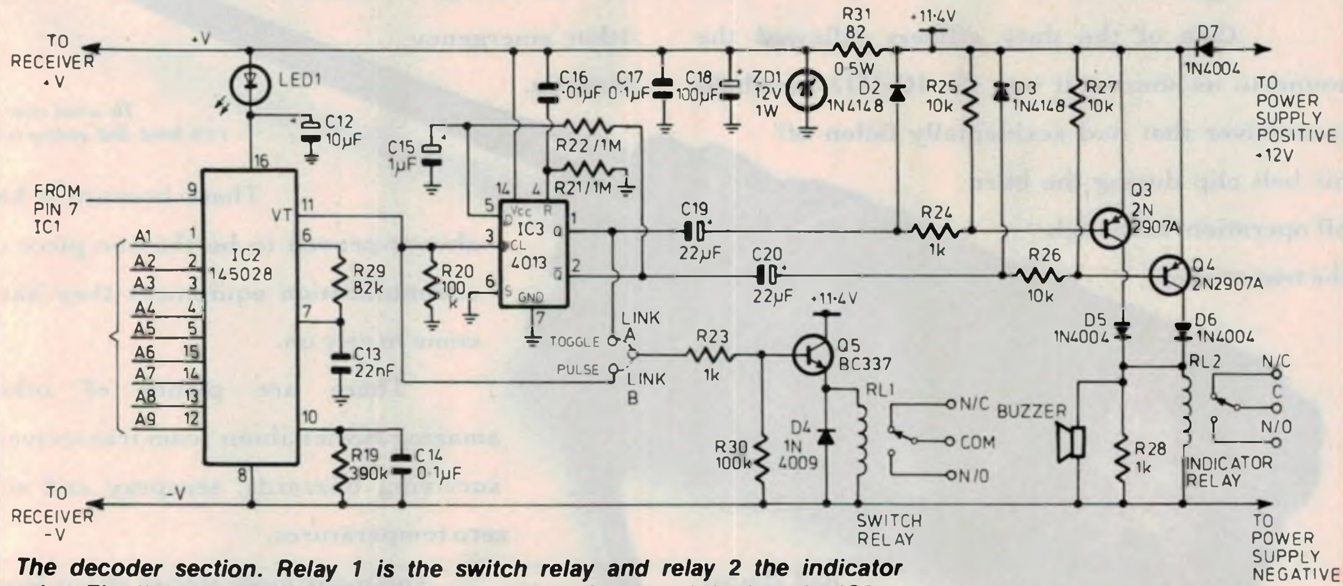
For toggle mode, the first press of the transmitter push-button will set the



The complete UHF single channel remote control system. It's considerably smaller and more versatile than the earlier version.



The circuit diagram of the receiver. The only tuning required is to adjust CV1 for best sensitivity. The output of this circuit connects to the decoder section.



The decoder section. Relay 1 is the switch relay and relay 2 the indicator relay. The link sets the mode of operation. Most of the work is done by IC2, a trinary decoder IC.

switch relay on, and cause the indicator relay to pulse for the long time interval. The next time the transmitter is activated, the switch relay will turn off, and the indicator relay will pulse for the short duration time interval.

The system has 19122 user selectable *key* codes, making it fairly secure against 'illegal' or unauthorised operation. The prototype was able to function reliably at distances exceeding 50 metres, giving excellent range. This will depend on the tuning of the transmitter and the receiver, as will be described.

How it works

The single channel transmitter that goes with this project was described in *EA* January 1989. The receiver/decoder is a bit more complex, as it comprises two sections. We start with the receiver section.

The circuitry associated with Q1 forms a self-detecting regenerative UHF receiver that operates at 304MHz. The detected output from this stage, representing the original binary information, is amplified by the common emitter amplifier comprising Q2 and its associated circuitry. Further amplification is provided by the inverting amplifier IC1a. This stage has a gain of 10 and its output is coupled to the Schmitt trigger IC1b.

Resistors R15 and R16 provide half-rail bias for both IC1a and IC1b. The original transmitted digital signal is produced at the output of IC1b and is then passed onto the decoder section. The decoder section receives the binary information from the output of IC1b, which is applied to the input (pin 9) of the trinary decoder IC2. If the code sequence at the input of IC2 matches its address lines and the rate of the code sequence matches its timing (set by R29, C13, R30 and C14), the valid transmission output terminal (VT-pin 11) will go high.

The indicator LED (LED1) is connected in series with the decoder's positive supply pin and serves as a visual indicator for correctly received data (lights up briefly during a valid transmission) and also drops the available supply voltage to the decoder by approximately 2 volts. This is necessary as the maximum recommended supply voltage for one of the two available decoders (SC1344) is 10 volts.

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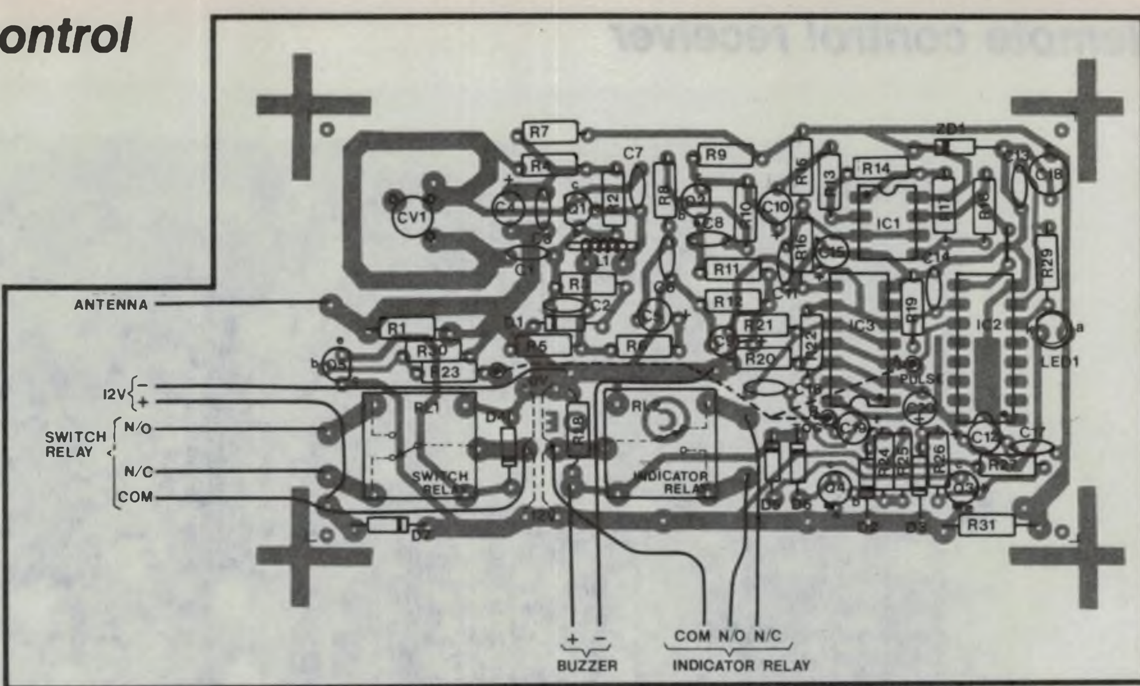
Remote control receiver



The PCB layout. The board is fairly crowded, requiring care that all components are correctly placed. All external connections should be taken from the points shown.

The valid transmission pulse output from the decoder IC2 is applied to the input of flipflop IC3, and also to a PCB terminal labelled 'pulse'. If this terminal is connected by link B to R23, a high at the valid transmission output will turn on transistor Q5 via resistor R23 and the switch relay will operate. Thus link B establishes the mode of operation in which the relay will only remain on only while the transmitter push-button is pressed, that is, *pulsed* operation.

The D-type flipflop IC3 has its Q-bar output connected to its D input, via R22, establishing toggle operation of the flipflop. This means that each time the VT output terminal of the decoder sends a pulse to the clock terminal of IC3, the outputs (pins 1 and 2) will toggle. This allows alternate presses of the transmitter push-button to toggle IC3. The addition of R22 and C15 stops IC3 from changing its output states at less than 1 second intervals, and prevents possible double toggling when the transmitter is operated for a longer than usual period.

C16 and R21 reset the flipflop when power is first applied to the relay board, setting the Q output to a low, and the Q-bar output to a high. If link A was connected (instead of link B), the low at pin 1 (Q output) will hold Q5 off, preventing the relay from operating. A pulse from the transmitter will now cause the flipflop to toggle, and turn on Q5 by the logic 1 now present at the Q output. A subsequent press will turn it off again. Thus if *toggle* operation is required, link A is connected to couple R23 to the Q output of the flipflop.

Links A and B therefore establish the mode of operation of the decoder, and are connected as required during construction. Note that both flipflops of the dual CMOS D flipflop (IC3) are connected in parallel, to give more output. This is not shown on the circuit, but has been implemented on the PCB.

The indicator relay is driven by Q3 and Q4, which are in turn driven by the flipflop through timing capacitors C19 and C20. The indicator relay is independent of the mode of operation – it always operates as though the system is in toggle mode. The switch relay can be driven either by the flipflop (toggle mode) or by the VT terminal (pulse mode). For this reason, you will probably only use the indicator relay when the system is in toggle mode.

The operation of the indicator relay driver circuitry is as follows. When the system is first powered up, pin 1 (Q output) of IC3 is set low, and pin 2 (Q-bar output) is set high. Because the Q output is low, timing capacitor C19 will charge through R24 and the parallel combination of R24 and the base-emitter junction of Q3. This will cause Q3 to conduct and operate the indicator relay until C19 has charged. This time interval is only short: around 100ms or so. Thus, the indicator relay will operate once at power on.

When a valid transmission is received, the flipflop will toggle, setting Q to a high (thereby turning on the switch relay) and the Q-bar output will go low. This causes C20 to charge through R26 and the parallel combination of R27 and the base-emitter of Q4, again operating the indicator relay. Because the value of R26 is larger than that of R24, the time the relay will operate is therefore longer (approximately 1 second), giving a longer pulse to indicate that the switch relay is now on.

If another valid transmission pulse is received, the Q output will go low, (turning off the switch relay) and allow C19 to charge as already described. This will give the short duration pulse to indicate that the switch relay is now turned off.

Diodes D2 and D3 provide a discharge path for the capacitors when the outputs of the flipflop return to their high state. Diodes D5 and D6 isolate the emitters of Q3 and Q4 from each other and allow these transistors to both operate the indicator relay.

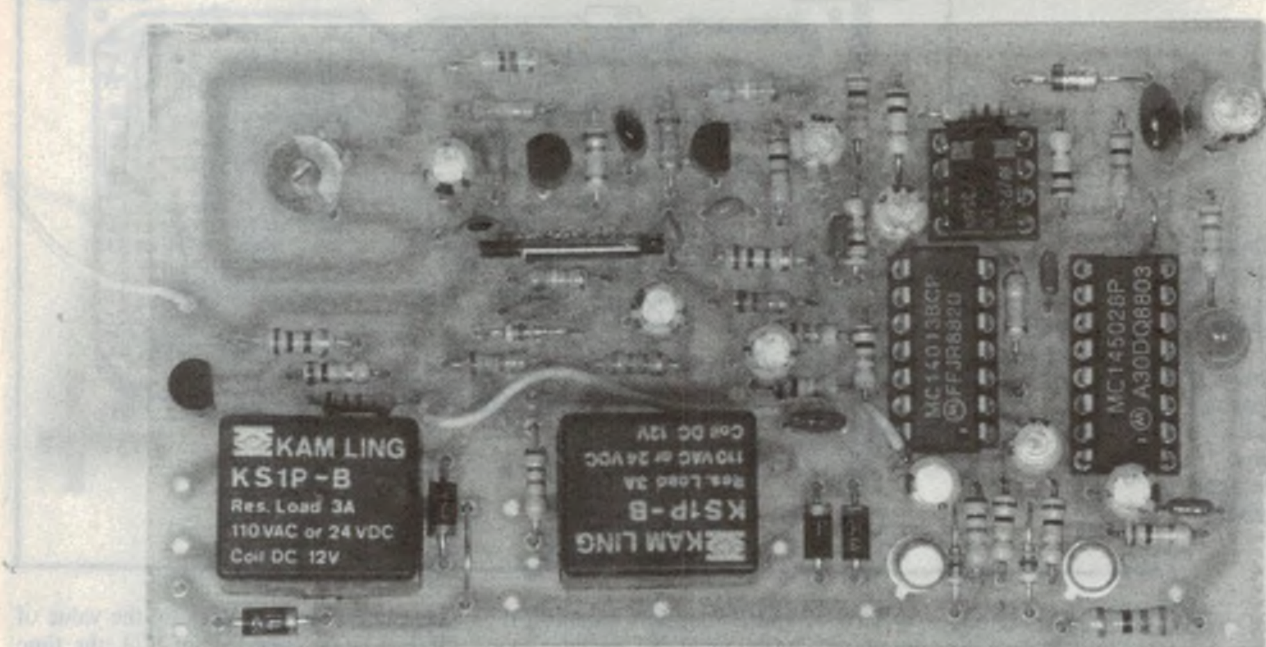
Resistor R31 and the 12V zener diode ZD1 are included to prevent the supply voltage to the ICs exceeding 12V, in the event of transients or if the applied supply voltage is greater than 12V. Diode D7 protects the circuit in the event of a reverse supply connection.

Construction

A complete kit of parts is available for this project from its designers, Oatley Electronics, who can also provide the necessary technical support to constructors. For this reason, the PCB artwork is not included in this article. Note that the matching UHF transmitter kit is also available from this supplier.

Before starting construction, carefully check the PCB for any faults. Then insert and solder the low profile compo-

Remote control receiver



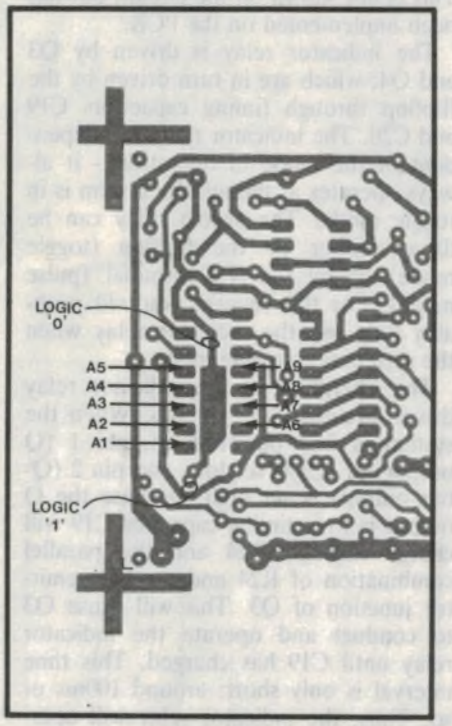
This picture shows the receiver/decoder PCB. The unit is set to 'toggle' mode by the long wire link. Note also that IC1 (the LM358) faces the opposite way to the other two ICs.

nents into the PCB, paying close attention to the orientation of the diodes and the electrolytic capacitors. Make sure that the 1N4148 signal diodes and the 1N4004 power diodes are not interchanged, as the signal diodes will fail if used in lieu of a power diode. There is one wire link required, next to IC2. Some components are placed fairly closely to each other on the PCB, and care should be taken to ensure they are placed in the correct position. All components mount horizontally.

Next install the transistors, again being careful that they are placed the correct way round, and that the type numbers are not interchanged. The 2N2907 types are PNP, and the BF199 type is for RF use. Now solder in the IC sockets and the relays. Note that IC1 (LM358) faces the opposite way to the other ICs.

Before proceeding, decide on the mode of operation you want. If toggle mode is selected, connect the link marked 'B' on the layout diagram. If pulse mode is required, connect the link shown as 'A'. Use a length of insulated single strand wire for this purpose (telephone-type wire is fine) and leave it long enough so you can change it later if needed.

Connect the leads for the antenna, power supply and any leads from the



This diagram shows how to code the receiver. Connect any or all of the nine address pins to either a logic 1, a logic 0 or leave open-circuit. The diagram shows the PCB tracks that can be used to supply either logic level. The code you choose must match the code in your transmitter.

relays you might require. It is important that the power supply earth be connected to the point shown on the layout diagram. The track extending from the antenna connection point to the main earth track actually behaves as an inductor at 304MHz, and should not be used as an earth point.

The antenna used on the prototype was a 250mm length of insulated multi-strand hookup wire.

Finally insert the ICs into their sockets, and check over your soldering and construction in general. The ICs should be handled carefully, as (apart from IC1) they are CMOS devices.

It is recommended that you code the transmitter and receiver only after you test the operation of the system. No coding need be applied for the following testing procedure, as the PCBs are supplied with all coded inputs left open circuit. This should match the transmitter, unless you are using a transmitter that has already been coded. In this case, either remove the code from the transmitter, or match the receiver to the transmitter code.

Testing

You will need a working transmitter to check the receiver/decoder. Remember that you can confirm if the transmitter is functioning by holding it next to

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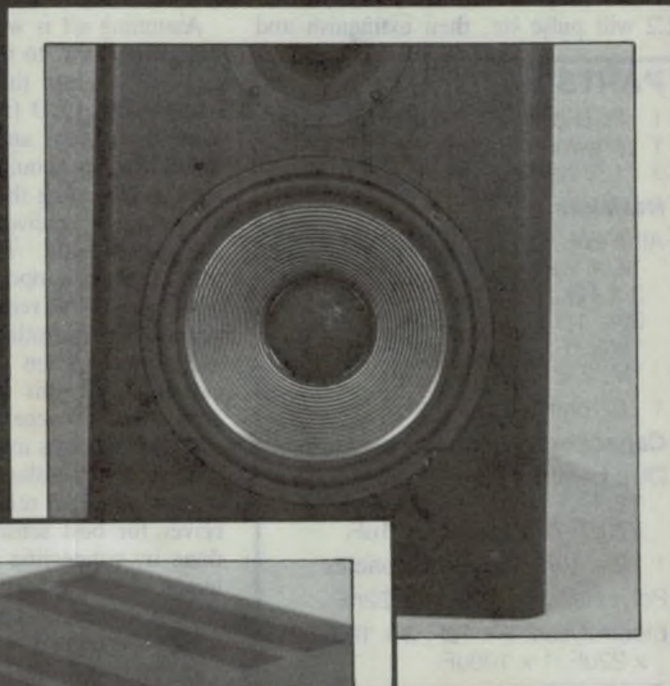

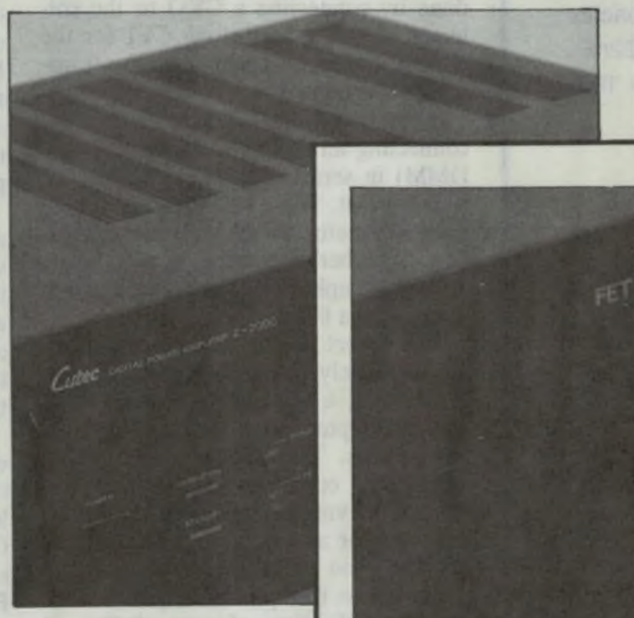

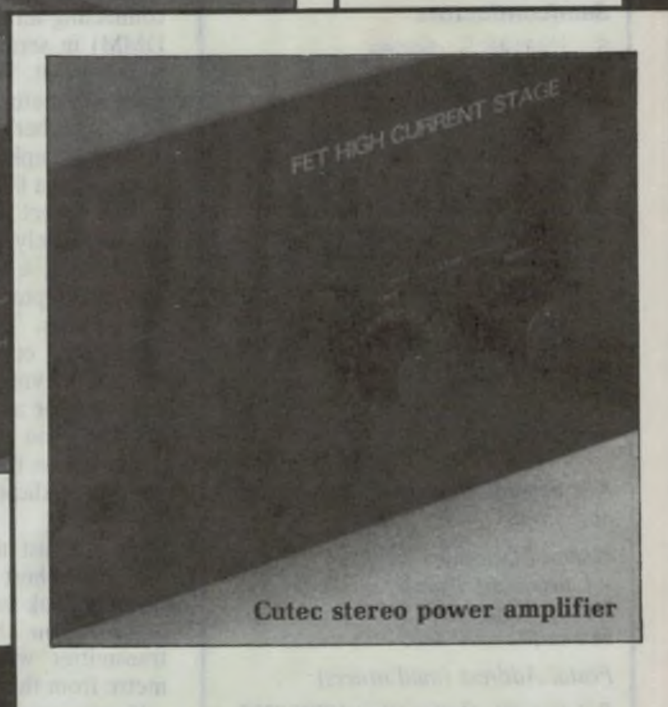

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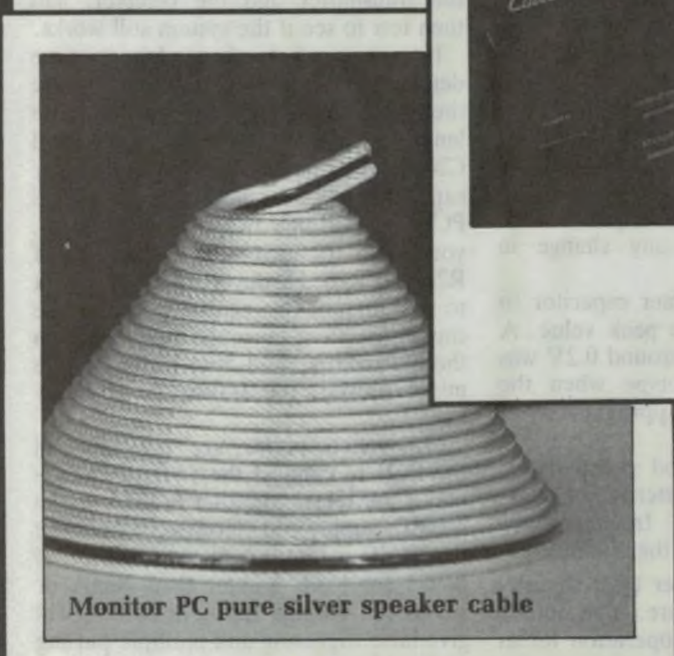

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the ferrite rod of an AM radio, and listening for interference when the transmitter button is pressed.

Apply 12V DC to the receiver/decoder, and if all is well the LED next to IC2 will pulse on, then extinguish and the indicator relay will operate for a brief time. If the LED stays on, check around IC2. If the LED stays on even with IC2 removed, either replace C12, or look for track shorts.

Assuming all is well so far, hold the transmitter next to the receiver's antenna, and operate the transmitter pushbutton. The LED (next to IC2) should come on briefly, and the indicator and switch relays should both operate. If not, try adjusting the trimmer capacitor CV1 on the receiver PCB, and repeat the experiment. The adjusting tool (preferably a proper insulated aligning tool) should be removed from the capacitor during testing, as it will detune the receiver when in contact with the capacitor. At this close range the receiver should receive the transmitted signal even if it is incorrectly tuned.

Having established correct operation at close range, it remains to tune the receiver for best sensitivity. This can be done by connecting a CRO to the collector of Q2 and adjusting CV1 for the highest amplitude signal when the transmitter is activated.

If you don't have a CRO, you can try connecting an AC voltmeter (analog or DMM) in series with a 0.1uF capacitor to this point. However, you will need a sensitive meter to get a useful indication. Another alternative is to connect an audio amplifier to this point, again in series with a 0.1uF capacitor.

The correct signal is a series of pulses, approximately 5ms wide, spaced by 5ms – in effect, a square wave of 100Hz – but interrupted every few pulses by a gap of 8ms. This will be quite audible through a conventional amplifier, although the volume should be kept down low, to hear any increase as adjustment is made. You could connect an AC voltmeter across the speaker to give a more reliable indication of any change in level.

Now adjust the trimmer capacitor to get the highest peak to peak value. A peak to peak value of around 0.2V was obtained on the prototype when the transmitter was held approximately 1 metre from the antenna.

If you cannot get good sensitivity, it may be that the transmitter is not operating at the correct frequency of 304MHz. Try adjusting the trimmer capacitor in the transmitter (just slightly) and repeat the procedure. You should be able to get reliable operation for at least 10 metres, and even more given ideal transmission conditions and correct tuning.

PARTS LIST

1 PCB coded OE89R
1 prewound inductor
2 12V relays

Resistors

All 1/4W, 5%: 2 x 100ohm, 3 x 1k, 1 x 2.2k, 1 x 4.7k, 1 x 6.8k, 3 x 10k, 1 x 15k, 1 x 33k, 2 x 39k, 1 x 82k, 4 x 100k, 1 x 180k, 1 x 220k, 1 x 390k, 5 x 1M, 2 x 10M.

1 82 ohm 1/2W.

Capacitors

Disc ceramics: 1 x 3.3pF, 1 x 12pF, 1 x 33pF, 1 x 330pF, 1 x 470pF, 1 x 1nF, 3 x 0.1uF.

1 2 – 10pF trimmer capacitor

Polyester: 1 x 10nF, 1 x 22nF

Electrolytics: 3 x 1uF, 3 x 10uF, 2 x 22uF, 1 x 100uF.

Semiconductors

3 1N4148 Si diodes
4 1N4004 1 amp diodes
1 12V 1W zener diode
1 Green LED (5mm)
1 BF199 Si NPN VHF transistor
1 2N5551 Si NPN transistor
2 2N2907A Si PNP transistors
1 BC337 Si transistor
1 LM358 dual op amp IC
1 MC145028 Trinary decoder IC
1 4013 CMOS dual D flipflop

Miscellaneous

Hook up wire, optional IC sockets, solder etc.

Kits of parts for this project are available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
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Postal Address (mail orders):

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Transmitter kit, new version (battery excluded) $19.99
Transmitter kit, old version (battery excluded) $15.00
12V Alkaline battery $2.00
Receiver (complete kit) $34.90
Post & Packing charge............. $2.50

Coding

This project gives you a security code combination of 19122 codes to choose from. The supplied circuit boards for both the transmitter and the receiver have all the address lines left open circuit and it is up to you to add your own code, but only after correct operation has been confirmed.

The method of coding the transmitter was explained in the text for that project, although a layout error resulted in the PCB artwork diagram being printed upside down. See the March edition, in the errata section, for the correct diagram.

The receiver code must match the code applied to the transmitter, and is applied in the same way. That is, the nine address pins of IC2 must be connected either to a logic 1, logic 0 or be left open-circuit.

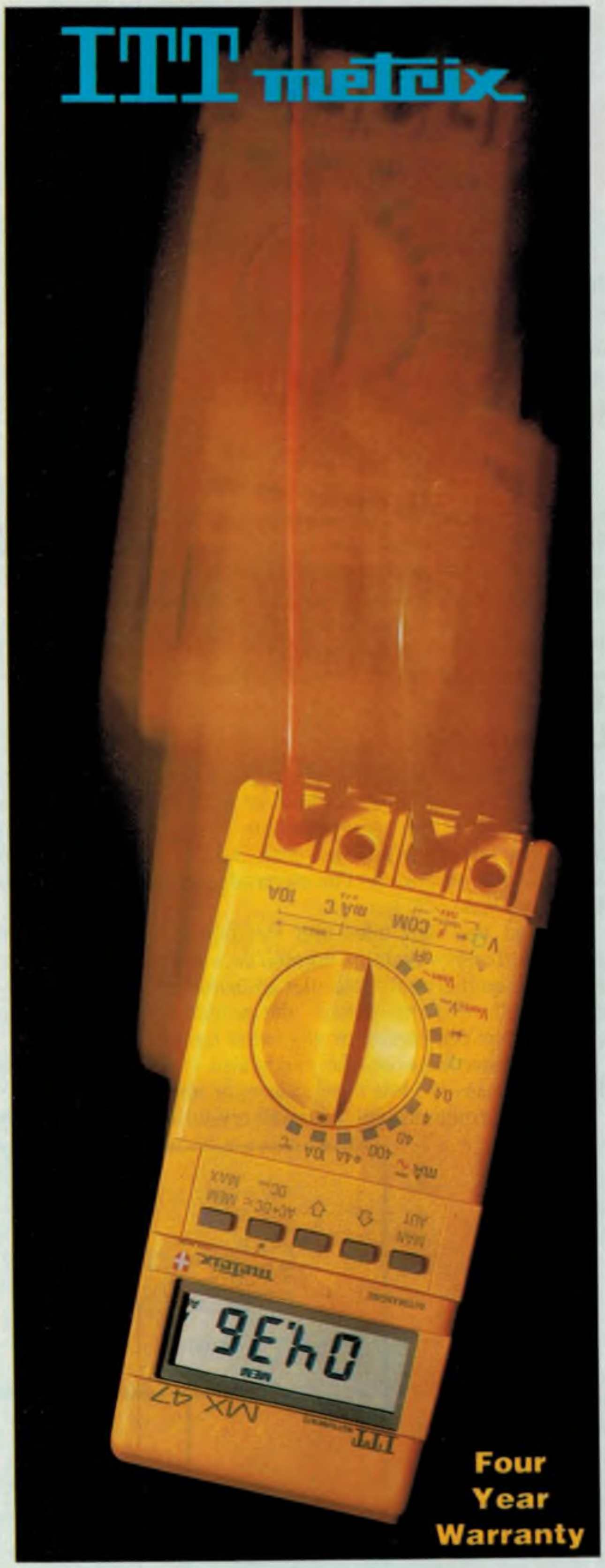
These connections are made by soldering short lengths of tinned copper wire to the chosen logic levels and the corresponding address pins on the PCBs. The method of doing this is shown in the coding diagram, which shows the PCB tracks you can connect to for a logic 1 or a logic 0 for coding purposes.

If you are a little unsure about the coding procedure, remember that the system will work to start with since all the codes are identical in that all pins are open-circuit. You can then try changing one code at a time, in both the transmitter and the receiver, and then test to see if the system still works.

If you want to have longer time delays for the indicator relay, change the value of C19 to modify the pulse length indicating switch relay OFF, and C20 for the relay ON indication. Larger capacitors will be a tight squeeze on the PCB, and if this becomes a problem, you could try increasing the values of R24 and R26. However, there is a limit to the amount this can be done, as the transistor base currents flow through these resistors, and too high a value might prevent the transistors conducting.

Connection points are provided on the PCB to connect the common terminal of the relays to either ground or the positive supply rail. However don't use the positive supply rail as a source of power for loads greater than 20mA or so, as the voltage transient caused will give false triggering and multiple pulsing of the relay.

Then all that remains is putting the system to work. And that's up to you...



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The patented Secur'X feature *locks* the leads into the terminals. So they can't fall out or get pulled out.

It's just one of the features that must make Metrix your first choice in hand held multimeters.

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While most multimeters only offer 2000 counts and a few boast 3200 counts, the Metrix offers higher 4000 count resolution. Metrix also feature easy reading from a distance with massive 12.7mm high digits.

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Model	Features	Ex Tax	Inc Tax
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MX43	0.5%dc accuracy, adds waterproofing	$220	$264
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A User's Guide to LCDs

Liquid crystals are now the fastest growing area of display technology, with LCDs firmly entrenched in many products including watches, calculators, digital multimeters, laptop computers and portable TV's. There are also quite a few different types of LCD in use. Here's a user guide to LCDs, how they work and how they're used.

Liquid crystals are materials which combine the properties of both liquids and crystals. Rather than a melting point they have a temperature range, known as a *mesophase*, within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to that of a solid crystal.

Around 1970 it was found that thin layers of a certain type of liquid crystals can be switched from transparent to opaque or vice-versa, by application of a voltage. This property is the fundamental operating principle of all liquid crystal displays (LCDs).

The main advantages and features of LCDs are:

- Flat and compact size. LCDs are lightweight and very thin; the thickness of the display is only a few millimetres.
- Low power consumption. Low power and supply voltage requirements mean that they can easily be powered over long periods by batteries and at the same time be compatible with modern electronic circuits, e.g., CMOS.
- Passive display. LCDs do not generate light and as such are comparable to printed material. One needs light to read the display and it does not fade as the ambient light increases. Reading in dark conditions is possible with the use of back lighting.
- Reliability. LCDs have a wide operating temparature range and a long life.
- Flexible design. A change in display size or layout is relatively simple, making LCDs very suitable for customization.
- Low cost. LCDs are the most economically produced flat display system, including drive and supply aspects.

Initially LCDs were used almost exclusively in watches, calculators and measuring instruments. These were simple, usually seven segment displays with a limited amount of numeric data. More recent advances in technology have extended legibility, information content and the temperature range, which has lead to applications in telecommunications, cars, entertainment electronics and computers.

LCDs are now the fastest growing display technology. They are currently replacing the CRT for the display of text and graphics and may eventually replace the CRT in TV applications.

LCD structure

An LCD consists of two glass plates which are sealed together with a gap between them of 6 to 10um (Fig.1). The inner surfaces of the glass plates are coated with transparent electrodes which define the characters, symbols, or other patterns to be displayed. The electrode material is usually Indium/Tin Oxide (ITO).

Between the electrodes and the liquid crystal there are polymeric layers which are treated in a way that induces the adjacent liquid crystal molecules to maintain a defined orientation angle. For this reason, the polymeric layers are also known as the *orientation* or *alignment* layers.

The distance between the two plates is set within narrow limits by means of glass fibre spacers or minute plastic balls.

The most common type of liquid crystal used in displays is

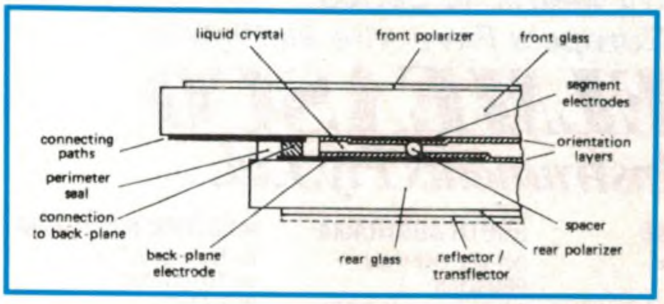


Fig.1: Construction of a liquid crystal display.

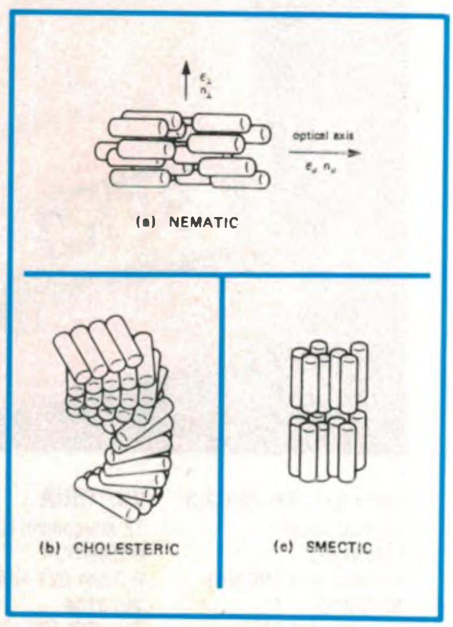
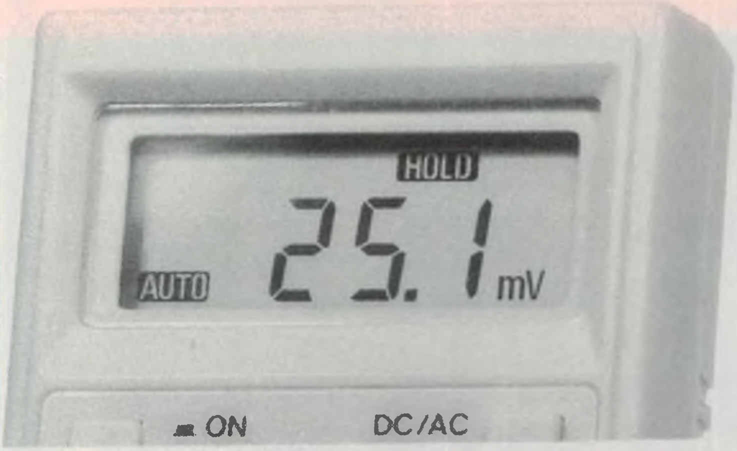


Fig.2: Molecular structure of liquid crystals
(a) nematic
(b) cholesteric
(c) smectic.



the *nematic* type of Fig.2(a). In nematic liquid crystal the long rod-like molecules align themselves spontaneously parallel to each other, which gives the material anisotropic optical and electrical properties – i.e., it has different properties in different directions.

Other classes of liquid crystal which are increasing in significance for displays are the *cholesteric* (Fig.2(b)) and *smectic* (Fig.2(c)) types.

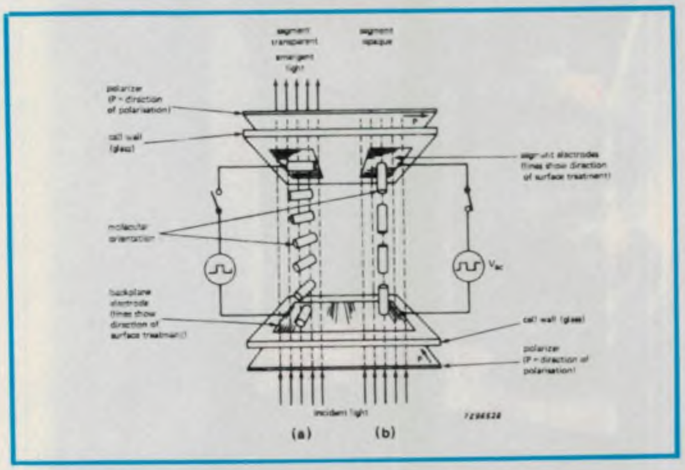


Fig.3: Principle of operation of the Twisted Nematic (TN) display (a) OFF state (b) ON state.

Twisted nematic LCD

The operating principle of *Twisted Nematic* (TN) LCDs is illustrated in Fig.3. The nematic liquid crystal molecules are anchored in a fixed direction at the top and bottom plates by the orientation layer.

As the orientation directions of the top and bottom plates differ by an angle of 90°, the crystal molecules are twisted through a 90° helix between the two plates. Polarising filters are aligned with the orientation directions at the respective sides. Polarised light from the bottom polariser is then guided by the crystal molecules through the helix to the top plate, with its polarisation direction rotated by 90°. This property is caused by the *optical* anisotropy of the molecules. As such the polarisation direction is aligned with the top polariser and the light passes unhindered through it to give the display a bright appearance (Fig.3(a)).

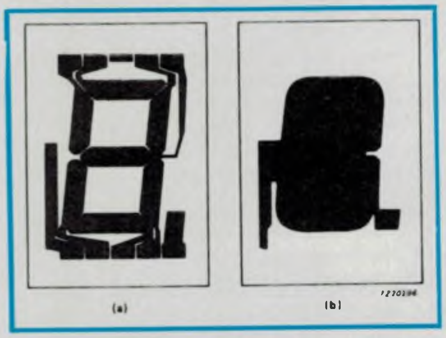
If sufficient voltage is applied across the electrodes, the *electrical* anistropy of the molecules will cause them to align with the electric field and the 90° twist in the optic axis will be distorted. The light will then pass through the liquid crystal but will maintain its polarisation direction and will be absorbed by the second polariser – see Fig.3(b).

On switching off, the initial state is restored and the cell is again transparent. Under these conditions the display will appear black when ON and bright when OFF, which is known as a *positive* image display.

If one polariser is rotated through 90° the effect will be reversed and the display will appear black under no voltage field conditions and bright when a voltage is applied – which is known as a *negative* image display.

When the electrodes completely cover the top and bottom plates the LCD will act as a light shutter. A more usual arrangement is for the electrodes to be patterned such that specific segments can be switched to form numbers, letters, or graphics. An example of this is the basic seven-segment digit shown in Fig.4. Any number can be displayed by

Fig.4: A seven segment plus decimal point display (a) segment electrodes (b) common electrodes.



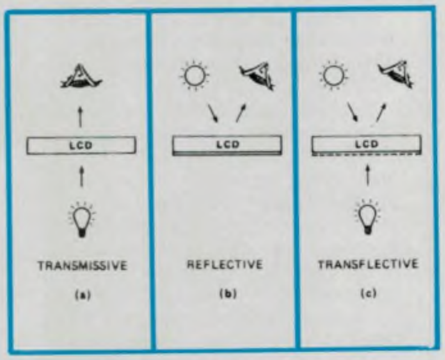
switching on the appropriate electrodes that form the various segments. It should be noted that the actual display segments are only formed where the segment electrodes and the common (back-plane) electrode overlap; the remaining parts of the electrodes are required for connections to the outside.

Illumination modes

LCDs can be operated in one of three modes, depending on the ambient light conditions:

- Reflective mode – where the LCD is backed by a diffuse metallic reflector, such as brushed aluminium foil, that reflects ambient light back through the display. This mode is

Fig.5: The three LCD illumination modes: (a) transmissive (b) reflective (c) transflective.



best suited to applications where there is always sufficient ambient light. Reflective mode is especially suited to battery operated displays as no lighting power is required. See Fig.5(b).
- Transmissive mode – where the display is lit from behind. Negative image displays are best suited to this mode. Their appearance is similar to active displays such as Light Emitting Diodes (LEDs), Vacuum Fluorescent Displays (VFDs) etc. This type of display can also be projected like a slide (Fig.5(a)).
- Transflective mode – a combination of transmissive and reflective modes. The display is backed by a partly transmissive

Guide to LCDs

reflector (transflector) which reflects ambient light as well as transmitting diffused back-lighting for night use (Fig.5(c)).

Colour in TN LCDs

Colour can be introduced into a TN display in three ways: colour selective polarisers, coloured filters and coloured back-lighting.

Colour selective polarisers produce coloured segments on a bright background or bright segments on a coloured background. By using two colour selective polarisers a two colour combination can be produced; for example red and green polarisers will give red segments on a green background or vice versa.

Coloured filters may be either foil behind the display or translucent colours printed onto the display itself. They are best suited to transmissive mode LCDs with a negative image i.e., coloured segments on a dark background.

Coloured back-lighting produces black segments on a coloured background or coloured segments on a dark background. It is possible to change the colour of the display by using two different coloured backlights e.g., between red and green, and by using both lights, white. It should be noted that the colour effect in a transflective display will be greatly reduced under high ambient light conditions.

Optical properties

The legibility of an LCD depends on a variety of factors such as pattern layout, technology, driving and illumination conditions, viewing direction, viewing angle, viewing distance and operating temperature. The most important optical characteristics that define legibility are brightness and contrast ratio.

The *brightness* of an LCD is expressed as the luminance of the reflected or transmitted light compared to the luminance of the incident light. For a reflective LCD a magnesium oxide (MgO) surface is used as a reference for testing luminance. The brightness of a TN LCD cannot be higher than 50%, since an ideal polarizer only transmits half the incident light. A reflective display will, therefore, tend to appear rather grey. A brighter display can be obtained by using backlighting.

The *contrast ratio* (C_R) of an LCD is the ratio between the brightness of the light areas (B_L) and the brightness of the dark areas (B_DB) of the display.

i.e., $C_R = B_L/B_D$

For a TN display the typical maximum contrast ratio can range from between 5 and 50.

In a reflective display, the maximum contrast ratio that can be detected by the human eye is normally about 10 and the lower limit of good legibility, about 2. For comparison the contrast ratio of this page is about 7.

A higher contrast ratio is necessary for back illuminated displays, especially for negative image displays, as the human eye can easily detect light leaking through the dark background of a display. The leakage can be reduced by matching the spectral transmission of the background and spectral emission of the backlighting system correctly (especially if a colour filter is used).

Both brightness and contrast depend on the type of polarisers used. For reflective displays with a positive image, low efficiency polarisers produce brighter displays with a low contrast. High efficiency polarisers produce a high contrast, but will reduce brightness considerably.

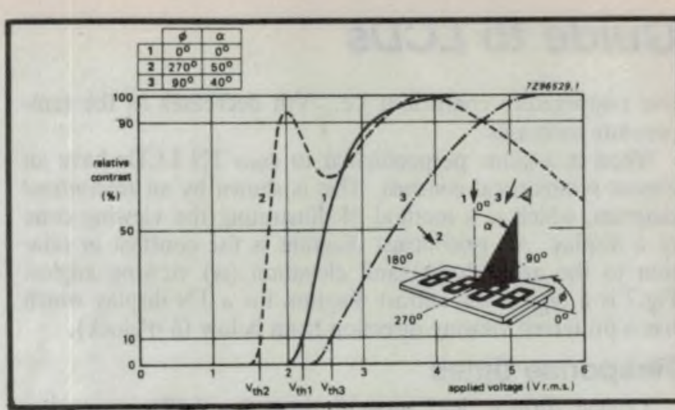


Fig.6: Relative contrast as a function of applied voltage.

Viewing angle

A twisted nematic LCD has a preferred viewing direction (ϕ_{pref} measured in the plane of the LCD), which is built-in during the manufacturing process by treatment of the orientation layers. For most standard applications this preferred direction is from below (6 o'clock direction), although other directions can also be manufactured.

Fig.6 shows a contrast versus voltage curve from three different viewing angles α which are referenced perpendicularly to the LCD. At a very low voltage the display is not visible; as the voltage is increased the pattern first appears at low elevation angles (high values of α) in the preferred viewing direction (curve 2). By further increasing the voltage the pattern becomes more visible at higher elevation angles.

If the contrast is observed at a fixed drive voltage within the plane ϕ_{pref} and perpendicularly to the LCD the viewing angle is α_{opt} and maximum contrast occurs. At higher voltages the value of α_{opt} becomes rather small. However, $\alpha_{opt} = 0$ can never be reached and a basic asymmetry will always remain.

The voltage at which a display becomes visible (10% of maximum contrast) at a specific viewing direction and viewing angle, is known as the *threshold voltage* (Vth). The voltage at which contrast reaches 90% of its maximum value is known as the saturation voltage (Vsat).

Voltage and contrast characteristics will vary for different liquid crystal mixtures. Most mixtures will also have a nega-

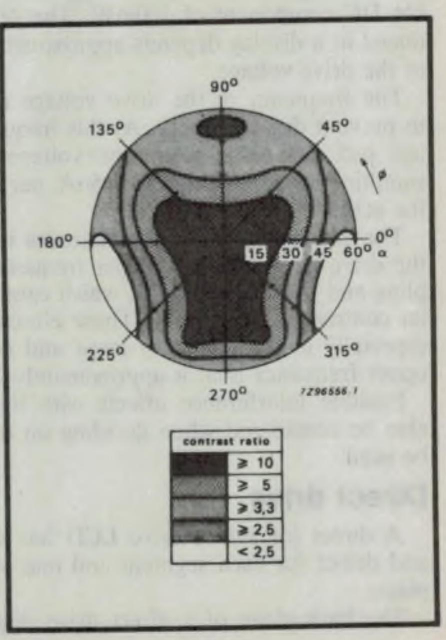


Fig.7: Typical isocontrast diagram for a direct-driven, reflective TN display, showing the variation of contrast as a function of the two components α and φ of the viewing angle.

Guide to LCDs

tive temperature coefficient i.e., Vth decreases as the temperature increases.

When in a plane perpendicular to ϕ_{pref} TN LCDs have an almost symmetrical contrast. This is shown by an *isocontrast diagram*, which is a method of illustrating the viewing cone of a display. An isocontrast diagram is the contrast in relation to the azimuth (ϕ) and elevation (α) viewing angles. Fig.7 is a typical isocontrast diagram for a TN display which has a preferred viewing direction from below (6 o'clock).

Response times

Typical turn-on and turn-off times for LCDs range between 50 and 100ms at room temperature. One of the main influences upon response times is the liquid crystal viscosity. As the viscosity of the material increases with decreasing temperature the molecules become less free to move, resulting in longer response times.

Response times are also affected by applied voltage, drive method and liquid crystal layer thickness.

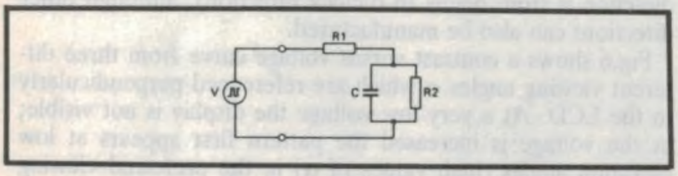


Fig.8: simplified equivalent circuit of an LCD. R1 is the series resistance of the electrodes. R2 the series resistance of the liquid crystal and C the interelectrode capacitance.

Typical values are $R1 = 1\ M\Omega/cm^2$, $C = 1.5nF/cm^2$.

Driving LCDs

Each segment of an LCD can be considered the equivalent of an electrical capacitance with a very high parallel and low series resistance (Fig.8). The capacitance is voltage dependant, as the liquid crystal molecules have anisotropic dielectric properties.

Applying a DC voltage will cause electro-chemical reactions which shorten the life of the LCD. For this reason, the drive voltage must be alternating with a maximum permissible DC component of 100mW. The optical effect then produced in a display depends approximately on the RMS value of the drive voltage.

The frequency of the drive voltage must be at least 30Hz to prevent display flicker. At this frequency and a drive voltage just above the saturation voltage, typical current consumption is approximately 1.5uA per square centimetre of the activated display area.

The current consumption increases in direct proportion to the drive frequency. An upper frequency limit is set by coupling and relaxation effects, which cause ghosting and irregular contrast in the display. These effects must be considered, especially in the layout of large and complex displays. The upper frequency limit is approximately 200Hz.

Possible interference effects with lighting systems should also be considered when deciding on the drive frequency to be used.

Direct drive

A direct (or static) drive LCD has a separate connection and driver for each segment and one for the common back-plane.

The back-plane of a direct drive display is usually driven by a square wave having a peak-to-peak value (Vop) that is above the saturation voltage (Vsat). To select a segment, the inverse of the back-plane waveform is applied to the appropriate electrode. This produces an RMS voltage between the back-plane and segment electrodes which is equal to Vop. The back-plane voltage waveform is also applied to all non-selected segments, which results in a net zero voltage across them. It should be noted that a *symmetrical* square wave must be used, otherwise undesirable DC components will be applied to the liquid crystal.

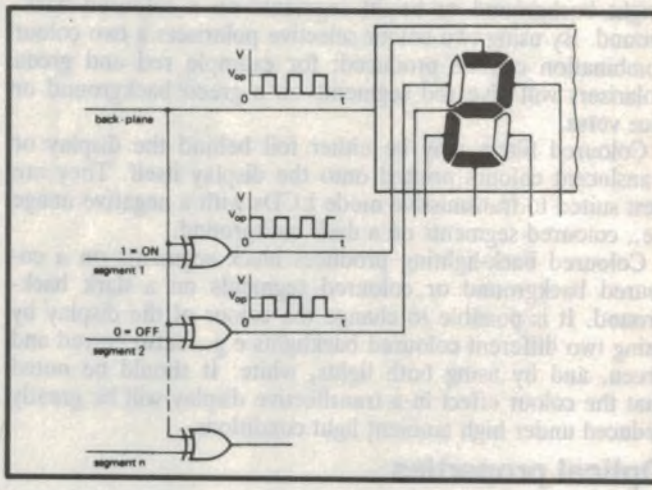


Fig.9: Phase-switching circuit for direct-drive.

Fig.9 illustrates a typical direct drive circuit with exclusive-OR gates controlling the voltage to the different segments. Individual segments are selected by switching the appropriate segment control line HIGH. This will have the effect of inverting the back-plane voltage applied to the segment. The control lines of non-selected segments are LOW, so that no inversion takes place.

The advantages of direct drive are broad temperature ranges, wide viewing angles, fast response times and insensitivity to driving voltage tolerance. However, the number of connections and driving circuits needed can become very large for complex displays.

Multiplex drive

In high information density displays, such as a dot matrix, it is difficult or impossible to connect each dot or segment individually to an edge contact. The large number of contacts and drivers required could lead to low reliability and high

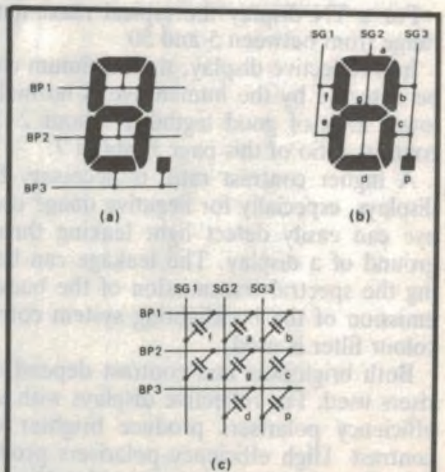


Fig.10: A single digit plus point, 8 segment LCD with 1:3 multiplex drive (a) Back-plane electrodes (b) Segment grouping (c) Equivalent circuit.

cost. Therefore, it is necessary to use multiplex (MUX) drive.

Multiplex drive electrodes are arranged in the form of a matrix. Segments are connected in groups and the back-plane is split into several commons, so that every segment in a group has a different back-plane. A segment is then no longer identified by an individual external contact, but by a group contact and a specific back-plane. The multiplex ratio is defined as 1:N, where N is the number of back-planes, or segments, per group.

Fig.10 illustrates the segment to back-plane assignment for a seven segment digit using 1:3 multiplex drive. The number of contacts needed has been reduced from the nine used in direct-drive, to six. Fig.10(c) shows the equivalent circuit, with each segment being represented by a capacitor.

The reduction in the number of contacts required by using multiplexing can be dramatic. A segment display having a multiplex ratio of 1:N and a total of M segments can be addressed using as few as M/N + N connections.

For example a 40 segment display requires 41 connections in direct drive but, by using a 1:4 multiplex drive, the number of connections is reduced to:

$$40/4 + 4 = 14$$

Similarly a dot matrix display with 20,000 elements (pixels) – i.e., 100 rows by 200 columns – can be controlled with only 300 connections (number of rows + number of columns), rather than the 20,001 connections that would be needed for direct drive.

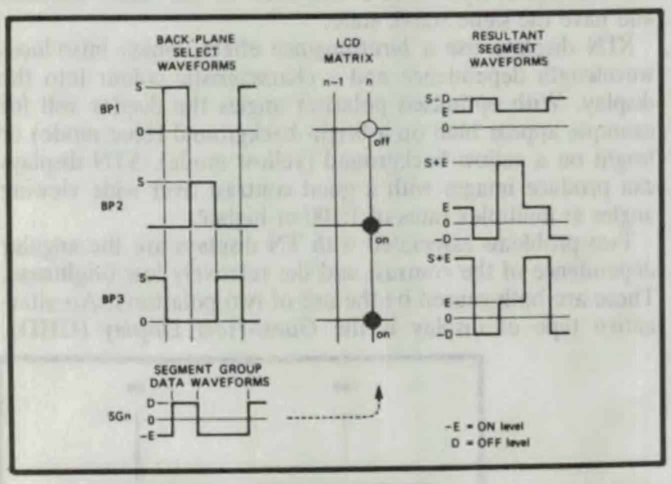


Fig.11: Row and column multiplexing waveforms for a display showing the voltage waveforms across individual elements.

An individual segment is selected by a combination of the back-plane and segment group signals. Fig.11 shows a simple example of matrix waveforms. Each back-plane is selected in sequence, and whether or not a segment is selected is determined by the level of the segment group voltage when the corresponding back-plane is addressed.

The waveforms illustrated have net DC components, which could cause electromechanical degradation of the liquid crystal. In practical addressing schemes, the net DC component is eliminated by inverting both the back-plane and segment group waveforms alternately.

Fig.11 shows that all of the elements receive a voltage. This means that the voltage at which non-selected elements should remain OFF has been raised above zero. The ratio of the ON to the OFF voltage (discrimination) decreases as the multiplex ratio increases (see Table 1) and the non-selected elements will become slightly visible. The discrimination can be optimised up to a certain limit, by increasing the number of multiplex levels.

Table 1 shows that the largest relative profit is obtained when going from direct drive to MUX 1:2 drive. The number of connections is approximately halved, but a reasonably good discrimination is obtained (2.24). Which is why MUX 1:2 is popular for displays up to 100-150 segments. Higher MUX rates would give little or no advantage, while reducing the contrast relatively rapidly.

multiplex ratio	1:1	1:2	1:3	1:4	1:8
discrimination, $\frac{V_{on(rms)}}{V_{off(rms)}}$	∞	2.24	1.92	1.73	1.45
number of connections required for a display having 120 segments	121	62	43	34	23

Table 1 Discrimination and number of connections compared to the multiplex rate

Electro-Optical characteristics of multiplexed LCDs

Most applications require the OFF elements to remain invisible up to a certain viewing angle (α). Which means, in order to keep the OFF voltage below the threshold (Vth) the value of the operating voltage (Vop) must not exceed a maximum limit (Fig.6). However, for ON elements a minimum contrast at a different viewing angle is required, which calls for a value of Vop that exceeds a minimum limit.

Since Vth is temperature dependant, both ON and OFF limits of Vop vary with temperature (see Fig.12 for MUX rates 1:2 and 1:8). The area between the ON and OFF limits is the recommended operating area, because it represents in-

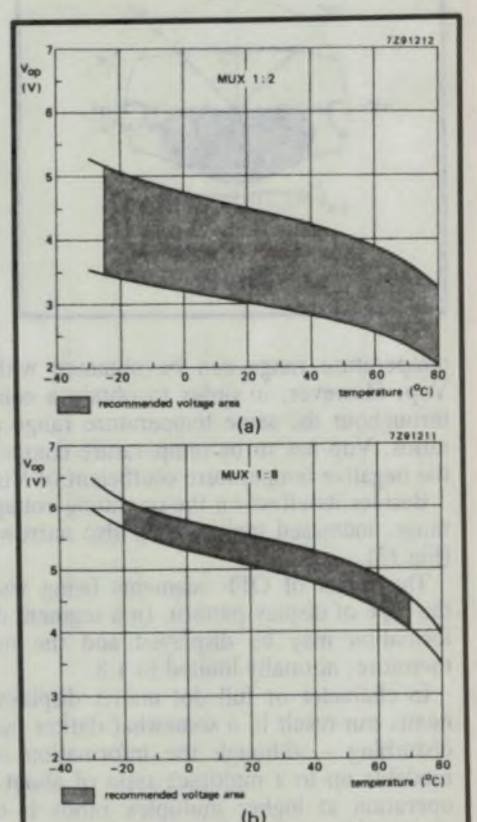


Fig.12: Typical recommended voltage areas for (a) 1:2 (b) 1:8 multiplex drive. At the lower boundary of each area the off segments become faintly visible at a viewing angle α = 40°, φ = 270° while the ON elements are visible with a contrast better than 2 at α = 0°.

visible OFF segments and ON segments with sufficient contrast.

At low multiplex ratios satisfactory operation over a wide

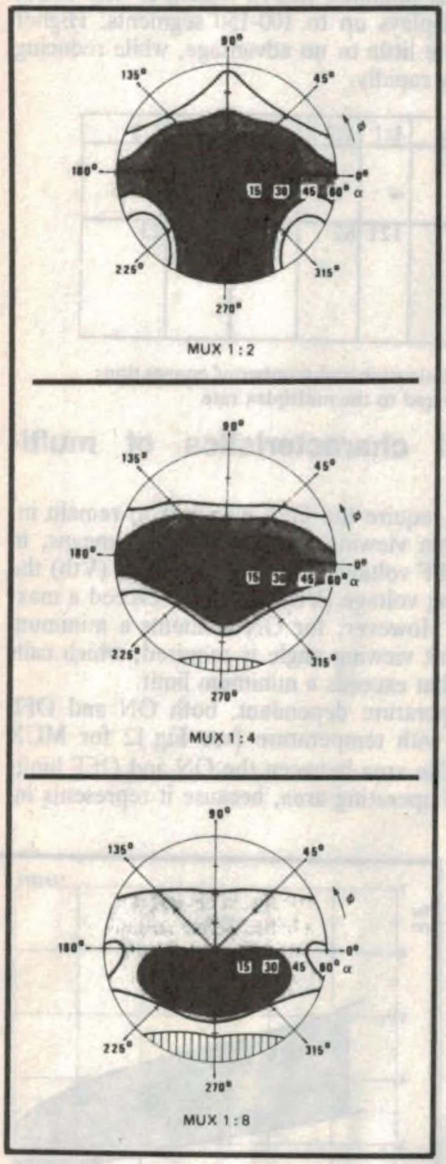


Fig.13: Isocontrast diagrams for various multiplex ratios.

temperature range can be obtained with a fixed value of Vop. However, in order to obtain a constant viewing cone throughout the same temperature range at higher multiplex ratios, Vop has to be temperature compensated to allow for the negative temperature coefficient of Vth.

Besides its effect on the operating voltage and temperature range, increased multiplexing also narrows the viewing cone (Fig.13).

The effect of OFF segments being visible depends upon the type of display pattern. In a segment display incorrect information may be displayed and the multiplex ratios are therefore, normally limited to 1:8.

In character or full dot matrix displays, visible OFF segments can result in a somewhat darker background, which is disturbing – although the information is still correct and readable up to a multiplex ratio of about 1:100. Satisfactory operation at higher multiplex ratios is obtained using advanced technologies like STN displays.

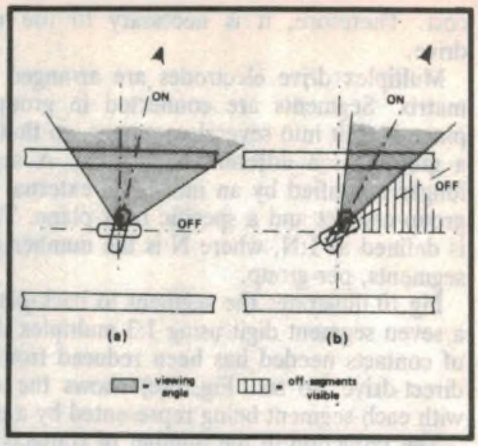


Fig.14: Angular variations of the centre liquid crystal molecule (a) direct drive (b) full multiplex drive.

Derived LCD technologies

The main limiting factor in the use of a multiplexed TN display is the gradual slope of the contrast as a function of the voltage curve. It has been discovered that this curve can be made much steeper by increasing the twist angle of the crystal beyond 90°, to a value that ranges from 180° to 270°. This is the technique used in *Super Twisted Nematic* or STN displays.

The larger twist angle is achieved by using a special *cholesteric doped* nematic liquid crystal. The cholesteric molecules have a helical screw structure (Fig.2) which helps to ensure that all liquid crystal molecules twist in the same direction and have the same stable state.

STN displays use a *birefringence* effect, which introduces wavelength dependence and a characteristic colour into the display. With optimised polariser angles the display will for example appear blue on a bright background (blue mode) or bright on a yellow background (yellow mode). STN displays can produce images with a good contrast over wide viewing angles at multiplex rates of 1:100 or higher.

Two problems associated with TN displays are the angular dependence of the contrast and the relatively low brightness. These are both caused by the use of two polarisers. An alternative type of display is the *Guest-Host Display* (GHD),

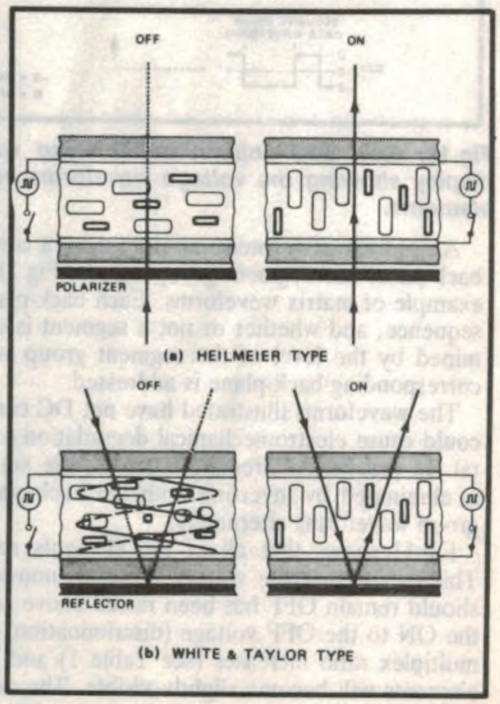


Fig.15: Operation of a GHD (a) Heilmeier (b) White and Taylor.

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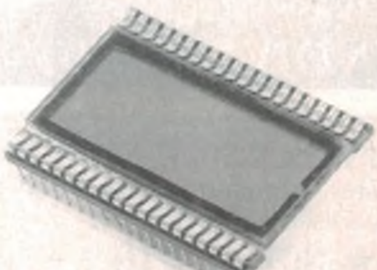
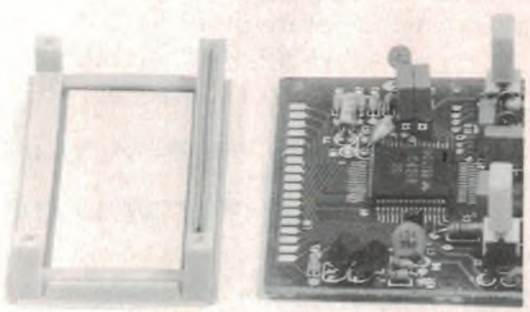
When there is no voltage applied, the molecules are aligned parallel to the display surface (OFF state), and certain wavelengths of the incident light are absorbed by the dye to make the display appear coloured. When sufficient voltage is applied the molecules will align perpendicular to the display (ON state); here the dye no longer absorbs the light and the display appears bright (Fig.15). GHDs typically have bright segments on a coloured background, the colour of which depends on the dye and can include black.

There are two main types of GHD. One is the *Heilmeier* type shown in Fig.15(a). This display requires a front polariser for good legibility, and must have good backlighting or be viewed in good ambient light conditions.

The other type of GHD is the *White and Taylor* type, shown in Fig.15(b). This display is optimised for reflective operation because it does not require polarisers and produces very bright segments against a coloured or grey background.

The advantage of guest-host displays over twisted nematic displays is the very wide and regular viewing cone. Disadvantages are the higher operating voltage and poor multiplexability.





Right: a typical LCD package with fixed pins attached to each side, as in Fig.16 (a).
Below: an LCD assembly (L) with a conductive elastomer contact strip, which mates with the row of pads on the PCB at night.

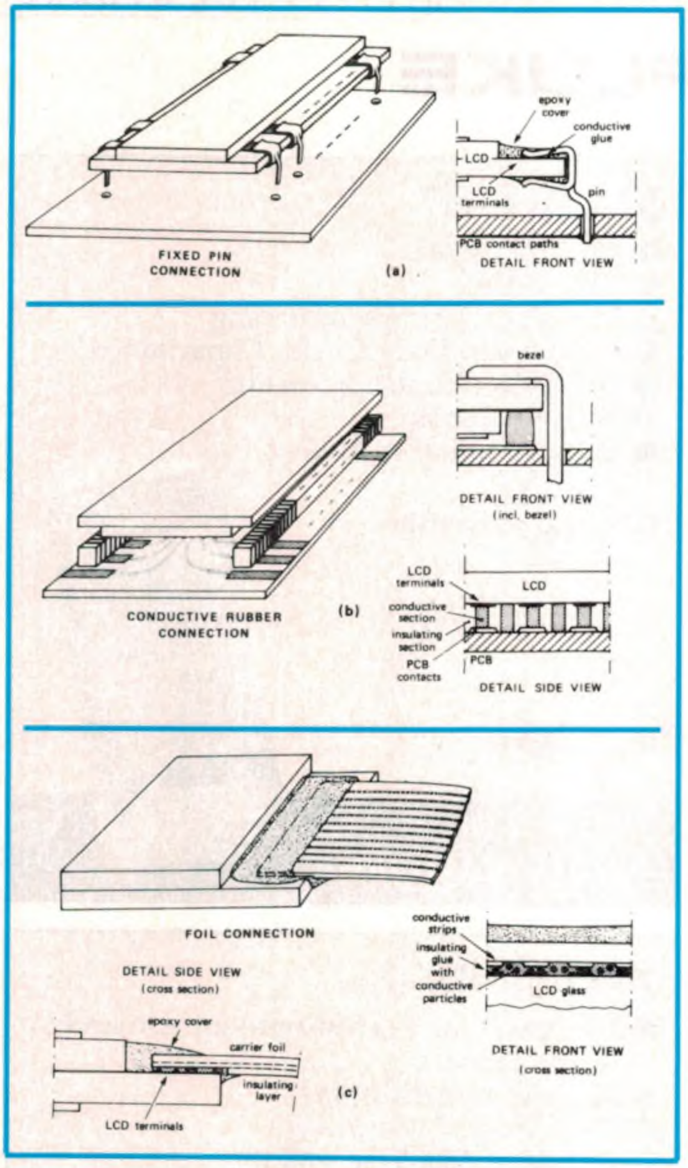


Fig.16: Connection techniques
(a) Fixed-Pin – displays with glued-on pins having a contact pitch of 2.54mm that can be soldered directly into a PC board.
(b) Elastomer (conductive rubber) 8 also known as zebra strips these are clamped between LCD and PC board and at least one conductive layer will connect matched contact pads while at least one insulator will isolate adjacent circuits.
(c) Foil – removes the need for an adjacent PC board and allows a display to be very very thin.

Connecting techniques

The terminals of an LCD are indium/tin oxide and are situated on at least one side of the cell. The three main methods used to electrically connect to LCDs are fixed pins, conductive rubber (elastomer) strips and foil.

Fixed pins are glued directly onto the LCD which can then be either soldered directly onto a PCB or connected via snap-on sockets (Fig.16(a)). Fixed pins are suitable for LCDs with a relatively low number of connections, and the glass length is sufficient to accommodate the required pins. However they provide a reliable method of contact.

Elastomer connectors consist of alternate conductive and insulating sections, that both support the LCD and connect it to the PCB (Fig.16(b)). The contacts of the LCD are on the underside of the top glass and these connect to the PCB via the conductive sections of the elastomer strip. Contact is maintained by a mounting bezel or clamp, which squeezes the LCD, elastomer strip and PCB together.

Care must be taken to ensure that a constant pressure is maintained over all the connections, which requires special attention for long displays. Without optical alignment a contact pitch down to about 1mm can be used, and down to about 0.5mm with optical alignment.

Foil connectors (Fig.16(c)) provide a flexible method of connection for LCDs. They consist of parallel conductors mounted on a foil which is glued directly onto the LCD. The contact area is thus sealed from the atmosphere. Connection pitches at each end of the foil can vary and the drivers can be mounted on a remote PCB, which is an advantage where a very thin display or back-lighting is required.

Mounting & illumination

Reflective and transreflective displays should be mounted as close as possible to the front surface of the equipment, to gain maximum illumination from the ambient light.

When choosing a mounting position, the viewing angle and isocontrast diagram published in the LCD data sheets must be considered. Auxiliary front lighting for a reflective display should be at an angle close to the normal viewing direction to minimise reflection and shadow effects.

Mounting pressure applied to LCDs using elastomer connectors should be as even as possible, and pressure on the seal or viewing areas must be avoided. Glass or non-birefringent plastic should be used to protect the front polarisers from scratches and humidity.

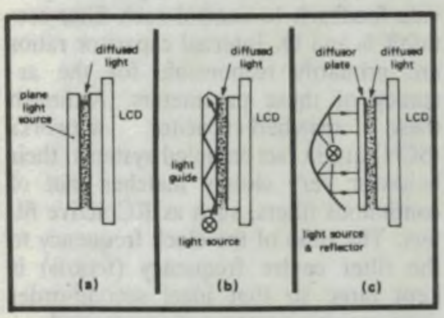


Fig.17: Back lighting methods.

Back lighting of a transreflective display is necessary to maintain legibility under poor environmental light conditions. The main methods of back lighting are as follows:

1. Electroluminescent light source (Fig.17(a)). This has the advantage that it is very thin and emits a diffuse and evenly distributed light. However its luminance is low, it requires a supply of from 100 to 200V at a few hundred hertz and it has a limited life.
2. Light guide (Fig.17(b)). This uses a point source such as an LED or a linear source such as a fluorescent tube, the light from which is distributed by a light guide using total reflection. Its construction can be flat, so little space is required behind the LCD. However uniform light distribution can be difficult to obtain and light loss can be considerable.
3. Light box (Fig.17(c)). Here light from an LED, halogen or fluorescent lamp is distributed by a light box consisting of a reflector and diffuser. This light source is very effective and efficient, but needs considerable space immediately behind the display.Any form of back lighting

Any form of back lighting for LCDs requires considerably more power than is used by an unlit display. This is a limiting factor when using a battery power supply.

(Adapted from the Philips publication Semiconductor Data Handbook S14 1988, by permission of Philips Components.)

Components Feature:

New programmable active filter chips

Design of active filters for signal processing or analysis, adaptive filtering and similar applications has now been simplified. Maxim has produced a family of programmable universal active filter chips, which interface directly to standard microprocessors and require virtually no external components to implement bandpass, lowpass, highpass, notch and allpass configurations.

The MAX260/261/262 CMOS dual second-order universal switched-capacitor active filters allow microprocessor control of precise filter functions. No external components are required for a variety of bandpass, lowpass, highpass, notch and allpass configurations. Each device contains two second-order filter sections which place center frequency, Q, and filter operating mode under programmed control.

An input clock, along with a 6-bit program input, determine the filter's centre or corner frequency (f_0) without affecting other filter parameters. The filter Q is also programmed independently. Separate clock inputs for each filter section operate with either a crystal, RC network, or external clock generator.

The MAX260 has superior offset and DC specifications than the MAX261 and MAX262 and a centre frequency f_0 range of 7.5kHz. The MAX261 handles centre frequencies to 30kHz while the MAX262 extends the centre frequency range to 75kHz by employing lower clock-to-f_0 ratios.

All devices are available in 24-pin DIP and a small outline packages in commercial, extended, and military temperature ranges.

Each MAX260/61/62 contains two second-order switched-capacitor active filters. Fig.1 shows the filter's state variable topology, employed with two cascaded integrators and one summing amplifier. The MAX261 and MAX262 also contain an uncommitted amplifier.

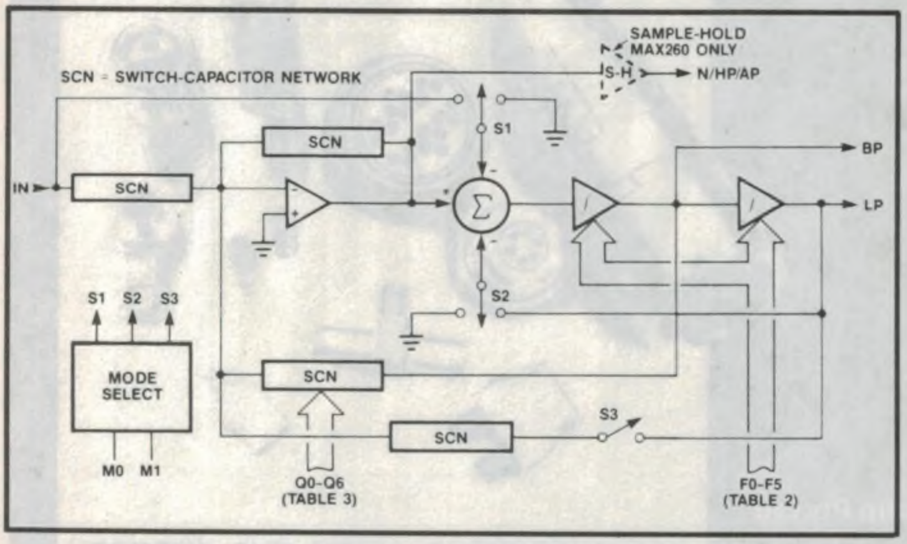


Fig.1: Block diagram showing the state variable topology for each of the two second-order switched capacitor active filters in the MAX260/1/2. Each consists of a summing amplifier and two cascaded integrators, together with four switched capacitor networks.

On-chip switches and capacitors provide feedback to control each filter section's f_0 and Q. Internal capacitor ratios are primarily responsible for the accuracy of these parameters. Although these switched-capacitor networks (SCN) are in fact sampled systems, their behavior very closely matches that of continuous filters, such as RC active filters. The ratio of the clock frequency to the filter centre frequency (f_{CLK}/f_0) is kept large so that ideal second-order state-variable response is maintained.

The MAX262 uses a lower range of sampling (f_{CLK}/f_0) ratios than the MAX260 or MAX261 to allow higher operating f_0 frequencies and signal bandwidths. These reduced sample rates result in somewhat more deviation from ideal continuous filter parameters than with the MAX260/61. However, these differences can be compensated using Fig.11.

The MAX260 employs auto-zero circuitry not included in the MAX261 or 262. This provides improved DC characteristics, and improved low frequency performance at the expense of high end f_0 and signal bandwidth.

The N/HP/AP outputs of the MAX260 are internally sample-and-held, as a result of its auto-zero operation. Signal swing at this output is somewhat reduced as a result (MAX260 only). See Table 1 for bandwidth comparisons of the three filters.

Maxim also provides design programs which aid in converting filter response specifications into the f_0 and Q program codes used by the MAX260 series devices. This software also precompensates f_0 and Q when low sample rates are used.

It is important to note that in all MAX260 series filters, the filter's internal sample rate is one half the input

```
100  AB$="FILTER A " : GOSUB 150 : REM GET DATA FOR SECTION A
110  ADD = 0 : GOSUB 220 : REM WRITE DATA TO THE PRINTER PORT
120  AB$="FILTER B " : GOSUB 150 : REM GET DATA FOR B
130  ADD = 32 : GOSUB 220 : REM WRITE DATA TO PRINTER PORT
140  GOTO 100
150  PRINT "MODE (1 to 4, see Table 5) "; AB$; : INPUT M
160  IF M<1 OR M>4 THEN GOTO 150
170  PRINT "CLOCK RATIO (0 to 63, N of Table 2) "; AB$; : INPUT F
180  IF F<0 OR F>63 THEN GOTO 170
190  PRINT "Q (0 to 127, N of Table 3) "; AB$; : INPUT Q
200  IF Q<0 OR Q>127 THEN GOTO 190 ELSE : PRINT
210  RETURN
220  LPRINT CHR$(ADD+M-1); : ADD = ADD+4
230  FOR I = 1 TO 3
240  X=(ADD + (F - 4*INT(F/4))) : LPRINT CHR$(X);
250  F=INT(F/4) : ADD = ADD + 4
260  NEXT I
270  FOR I = 1 TO 4
280  X=(ADD + (Q - 4*INT(Q/4))) : LPRINT CHR$(X);
290  Q=INT(Q/4) :: ADD = ADD + 4
300  NEXT I
310  RETURN
```

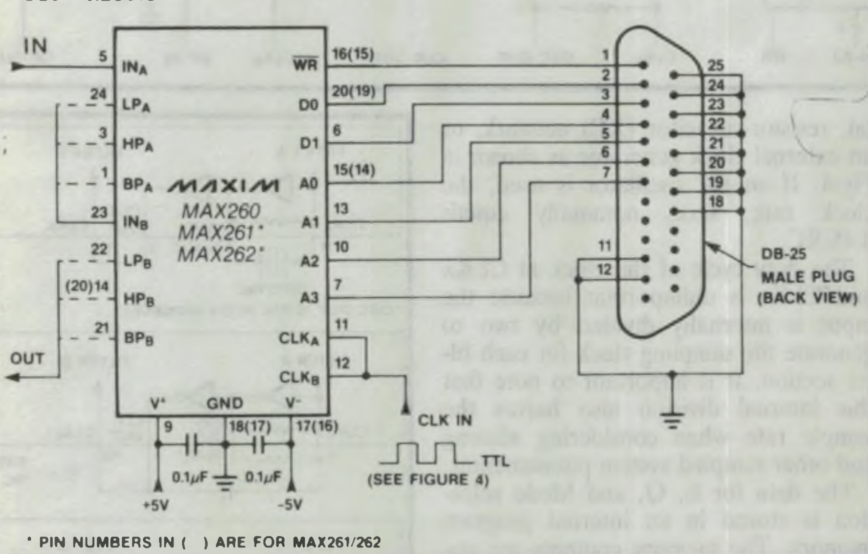


Fig.2: Basic hardware connections and software needed to experiment with one of the chips, driven from the parallel printer port of a PC.

clock rate (CLK_A or CLK_B) due to an internal division by two. All clock related data, tables, and other discussions in this data sheet refer to the frequency at the CLK_A or CLK_B input, i.e. twice the internal sample rate, unless specifically stated otherwise.

Basic design procedure

The MAX260, MAX261 and MAX262, with Maxim's filter design software, greatly simplifies the design procedures for many active filters. Most designs can be realised using a three step process described in this section.

1 – Filter Design Start with the program 'PZ' to determine what type of filter is needed. This helps determine the type (Butterworth, Chebyshev, etc.) and the number of poles for the optimum choice. The program also plots the frequency response and calculates the pole/zero (f_0) and Q values for each second-order section. Each MAX260/61/62 contains two second-order sections and devices may be cascaded for higher order filters.

2 – Generate Programming Coefficients Starting with the f_0 and Q values obtained in Step 1, use the program 'MPP' to generate the digital coefficients which program each second-order section's f_0 and Q. The program displays values for 'N' ('N = – for f_0' and 'N = – for Q'). N is the decimal equivalent of the binary code that sets the filter section's f_0 or Q.

An input clock frequency and filter 'Mode' must also be selected in this step, however if a specific clock rate is not selected, 'GEN' will pick one. With regard to mode selection, Mode 1 is the most convenient choice for most bandpass and lowpass filters. Exceptions are elliptic bandpass and lowpass filters which require Mode 3. High pass filters also use Mode 3, while allpass filters use Mode 4.

3 – Loading the Filter When the N values for the f_0 and Q of each second-order filter section are determined, the filter can then be programmed and operated. What follows is a convenient method of programming the filter and evaluating a design if a personal computer is available.

A short BASIC program loads data into the MAX260/261/262 via the personal computer's parallel printer port. The program asks for the filter Mode as well as the N values for the f_0 and Q of each section. These coefficients are then

Table 1. Typical Clock and Center Frequency Limits

PART	Q	MODE	f_{CLK}	f_0
MAX260	1	1	1Hz-400kHz	0.01Hz-4.0kHz
	1	2	1Hz-425kHz	0.01Hz-6.0kHz
	1	3	1Hz-500kHz	0.01Hz-5.0kHz
	1	4	1Hz-400kHz	0.01Hz-4.0kHz
	8	1	1Hz-500kHz	0.01Hz-5.0kHz
	8	2	1Hz-700kHz	0.01Hz-10.0kHz
	8	3	1Hz-700kHz	0.01Hz-5.0kHz
	8	4	1Hz-600kHz	0.01Hz-4.0kHz
	64	1	1Hz-750kHz	0.01Hz-7.5kHz
	90	2	1Hz-500kHz	0.01Hz-7.0kHz
	64	3	1Hz-400kHz	0.01Hz-4.0kHz
	64	4	1Hz-750kHz	0.01Hz-7.5kHz
MAX261	1	1	40Hz-4.0MHz	0.4Hz-40kHz
	1	2	40Hz-4.0MHz	0.5Hz-57kHz
	1	3	40Hz-4.0MHz	0.4Hz-40kHz
	1	4	40Hz-4.0MHz	0.4Hz-40kHz
	8	1	40Hz-2.7MHz	0.4Hz-27kHz
	8	2	40Hz-2.1MHz	0.5Hz-30kHz
MAX261	8	3	40Hz-1.7MHz	0.4Hz-17kHz
	8	4	40Hz-2.7MHz	0.4Hz-27kHz
	64	1	40Hz-2.0MHz	0.4Hz-20kHz
	90	2	40Hz-1.2MHz	0.4Hz-18kHz
	64	3	40Hz-1.2MHz	0.4Hz-12kHz
	64	4	40Hz-2.0MHz	0.4Hz-20kHz
MAX262	1	1	40Hz-4.0MHz	1.0Hz-100kHz
	1	2	40Hz-4.0MHz	1.4Hz-140kHz
	1	3	40Hz-4.0MHz	1.0Hz-100kHz
	1	4	40Hz-4.0MHz	1.0Hz-100kHz
	8	1	40Hz-2.5MHz	1.0Hz-60kHz
	8	2	40Hz-1.4MHz	1.4Hz-50kHz
	8	3	40Hz-1.4MHz	1.0Hz-35kHz
	8	4	40Hz-2.5MHz	1.0Hz-60kHz
	64	1	40Hz-1.5MHz	1.0Hz-37kHz
	90	2	40Hz-0.9MHz	1.4Hz-32kHz
	64	3	40Hz-0.9MHz	1.0Hz-22kHz
	64	4	40Hz-1.5MHz	1.0Hz-37kHz

Table 1: Bandwidth comparisons between the three chips in the Maxim programmable filter family.

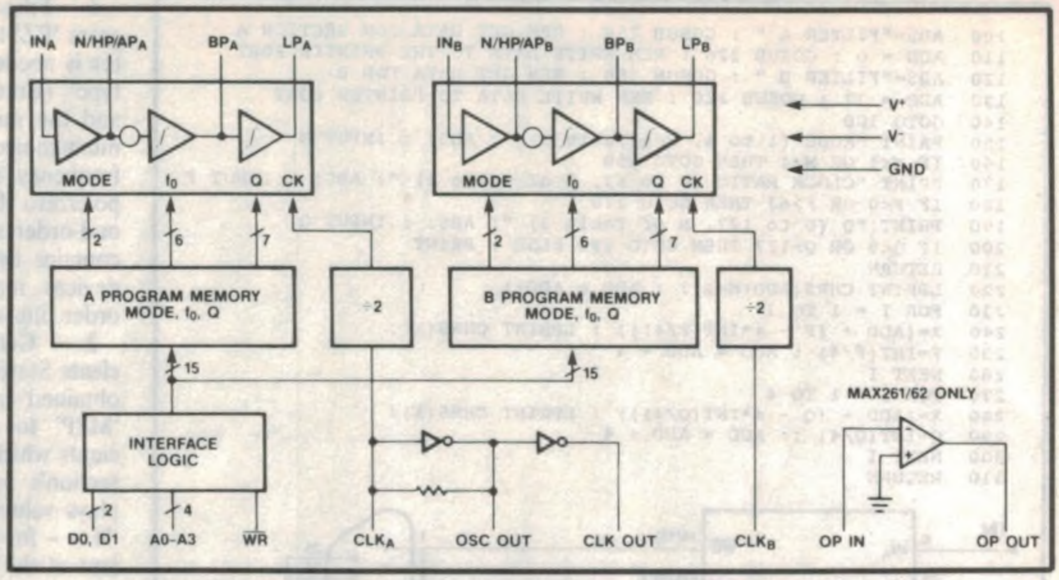


Fig.3: Basic electrical block diagram for the filter chips. The two filters are independently programmable.

loaded into the filter in the form of ASCII characters. This program may be used with or without Maxim's other filter design software. The program and the appropriate hardware connections for a Centronics type printer port are shown in Fig.2.

In more detail

Fig.3 shows a block diagram of the MAX260. Each 2nd-order filter section has its own clock input and independent f_0 and Q control. The actual centre frequency is a function of the filter's clock rate, 6-bit f_0 control word, and operating Mode. The Q of each section is also set by a separate programmed input. This way each half of a MAX260/61/62 is tuned independently so that complex filter polynomials can be realised.

The clock circuitry of the MAX260/61/62 can operate with a crystal, resistor-capacitor (RC) network, or an external clock generator as shown in Fig.4. If an RC oscillator is used, the clock rate, f_{CLK}, nominally equals 0.45/RC.

The duty cycle of the clock at CLK_A and CLK_B is unimportant because the input is internally divided by two to generate the sampling clock for each filter section. It is important to note that this internal division also halves the sample rate when considering aliasing and other sampled system phenomenon.

The data for f_0, Q, and Mode selection is stored in an internal program memory. The memory contents are updated by writing to addresses selected by A0-A3. D0 and D1 are the data inputs. A map of the memory locations is shown in Table 2. data is stored in the selected address on the rising edge of WR. Address and data inputs are TTL and CMOS compatible when the filter is powered from +/−5 volts. With other power supply voltages, CMOS logic levels should be used. Note: Clock inputs CLK_A and CLK_B have no relation to the digital interface. They control the switched-capacitor filter sample rate only.

DATA BIT D0	DATA BIT D1	ADDRESS A3	ADDRESS A2	ADDRESS A1	ADDRESS A0	LOCATION
FILTER A						
$M0_A$	$M1_A$	0	0	0	0	0
$F0_A$	$F1_A$	0	0	0	1	1
$F2_A$	$F3_A$	0	0	1	0	2
$F4_A$	$F5_A$	0	0	1	1	3
$Q0_A$	$Q1_A$	0	1	0	0	4
$Q2_A$	$Q3_A$	0	1	0	1	5
$Q4_A$	$Q5_A$	0	1	1	0	6
$Q6_A$		0	1	1	1	7
FILTER B						
$M0_B$	$M1_B$	1	0	0	0	8
$F0_B$	$F1_B$	1	0	0	1	9
$F2_B$	$F3_B$	1	0	1	0	10
$F4_B$	$F5_B$	1	0	1	1	11
$Q0_B$	$Q1_B$	1	1	0	0	12
$Q2_B$	$Q3_B$	1	1	0	1	13
$Q4_B$	$Q5_B$	1	1	1	0	14
$Q6_B$		1	1	1	1	15

Note: Writing 0 into $Q0_A$-$Q6_A$ (address locations 4-7) on Filter A activates shutdown mode. BOTH filter sections deactivate.

Table 2: Program address locations for the filter chip's internal memory, used to store values for f_0, Q and Mode – for each of the two filters.

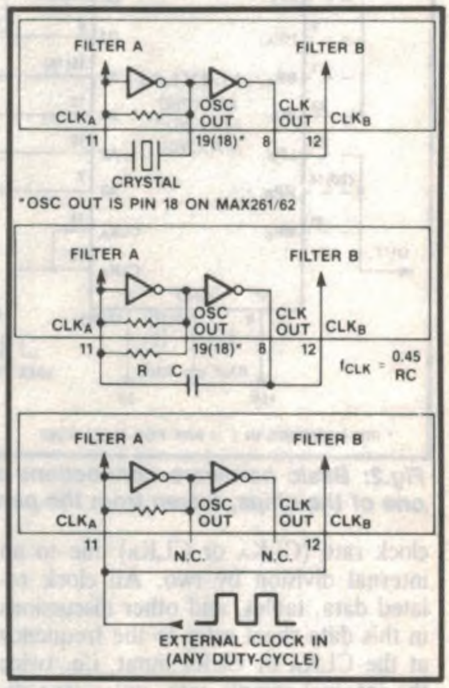


Fig.4: Clock circuit options for the MAX260/1/2. Either crystal or RC internal oscillators can be used, or alternatively an external oscillator.

Operating modes

There are several ways in which the summing amplifier and integrators in each MAX260/61/62 filter section can be configured. The four most versatile interconnections (modes) are selected by

FOUR NEW μP SUPERVISORY ICs!

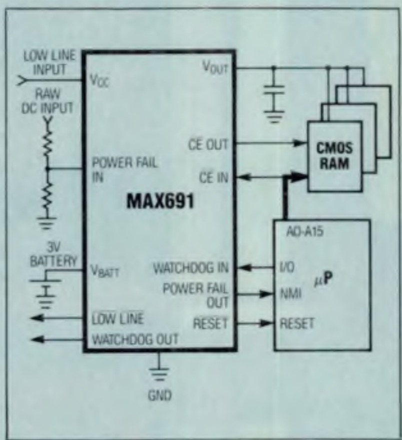
- **Micropower Supply Current (160μA) — ideal for battery applications**
- **Adjustable Reset Voltage — down to 3.0V for CMOS μP's**
- **200ms Reset Pulse — for Motorola μP compatibility**

Power-On/Low Line Reset

Maxim's supervisory ICs each have a precise factory trimmed or user adjustable threshold detector and timer that generates an accurate, reliable Reset signal for any power-on, brown-out or low battery condition.

Power-Fail Detection

An uncommitted 1.3V threshold comparator is built into each device for use as a power fail indicator or for monitoring the back-up battery voltage.



Watchdog Timer

A watchdog circuit built into every MAX690-697 constantly monitors all μP activity. It detects both hardware and software malfunctions and automatically issues a Reset command to the μP — effectively eliminating 'lock up' conditions.

Memory Protect — Chip Enable Gating

MAX690-697s prevent μPs from writing erroneous data into RAM during power-up, power-down, brown-outs, and momentary power interruptions.

Automatic Battery Switchover

The MAX690-696 monitor incoming power and automatically switch to battery back-up when the power supply drops below the battery voltage. Quiescent current drops to less than 1μA and ensures that the data in CMOS RAM or EEPROM remains intact until power is restored.

Part #	Pins	Reset (Volts)	Isupply (mA)	Reset (ms)	Battery Switchover	Memory Protect (CE)	Low Line In	Low Line Out
MAX690	8	4.65	4	50	Yes	No	No	No
MAX691	16	4.65	4	50*	Yes	Yes	No	Yes
MAX692	8	4.40	4	50	Yes	No	No	No
MAX693	16	4.40	4	50*	Yes	Yes	No	Yes
MAX694	8	4.65	4	200	Yes	No	No	No
MAX695	16	4.65	4	200*	Yes	Yes	No	Yes
MAX696	16	Adj	4	50*	Yes	No	Yes	Yes
MAX697	16	Adj	160μA	50*	No	Yes	Yes	Yes

*Internally preset value, also adjustable

The MAX690-MAX697 are available in DIP or SO packages and — like every other Maxim part — each is tested to rigorous reliability standards absolutely free. They offer you a price-performance value unmatched in the marketplace.

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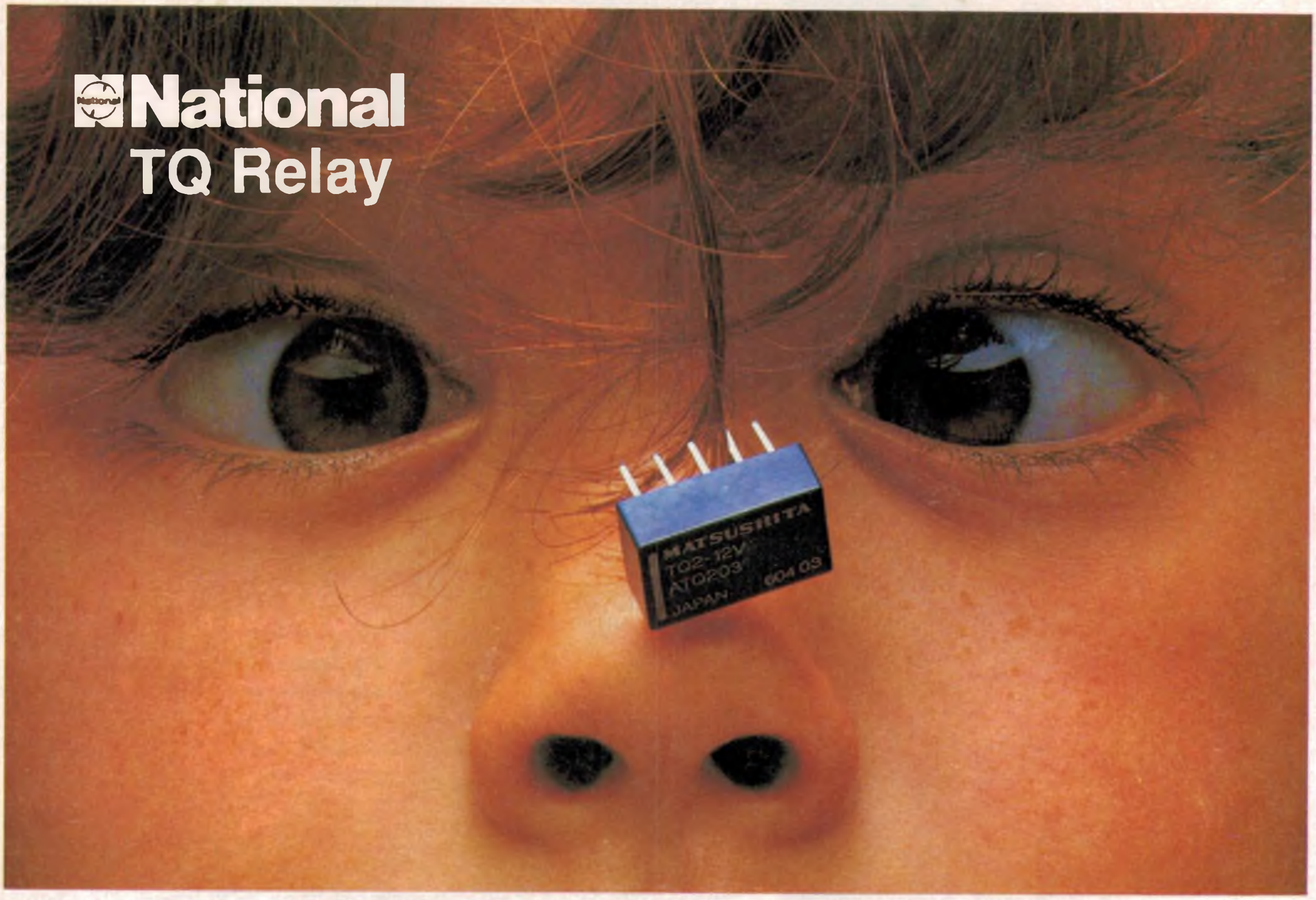

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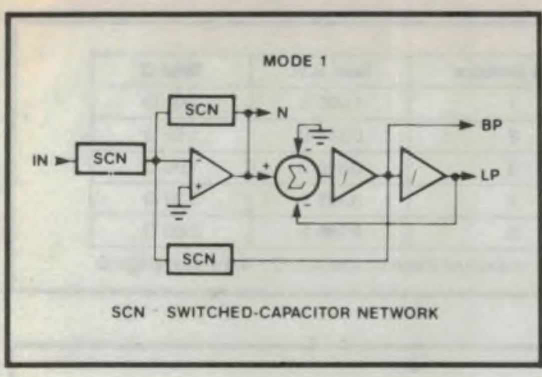
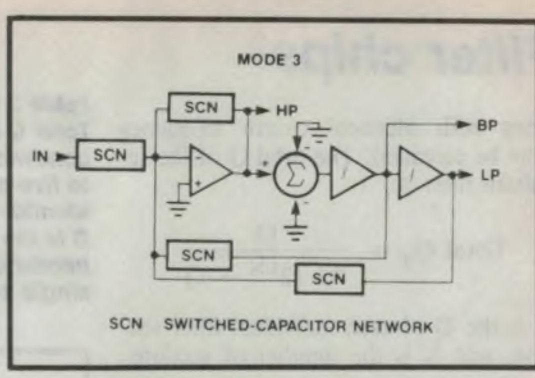


Fig.5 (left): Filter mode 1, covering second order bandpass, lowpass and notch.

Fig.7 (right): Filter mode 3 – second order bandpass, lowpass and highpass.



writing to inputs M0 and M1. These modes use no external components. A fifth mode, 3A, makes use of an additional op-amp (included in the MAX261 and 262) and external resistors but uses the same internal configuration, and is selected with the same programming code, as Mode 3.

Figs. 5 through 9 show symbolic representations of the MAX260 filter modes. Only one second-order section is shown in each case. The A and B sections of one MAX260/61/62 can be programmed for different modes if desired.

Mode 1 (Fig.5) is useful when implementing all-pole lowpass and bandpass filters such as Butterworth, Chebyshev, Besssel, etc. it can also be used for notch filters, but only second-order notches because the relative pole and zero locations are fixed. Higher order notch filters require more latitude in f_0 and f_N, which is why they are more easily implemented with Mode 3A.

Mode 1, along with Mode 4, supports the highest clock frequencies (See Table 1) because the input summing amplifier is outside the filter's resonant loop (Fig.5). The gain of the lowpass and notch outputs is 1, while the bandpass gain at the centre frequency is Q. for bandpass gains other than Q, the filter input or output can be scaled by a resistive divider or op-amp.

Mode 2 (Fig.6) is used for all-pole lowpass and bandpass filters. Key advantages compared to Mode 1 are higher available Qs and lower output noise. Mode 2's available f_{CLK}/f_0 ratios are $\sqrt{2}$ less than with Mode 1 so a wider overall range of f_0's can be selected from a single clock when both modes are used together. This is demonstrated in the Wide Passband Chebyshev Bandpass design example.

Mode 3 (Fig.7) is the only mode which produces high-pass filters. The maximum clock frequency is somewhat less than with Mode 1 (See Table 1).

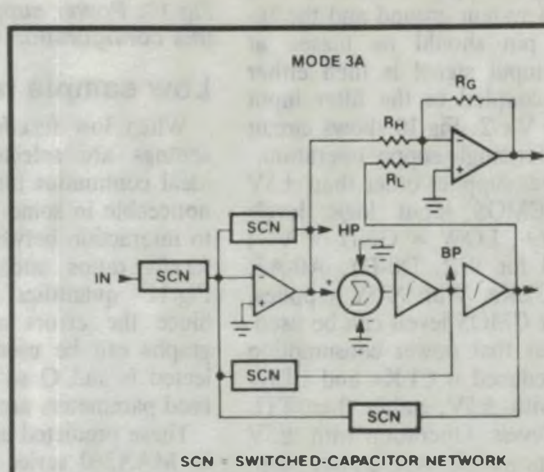
Mode 3A (Fig.8) uses a separate op-amp to sum the highpass and lowpass outputs of Mode 3, creating a separate notch output. This output allows the notch to be set independently of f_0 by adjusting the op-amp's feedback resistor ratio (R_H, R_L). R_H, R_L, and R_G are external resistors. Because the notch can be independently set, Mode 3A is also useful when designing pole-zero filters such as elliptics.

Mode 4 (Fig.9) is the only mode that provides an allpass output. This is useful when implementing group delay equalisation. In addition to this, Mode 4 can also be used in all-pole lowpass and bandpass filters. Along with Mode 1, it is the fastest operating mode for the filter, although the gains are different than in Mode 1. When the allpass function is used, note that some amplitude peaking occurs (approximately 0.3dB when Q = 8) at f_0. Also note that f_0 and Q sampling errors are highest in Mode 4 (See Fig.11).

Cascading filters

In some designs, such as very narrow band filters, several second-order sec-

Fig.8 (right): Filter mode 3A – second order bandpass, lowpass, highpass and notch. For elliptic LP, BP, HP and Notch, the N output is used.



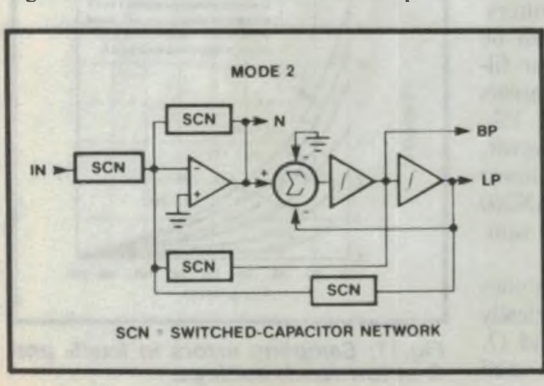
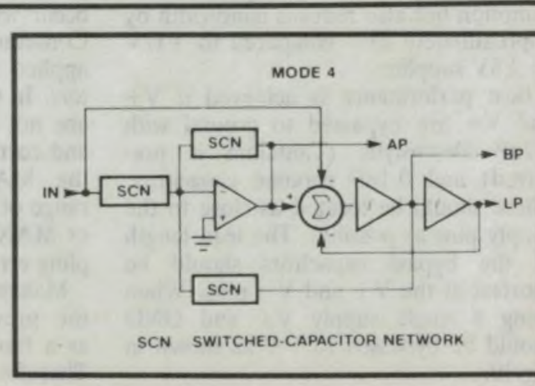


Fig.6 (left): Filter mode 2 – second order bandpass, lowpass and notch.

Fig.9 (right): Filter mode 4 – second order bandpass, lowpass and allpass.



Filter chips

tions with identical centre frequency may be cascaded. The total Q of the resultant filter is:

$$\text{Total } Q_T = \frac{Q}{\sqrt{(2^{1/N} - 1)}}$$

Q is the Q of each individual filter section, and N is the number of sections. In Table 3, the total Q and bandwidth are listed for up to five identical second-order sections. B is the bandwidth of each section.

In high order bandpass filters, stages with different fo's and Q's are also often cascaded. When this happens the overall filter gain at the bandpass centre frequency is not simply the product of the individual gains because fo, the frequency where each section's gain is specified, is different for each second-order section. The gain of each section at the cascaded filter's centre frequency must be determined to obtain the total gain.

Power supplies

The MAX260/61/62 can be operated with a variety of power supply configurations including +5V to +12V single supply, or ±2.5V to ±5V dual supplies. When a single supply is used, V− is connected to system ground and the filter's GND pin should be biased at V+/2. The input signal is then either capacitively coupled to the filter input or biased to V+/2. Fig.10 shows circuit connections for single supply operation.

When power supplies other than ±5V are used, CMOS input logic levels (HIGH = V+, LOW = GND or V−) are required for WR, D0-D1, A0-A3, CLK_A and CLK_B. With √5V supplies, either TTl or CMOS levels can be used. Note however that power consumption at ±5V is reduced if CLK_A and CLK_B are driven with ±5V, rather than TTL or 0 to 5V levels. Operation with ±5V or ±2.5V power lowers power consumption but also reduces bandwidth by approximately 25% compared to +12V or ±5V supplies.

Best performance is achieved if V+ and V− are bypassed to ground with 4.7uF electrolytic (Tantalum is preferred) and 0.1uF ceramic capacitors. These should be located as close to the supply pins as possible. The lead length of the bypass capacitors should be shortest at the V+ and V− pins. When using a single supply V+ and GND should be bypassed to V− as shown in Fig.10.

Table 3 (right): Total Q and bandwidth for up to five cascaded identical sections. B is the bandwidth of a single section.

Total Sections	Total B.W.	Total Q
1	1.000 B	1.00 Q
2	0.644 B	1.55 Q
3	0.510 B	1.96 Q
4	0.435 B	2.30 Q
5	0.386 B	2.60 Q

Note: B = individual stage bandwidth, Q = individual stage Q.

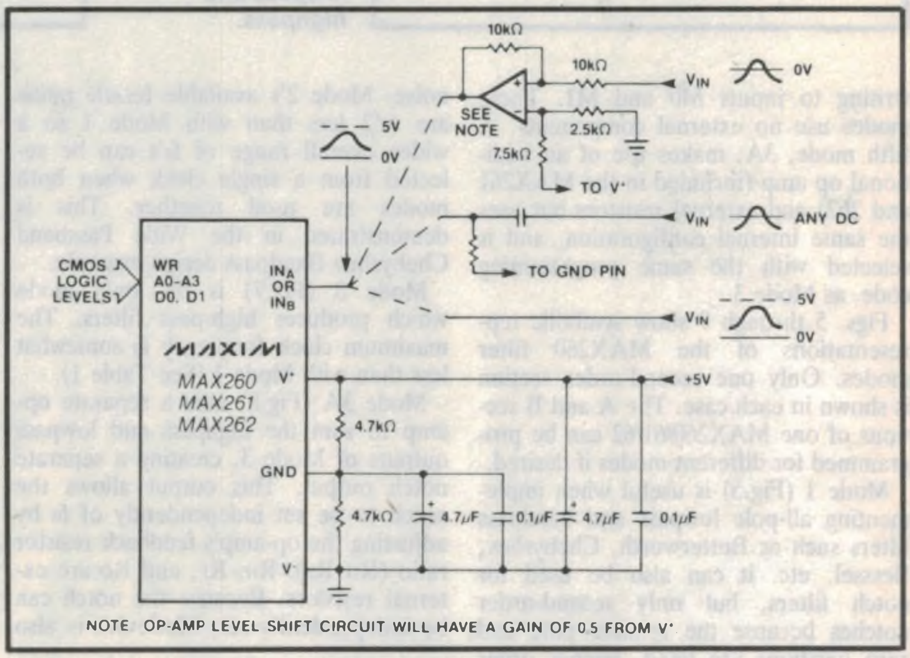


Fig.10: Power supply and input connections for single supply operation. For this configuration CMOS input logic levels are required.

Low sample rates

When low f_{CLK}/f_0 ratios and low Q settings are selected, deviation from ideal continuous filter response may be noticeable in some designs. This is due to interaction between Q, and fo at low f_{CLK}/f_0 ratios and Q's. The data in Fig.11 quantifies these differences. Since the errors are predictable, the graphs can be used to correct the selected fo and Q so that the actual realised parameters are on target.

These predicted errors are not unique to MAX260 series devices and in fact occur with all types of sampled filters. Consequently, these corrections can be applied to other switched-capacitor filters. In the majority of cases, the errors are not significant, i.e., less than 1%, and correction is not needed. However, the MAX262 does employ a lower range of f_{CLK}/f_0 ratios than the MAX260 or MAX261 and is more prone to sampling errors as the tables show.

Maxim's filter design software applies the previous corrections automatically as a function of desired f_{CLK}/f_0 and Q. Therefore, Fig.11 should NOT be used

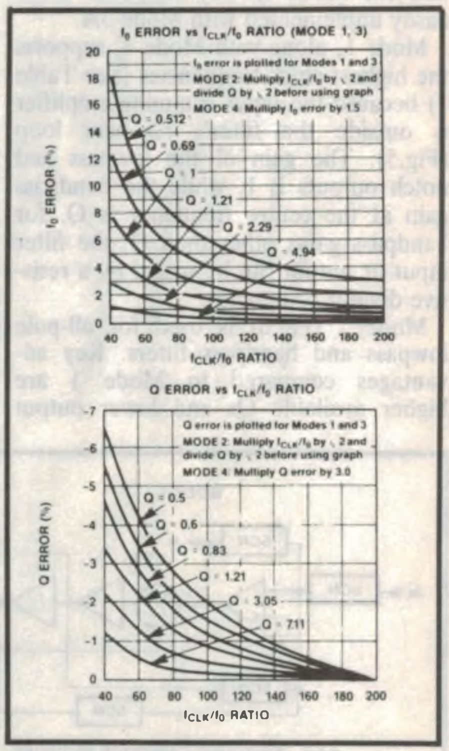


Fig.11: Sampling errors in f_{CLK}/f_0 and Q at low f_{CLK}/f_0 settings.

when Maxim's software determines f_o and Q. This results in overcompensation of the sampling errors since the correction factors are then counted twice.

Aliasing

As with all sampled systems, frequency components of the input signal above one half the sampling rate will be aliased. In particular, input signal components near the sampling rate generate difference frequencies that often fall within the passband of the filter. Such aliased signals, when they appear at the output, are indistinguishable from real input information.

For example, the aliased output signal generated when a 99kHz waveform is applied to a filter sampling at 100kHz, (f_o = 200kHz) is 1kHz. This waveform is an attenuated version of the output that would result from a true 1kHz input. Remember that with the MAX260 series filters, the Nyquist rate (one half the sample rate) is in fact $f_{CLK}/4$ because f_{CLK} is internally divided by two.

A simple passive RC lowpass input filter is usually sufficient to remove input frequencies that can cause aliasing. In many cases the input signal itself may be band limited and require no special anti-alias filtering. The wideband MAX262 uses lower f_{CLK}/f_o ratios than the MAX260/61 and for this reason it is more likely to require input filtering than the MAX260 or MAX261.

Other filter products

Maxim has developed a number of other filter products in addition to the MAX260, MAX261 and MAX262. These include:

PIN PROGRAMMABLE ACTIVE FILTERS – A dual second-order universal filter that needs no external components. A Microprocessor interface is not required.

MAX263	0.4Hz to 30kHz f_o range
MAX264	1Hz to 75kHz f_o range

RESISTOR AND PIN PROGRAMMABLE FILTERS – A dual second-order universal filter where f_o adjustment beyond pin-programmable resolution employs external resistors.

MAX265	0.4Hz to 30kHz f_o range. Includes two uncommitted op-amps.
MAX266	1Hz to 75kHz f_o range. Includes two uncommitted op-amps.
MF10	Industry Standard. Resistor Programmed Only.

PIN PROGRAMMABLE BANDPASS FILTERS – A dual second-order bandpass that needs no external components. A microprocessor interface is not required.

MAX267	0.4Hz to 30kHz f_o range.
MAX268	1Hz to 75kHz f_o range.

PROGRAMMABLE ANTI-ALIAS FILTER – A programmable dual second-order continuous (not switched) lowpass filter. No clock noise is generated. Designed for use as an anti-alias filter in front of, or as a smoothing filter following, any sampled filter or system.

MAX270	1kHz to 25kHz Cutoff Frequency Range

5TH ORDER LOW PASS FILTER – Features zero offset and drift errors for designs requiring high DC accuracy.

MAX280, LT1062	0.1Hz to 20kHz Cutoff Frequency Range.

Adapted from the MAX260/61/62 data sheets with permission. For further information on Maxim devices contact Veltek, at Suite 4, 5 King Street, Rockdale 2216 or phone (02) 599 1900.

Components Feature:

New Components

SMPS capacitors

Electronic Concepts (USA) has released a new range of miniature metallised polycarbonate film capacitors designed specifically for switch-mode power converters. Compact physical configurations conserve circuit board space, promote low ESR, excellent ripple capability and high resonant frequency.

The capacitors are available with an assortment of terminations that include axial, tab and coaxial. An outstanding feature of the internal coaxial lead design is the minimal inductance, thereby maximising resonant frequency.

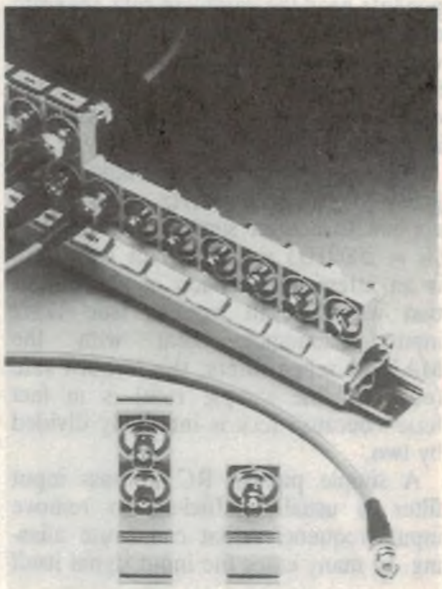
Details of the capacitors are available from Clarke & Severn Electronics, PO Box 129, St Leonards 2065 or phone (02) 437 4199.

Modular coax terminal blocks

Recently released by West German manufacturer Phoenix Contact are two coax modular teminal blocks. They are designed for mounting coax connections to commercially available DIN/EN mounting rails, and are available in single or double-level versions depending upon space considerations.

As the insulation housing is of fracture-proof 6.6 polyamide, a shield to ground contact is not included. Both BNC connectors offer characteristic impedances of 50 or 75 ohms and can be individually marked with standard labels.

For further information contact Anitech, 1-5 Carter Street, Lidcombe 2141 or phone (02) 648 1711.



Male headers

A range of open type strip male headers in both single and double row and in straight or right angle versions, has been released by Tecnico Electronics.

The headers feature standard 0.025″ (0.64mm) square posts and 0.100″ (2.54mm) spacing between posts. The contact posts are 0.1236″ (6mm) long and contact tails are 0.118″ (3mm) long. Full length headers contain 40 contacts per row and these can be cut to any required length.

Standard plating supplied is gold over copper alloy; the insulation material is glass filled thermoplastic, rated UL94V-0. The contacts are rated at 1 amp.

For further information contact Tecnico Electronics, 11 Waltham Street, Artarmon 2064 or phone (02) 439 2200.

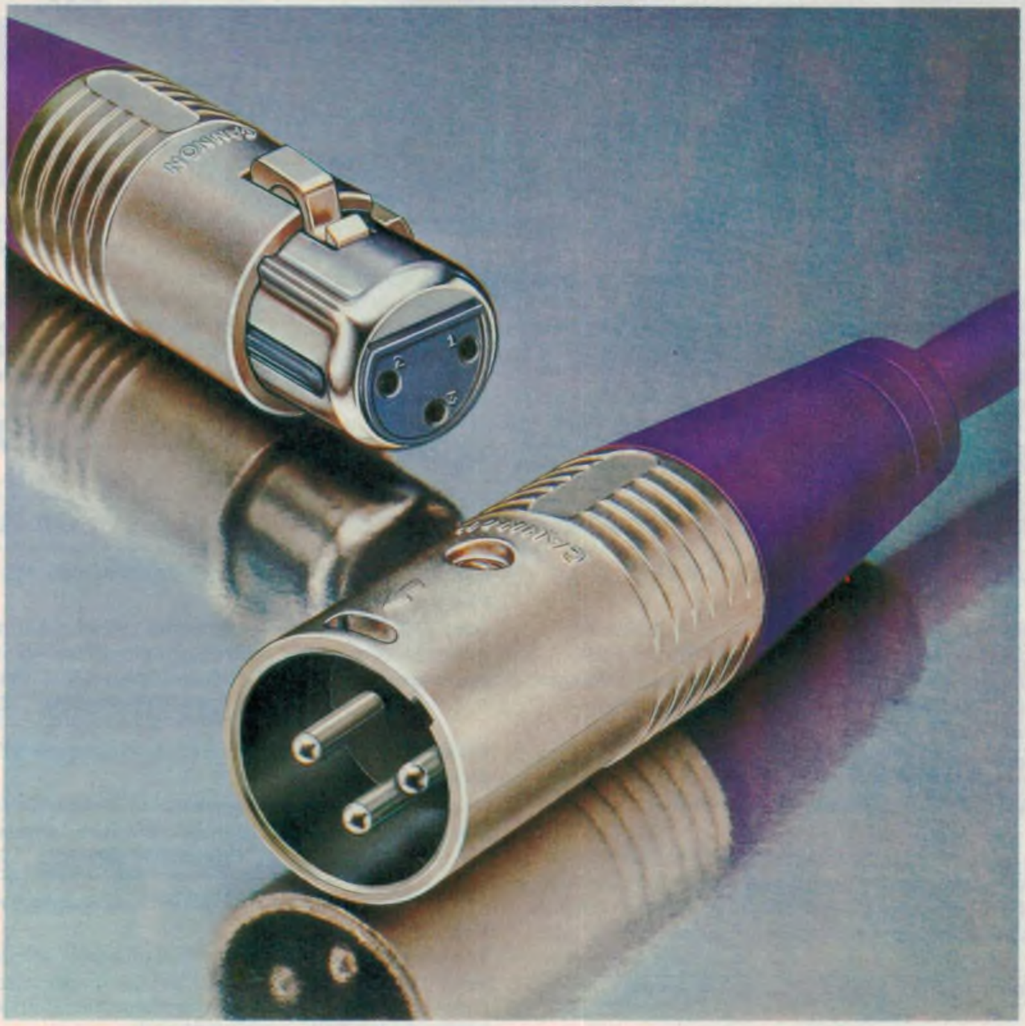
DC solenoids

Crusader has now available a comprehensive range of open frame style DC operated solenoids.

A high force/size ratio is achieved through precision and quality design. Sizes range from miniature (8 x 10 x 15mm) to the larger (52 x 58 x 83mm) dimensions. Industry standard models are complimented by a variety of latching options: self, external spring and built in permanent magnet latching, as well as noiseless and noise reduced versions.

High efficiency twin section coil versions are available from 6 to 317/415 VDC and power requirements range from 0.8 up to 110 watts depending on the length and frequency of operation. A working life cycle of 70,000 operations is typical. A selective range of accurately machined pole/plunger shapes are also available to facilitate a wide range of applications.

Type overview selection charts are available from Crusader Electronic Components, 73-81 Princes Highway, St Peters 2044 or phone (02) 516 3855.



Solid State Update

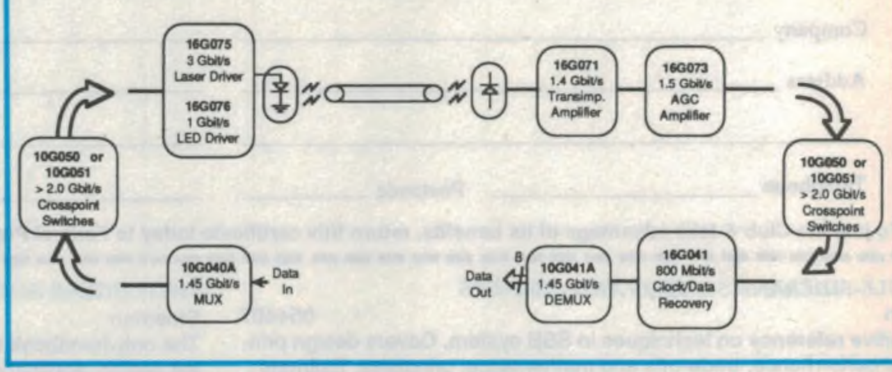
KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

Complete GaAs fibrecom chip set

Gigabit Logic, Inc. has announced seven new analog and digital GaAs ICs specifically designed for high speed (Gbit) digital fibre optic transmitters and receivers.

The new ICs are the 16G071 transimpedance amplifier, the 16G073 AGC amplifier, the 16G075 laser diode driver, the 16G076 LED driver, the 16G041 low power phase locked loop clock and data recovery circuit, the 10G0505 8 x 8 crosspoint switch and the 10G051 16 x 16 crosspoint switch. These seven new ICs add to GigaBit Logic's time division multiplexer, demultiplexer and previous-generation clock recovery circuit, to form the first truly complete and available family of GaAs ICs for the total system design of high performance digital fibre optic communications links.

GigaBit Logic GaAs IC Chip Set Defines a Complete High Speed Fiber Communication Link



The new 1.4 Gbit/s 16G071 transimpedance amplifer incorporates feedback circuits for high gain and stable operation. Four choices of precise on-chip feedback resistance (1.0, 1.5, 2.0, and 3.0K ohm) are available.

The 16G075 3 Gbit/s laser diode driver features single -5.2V power supply operation, ECL/GaAs compatible interface, 0 to 40mA bias current, up to 50mA output modulation current, and an auto-power control for bias current modulation and protection of the laser against thermal runaway.

The 16G076 LED driver is the first circuit of its kind and is designed to address the needs of the emerging class of new, very fast LEDs. Its shunt drive circuit permits operation up to 1Gbit/s with very low output jitter and, in conjunction with the LED, provides a high on/off ratio (13dB) of optical pulses. Output rise and fall times are 300ps and 500ps respectively and power is limited to just 500mW.

The 16G041-H is a low power version of GigaBit Logic's previous generation phase locked loop clock and data recovery circuit, optimised for low power, small size and ease of use. The 16G041-H is a true three terminal clock/data recovery solution – data in, recovered clock and re-timed data out. The loop filter, VCO resonator and all other components are included within the surface mount package which measures just 3.175cm on a side. The circuit dissipates under 1W and is factory tunable from 50Mbit/s to 800Mbit/s.

The 10G050 and 10G051 crosspoint switches are the first devices of this kind, designed for very high data rate bit stream switching matrices. Both devices are LSI-complexity GaAs ICs featuring 2Gbit/s and greater performance, less than 2ns reconfiguration times and non-blocking (any input can be switched to any output) architectures. Further, the 10G050 8 x 8 switch is expandable to wider crosspoint matrix sizes with no external components.

The 16G073 AGC amplifier is the only member ot the chip set not immediately available. It is slated for shipping in June 1989. The 16G073 will feature 1.5Gbit/s speed at 650 mW power dissipation.

For further information contact Integrated Silicon Design, PO Box 99, Rundle Mall 5000 or phone (08) 223 5802

Pin-selectable voltage reference

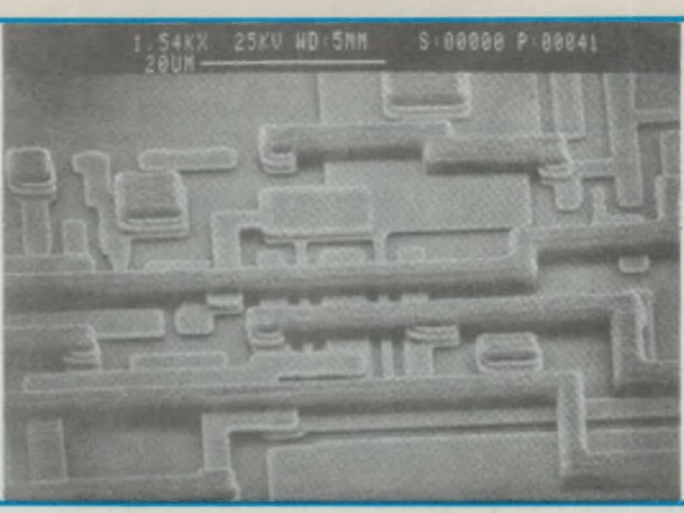
The PMI REF-08 is a series regulation, buried Zener, negative voltage reference with pin-selectable output voltage. Its low temperature coefficient, low noise, and selectable output make it an ideal reference for A/D converters such as the PMI ADC-908 or the PM-7574. The REF-08 is also well suited for CMOS DAC applications where a positive output voltage is desired.

Applications with 8-bit accuracy will typically be able to use the REF-08 without trimming its output voltage. This is particularly true of CMOS DAC's with low gain errors such as the DAC-8408 and PM-7528. Leaving the SELECT pin open will result in a -10V output. Grounding SELECT will produce a -10.24V output (ie. -10mV per 10-bit LSB) that is ideal for binary applications.

A +/– 270mV adjustment range is available with the REF-08, which exhibits a tight 0.04ppm/°C/mV of adjustment temperature coefficient. In many applications, the combined tempcos of an adjusted REF-08 will be superior to more expensive precision references with tighter initial tempcos but greater changes with adjustment.

The REF-08 has been designed to operate from a 'worst case' -12V power supply (-11.4V). This low dropout voltage makes the best of the poor supply regulation in some digital systems. Its 10mA output current capability and unloaded supply current of only 2mA provide better power/performance than most traditional op amp inverter circuits.

For further information contact VSI Electronics (Australia), 16 Dickson Avenue, Artarmon 2064 or phone (02) 439 4655.



Triple metal process for GaAs VLSI

GigaBit Logic of Newberry Park, California has developed a high performance three level interconnect process for manufacturing VLSI digital GaAs integrated circuits. This process uses for the first time in commercial GaAs technology, parallel and perpendicular crossings of second and third level metal lines over active devices – allowing higher circuit density and higher routing efficiency, along with lower power dissipation and high performance.

This innovative manufacturing approach, together with GigaBit's recessed gate E/D process, has been used in manufacturing the world's first commercially available 3ns 4K RAM, 1ns 4K ROM, and various other ASIC designs.

The entire three level metalisation process is built around a production-proven dielectric assisted lift-off technique. After the first level contacts and interconnects are fabricated, another planar surface is formed as a result of choosing the thickness of the dielectric and metals to be similar. This approach results in a smooth planar surface, greatly facilitating highly reliable multilayer interconnect structures. In addition, to make connections between the first and second level metals, 'via' windows are etched into the interlevel dielectric and filled with metal (equal in thickness to the interlevel dielectric). This via-fill process results in highly reliable interconnections between the first and second level metal. A similar process is used to connect second to third level metal.

GBL says the process is highly manufacturable and avoids the pitfalls associated with more complex approaches. Furthermore, the use of filled via holes avoids the step-coverage problems associated with sloped via holes, and allows the fabrication of ICs with an extremely planar surface topology. Moreover, the surface planarity results in very compact metal layer design rules.

The use of these compact design rules and three levels of interconnects in the layout of the 12G044 4K self-timed RAM and the 4K ROM resulted in a cell size reduction of approximately 25% compared to a layout utilising only two levels of interconnect.

The use of three levels of interconnect and active device crossovers will allow extreme flexibility in the layout and routing of power and signal lines in GaAs VLSI ASIC and custom parts. Besides fabricating standard and full custom parts, GigaBit uses three layer metal interconnect in the SC10000 Standard Cell Library to push the level of integration to 10,000 gates. The SC10000 Standard Cell Library will be available in the fourth quarter of this year.

For further information contact Integrated Silicon Design on (08) 224 0464.

12-bit CMOS ADC has serial output

A new high-speed monolithic analog-to-digital converter (ADC) guarantees a minimum 10us conversion time and offers serial data transfer capabilities. The serial data port reduces pin count, permitting the Analog Devices AD7772 to be packaged in small 20-terminal LCCC and PLCC surface-mount packages, as well as a skinny 0.3" 20-pin plastic or ceramic DIP. It also simplifies connecting the ADC to microprocessors, microcontrollers, and high-speed signal processors.

The AD7772 handles both 0 to +5V, 0 to +10V unipolar and +/−5V or +/−10V bipolar input ranges with on-chip applications resistors. An on-chip buried-Zener reference has a low 25ppm/°C temperature coefficient for accurate operation over a wide temperature range.

Fabricated in Analog Devices' proprietary high-accuracy LC^{2}MOS process, the AD7772 operates from +5V, −15V supplies and typically consumes 135mW of power. When used with a high-speed S/H amplifier such as the AD585, the ADC can achieve throughput rates of 76kHz.

The AD7772 also has an on-chip clock oscillator. The converter can be driven by the internal or an external clock in an asynchronous or synchronous mode. Pin-programmable data formats include 2's complement, straight binary, offset binary, complementary binary, and complementary offset binary.

For further information phone Parameters on Sydney (02) 888 8777 or Melbourne (03) 575 0222.

Hyperabrupt GaAs tuning varactors

High Q, constant gamma of 1.0 & 1.25, GaAs hyperabrupt tuning varactors are now available for a tuning voltage range of 2V through 20V. Manufactured by Alpha Industries, the devices exhibit high Q (up to 5000) and capacitance – versus voltage characteristics, and can be supplied in matched sets to a customer's specified tolerances.

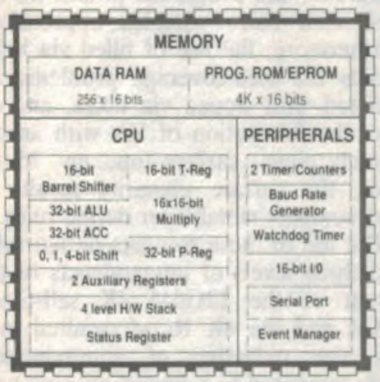
Either chips or a variety of packages are available, such as ceramic waveguide, coax, stripline, and also beam lead versions for applications requiring minimum parasitics.

When used in analog phase shifters and tunable filters, constant gamma diodes improve frequency tuning linearity, eliminate the need for a circuit lineariser, and minimise AM/FM noise & power loss in the varactor. Typical applications are VCO's (including phase-locked), LO's for Radar, and VCO's for tunable synthesisers.

For further information phone Benmar International (02) 233 7566.

Solid State Update

Internal Blocks of the TMS320C14/E14



Fast DSP microcontroller

Texas Instruments has introduced the TMS320C14, a 16-bit digital signal processing (DSP) microcontroller. The TMS320C14 is the first device to combine the high performance of a DSP with the on-chip peripherals of a microcontroller.

Operating at 25.6MHz, the new device is claimed to be the world's fastest microcontroller. The TMS320C14 offers five to ten times the speed of traditional 16-bit microcontrollers, yet is comparably priced.

The TMS320C14 is object-code compatible with the industry-standard TMS320C10 DSP and offers 256 words of on-chip RAM and 4K words of on-chip ROM or EPROM. The device can also address 4K words of off-chip memory.

The TMS320C14's on-chip peripheral functions include: 4 timers, bit selectable I/O, an event manager, a serial port with three modes of operation, and 15 external/internal interrupts including one nonmaskable interrupt.

The processing power of a DSP engine allows the TMS320C14 to compute advanced control algorithms such as Kalman filters and state controllers for analog-type performance. However, the TMS320C14 is not affected by inaccuracies due to environmental conditions such as temperature drift and aging.

For further information contact Texas Instruments (Aust.) offices in each state.

'Femtoamp'

The PMI OP-80 is a low cost CMOS operational amplifier offering exceptionally low input currents over a wide operating temperature range. Input current is typically only 200 femtoamps at 25°C and increases to only 500 femtoamps at +85°C, with exceptionally high common-mode and differential input impedances.

Incorporating a novel input protection design, the OP-80 achieves over 700V of ESD protection while maintaining this very low input current.

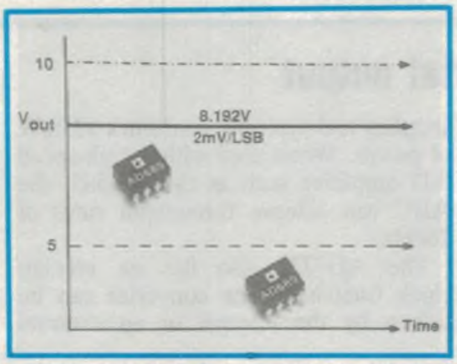
Low supply current minimises thermal power dissipation, virtually eliminating the effects of chip self-heating. The OP-80's CMOS design gives a good speed/power ratio, permitting a 0.2V/us minimum slew rate and a 300kHz gain-bandwidth product with unity-gain stability.

The OP-80 offers greater than 100dB of gain into a 2k ohm load, with output source/sink capability exceeding 15mA. In single supply applications, the OP-80's input range and output swing extends to ground. No pull-down resistor is required for the output to actively swing to within 200uV of ground.

For further information contact VSI Electronics (Australia), 16 Dickson Avenue, Artarmon 2064 or phone (02) 439 4655.

High resolution voltage reference

Analog Devices' new +8.192V reference provides designers with the highest effective resolution for systems operating from a nominal 12V supply. Unlike +10V references which cannot operate reliably at the lower limit of a 12V+/–10% supply, the AD689 is guaranteed to operate with supplies as low as 10.8V. It also provides 2mV/LSB for 12-bit converters, compared to the 1.2207mV/LSB resolution of a 5V reference.



Force and Sense connections on the monolithic AD689 allow remote sensing of the load and ground voltage to maintain accuracy of reference value at the load. The Force and Sense connections can also be used to boost output current, with a high-current transistor connected inside the loop at the reference output.

Initial accuracy is laser trimmed to within +/–4 to +/–16mV, depending on grade. An optional fine trim connection allows the output voltage to be adjusted +8%, –3%, for higher accuracy or a precise 8.000V reference value. Peak-to-peak (p-p) noise is typically below 2uV (0.1 to 10Hz); wideband (to 1MHz) noise is typically less than 400uV p-p and can be reduced to less than 200uV with an external capacitor.

Maximum temperature drift is from 5 to 25ppm/°C, with the lowest drift in the highest accuracy grade. A 15ppm/1000Hr typical long term drift assures stability over time.

For further information contact Parameters, 1064 Centre Road, Oakleigh 3167 or phone (03) 575 0222.

CMOS analog filter is latchup-free

Reticon has produced a CMOS version of its highly popular lowpass switched-capacitor filter.

The RF6609ANP-011 is a 7th-order elliptical lowpass filter with all the benefits of CMOS technology including low power, low DC offset, lower noise and reduced clock feedthrough. Its excellent out-of-band rejection and low DC offset are useful in anti-aliasing and signal reconstruction tasks. Distortion remains less than 1% for 6Vp-p input signal levels (+/–5V supplies).

In addition, it is totally free of latchup problems often present in some other CMOS switched-capacitor filters. This makes the RF6609A well suited for applications including data acquisition, general instrumentation, and biomedical and telecommunication systems, while its small size and low power make it also suitable for portable devices.

For more information contact Email Electronics, 15-17 Hume Street, Huntingdale, 3166 or phone (03)544 8244.

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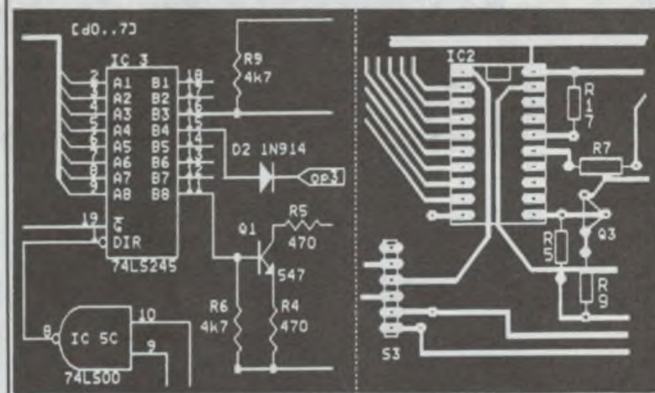

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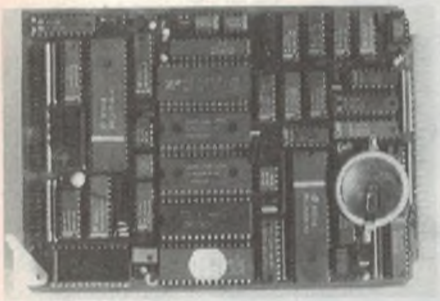

CMOS single board computer

A new STD-bus computer has just begun production at JED Microprocessors in Melbourne. It is designed for applications where a low current consumption, CMOS, system is needed for data logging, process control or where intelligent interfaces are needed between instruments, transducers, and PLCs or PCs used for control systems.

The STD-801 is easily programmed in BASIC (using an on-board interpreter) or in C, Modula-2 or in MTBASIC, (a compiled multi-tasking system), using a PROM-based BDOS-BIOS emulator supplied with the board.

There is an 8-channel, 10-bit accuracy D/A converter on the board, saving users the expense of additional boards. Thirty I/O lines, (including 8 or 12 FET power drivers) provide direct control facilities on the board.

A dual-channel UART provides two serial RS-232 I/O channels. One channel can also have RS-485 drivers and receivers, allowing the board to operate in party-line situations.

An interface to a small keyboard and LED/LCD displays, and to the JED Datasafe, a small secure memory box for data transport is provided.

A battery-backed real-time-clock on the board can control system power, allowing the card to be the heart of a scientific instrument or logger which can be solar powered and battery-backed and consume very little average power. Operating power consumption is under 0.5 watts from a single 5 volt rail.

Four memory sockets allow users to add 64KB of battery backed RAM (or a mixture of PROM and RAM) to the basic 8KB RAM and 16KB executive PROM supplied as standard.

The STD-801 is priced from $500. Further information is available from JED Microprocessors, PO Box 30, Boronia 3155 or phone (03) 762 3588.

SCSI bus controller

A very high performance CMOS SCSI Bus Controller chip, the L5380/L53C80 offers a 2.5 times speed improvement while using a tenth of the power of competitive chips.

Now available in Australia from Dynamic Component Sales, the Logic Devices controller features an asynchronous transfer rate of up to 4Mbytes per second.

The chip is pin and functionally compatible with the NMOS NCR5380, but its replacement with the Logic L5380/L53C80 is claimed to result in REQ/ACK and DRQ/DACK handshake response times up to five times faster than previous devices. The low power CMOS technology is also said to give a ten times power reduction.

The controller supports asynch data transfer between initiator and target, and operates in either role. It offers a choice between programmed I/O (direct microprocessor manipulation of handshake), or any of several DMA modes (autonomous handshake and data transfer options).

The L5380/L53C80 has internal hardware to support arbitration, and can monitor and generate interrupts for a variety of error conditions.

For further information contact Dynamic Component Sales, Showroom 1, 17 Heatherdale Road, Ringwood 3134 or phone (03) 873 4755.

Peripheral sharing for PC users

Data Bridge Communications has released a low-cost peripheral sharing device for businesses requiring up to five personal computers utilising one printer.

The product, Print Director Junior, is configured with 256K of buffer memory that is expandable to 512K. It comprises six serial ports – five to connect PCs and one for output to most types of printers or plotters.

Print Director Jr is the simplest device in the peripheral sharing range with no software or hardware configurations to set. Its special setup codes allow compatibility to a large range of printers. Each port is fixed at 9,600 bits per second, and status is displayed on the front panel – allowing users to monitor activity on each port.

The in-built buffer can accommodate several printing jobs, freeing up individual PCs even if the printer is in use.

For further information contact Data Bridge Communications, Cary Street, Drummoyne 2047 or phone (02) 819 6474.

Experimenter card for IBM PC/XT/AT/386

Electronic Solutions has just released a universal wirewrap card for engineers and other technical people developing hardware add-ons for the IBM PC/XT/AT/386 or compatibles.

The card provides a complete built-in data bus, address bus and I/O line buffer circuit. It incorporates a universal address decoding chip and a D25 female connector. Buffering of the inputs and outputs makes damage to the PC's bus from faults on the card virtually impossible.

The wire-wrap area is 4000 holes which are plated through for easy prototyping work. The card is built to a very high standard and can withstand heavy use. It carries a full three month warranty.

For further information contact Electronic Solutions, PO Box 426, Gladesville 2111 or phone (02) 427 4422.

Standard resistors

Guildline Instruments has added to its line of Standard Resistors. The 100 megohm value of the 9330 series offers an increase in the upper range of standard resistors from the current standard ceiling of 10 megohms. Now Guildline Instruments can offer a complete series of precision standard resistors form 0.1 ohms to 100 megohms.The specifications for the 9330/100M are as follows:

Resistance value – 100,000,000; Accuracy – .005%; Temperature coefficient (from 20-30C) – 5ppm/₀C; Power rating (Watts) – 0.1; Time constant – 60 seconds to within 0.2ppm of final value.

For further information contact Parameters, Centrecourt, 25-27 Paul Street North, North Ryde 2113 or phone (02) 888 8777.

Colour scanners for PCs

Sharp has announced what it claims are the first desktop colour scanners for personal computers. The scanners provide colour resolution of up to 300 dots per inch, with alternative resolutions adjustable to match a wide variety of applications. A colour palette of over 260,000 tones will capture every nuance of colour.

There are two Sharp scanners available. The JX450 scans up to A3 size (17" x 11 5/8"); and the smaller more economical JX300 scans up to A4 size (8.5" x 11"). Both colour scanners are fully compatible with IBM PC and PS/2 and compatibles, Apple Machintosh II family, plus many other systems.

For further information contact Sharp Corporation, 1 Huntingwood Drive, Blacktown 2148 or phone (02) 831 9111.

Surge protector

HPM's new Power Protector (Cat. 105/PP/4) provides a sophisticated defence against power surges and other damaging electrical disturbances.

The Power Protector, which retails around $80.00, has a range of protection features to assure clean power. These include surge/spike clipping and filtering. The unit also includes an overload cut-out which is triggered when the total power drawn through the Power Protector exceeds 2400 watts or 10 amps.

For further information contact HPM Industries, 4 Hill Street, Darlinghurst, NSW or phone (02) 361 9999.

Compact HV supplies

A small, economical source of adjustable high voltage is provided by the 7000 range of DC to DC converters from Emco High Voltage Co., of California. Available in Australia from Amtex Electronics, these 5 watt devices have an output which is adjustable from 0 to 100% and can be supplied in may combinations of input and output voltages. Standard configurations are 5kV, 10kV, 15kV and 20kV outputs, produced from an input of 28V DC.

Output adjustment on the 7000 series can be programmed by an external voltage source, an external potentiometer or by a front panel accessible multi-turn potentiometer. Providing excellent regulation and very low output ripple, the converter's design includes RFI filtering and shielding and protection against short circuit and reverse polarity.

Also available from Emco is the 6000 series, a range of high voltage DC to DC converters, offered in single or multiple outputs. A typical configuration of high voltage (17kV) with two auxiliary outputs such as +1, 100V and −100V is ideal as a supply for high resolution CRT monitor applications.

Both series of power supplies have two 6-32 studs which enable the unit to be mounted in the industry standard 75mm (3") mounting pattern.

For further information contact Amtex Electronics, 13 Avon Road, North Ryde 2113 or phone (02) 805 0844.

Synthesised signal generators

Two new RF synthesised signal generators have been introduced by Hewlett-Packard Australia.

The HP8644A and HP8665A generators provide low phase noise and spurious levels, commonly needed in R&D and manufacturing. The HP8644A covers a frequency range to 2GHz and the HP8665A covers a range to 4.2GHz.

Built in a modular mainframe, the new generators can be configured with a variety of options that allow customers to select the right performance level for specific applications. They are the second and third members of the new performance signal-generator series, sharing a common user interface and support strategy with the JP 8645A agile signal generator.

For high-cycle production applications, the HP8644A is available with a solid-state electronic attenuator warranted for five years. The special design uses PIN switching elements with 3 million hours MTBF, giving the attenuator an estimated 0.2% failure rate. This optional attenuator currently is used in the HP8657A signal generator and has been proven in many production applications.

For receiver measurements, the HP8644A offers simultaneous FM, AM and pulse modulation. Users can test communication receivers or low-rate data links with FM deviations up to 20MHz, combined with specified rates to 100kHz.

The HP8665A shares the same phase-noise and spurious levels as other members of the HP performance signal-generator series, but now provides this capability up to 4.2GHz. This combination of frequency and performance previously has been unavailable.

For further information contact Hewlett-Packard Australia, 31-41 Joseph Street, Blackburn 3130 or phone (03) 895 2895.

New Products

Handheld 10MHz DSO

Tektronix has announced a new 2kg handheld digital storage oscilloscope (DSO). The Tek 222 delivers dual-channel 10MHz performance in a compact package measuring only 9 x 15 x 25cm. Yet the 222 provides powerful features, including automatic setup and digital save/recall of both front-panel settings and captured waveforms. It also provides a built-in battery and two independent isolated channels for amking elevaqted ground measurements safely.

Although the 222 is small enough to be handheld, it offers a number of high-powered digital features. For example, glitch capture up to 100ns, dual channels, 10MHz bandwidth, and 10MS/sec sample rates are all features normally found on larger oscilloscopes.

The 222 also features the ability to float grounds to high voltages (400V) , for power supply and motor control measurements that are common in industrial environments.

The 222 includes a carrying case, battery charger, and optional spare battery. The scope's snug, nylon carrying strap provides comfortable handling and an easy grip. With the convenient neck strap, users can operate the scope with one hand, and use the other hand for probe positoning or, if necessary, to steady themselves while making measurements from precarious positions.

The 222 is fully programmable via an RS-232-C interface, which comes standard. This allows users to connect their scope to a computer for data analysis, automatic acquisition, or record keeping.

Further details from Tektronix Australia, 80 Waterloo Road, North Ryde 2113 or phone (02) 888 7066.

DSOs have dual ADCs

Intron Instruments, the specialist manufacturer of digital storage oscilloscopes from the Netherlands, has appointed Emona Instruments as its Australian distributor. The move will finally make these uniquely high specification, yet low cost oscilloscopes available in Australia.

The outstanding feature of the Intron DSO-2020 series is that each model fetures dual ADCs – i.e. one converter per channel, which ensures that simultaneous data will always be captured in 2 channel operation. While this feature in itself is not new, the fact that prices start at around $2000 is significant and Emona claims that such a breakthrough has never before been achieved.

Intron's DSO's offer 2kB memory per channel, allowing 200 points/division horizontal resolution. A split memory mode for recording multiple events is also available.

Two series are available: the DSO-2010, a basic 10MS/s per channel instrument and four models in the faster DSO-2020 series. The DSO-2020 is a basic low cost unit with 20MS/s per channel. The DSO-2020A includes reference memory facilities and a XY(t) analog plotter output. The DSO-2021 is as the 2020A, only it includes an RS-232 interface that directly drives any popular low cost HP-GL plotter, plotting axes and scale information. In effect, it provides a detailed plot of the CRT. Finally, the DSO-2022 includes a GP-IB interface for complete computer control of DSO data transfer.

Further details are available from Emona Instruments, 86 Parramatta Road, Camperdown 2050 or phone (02) 519 3933.

Frequency synthesisers

Z-Communications has recently introduced two new frequency synthesisers covering a range 325-850MHz and 800-1200MHz with 150 microseconds switching speed. These are high performance PLL (phase locked loop) synthesisers based on Z-Communications own proprietary VCO technology.

The unit size is 102 x 76 x 7.6mm. The phase noise is claimed to be a very powerful feature offering -90dBc at 100Hz offset from carrier at 400MHz. RF output is provided on SMA connector and the power level throughout the range is approx. 13dBm. All the spurious signals are claimed to be less than -60dBc over the entire frequency range.

Details of the Z-Comm product range is available from Clarke & Severn Electronics, PO Box 129, St Leonards 2065 or phone (02) 437 4199.

Process monitor/controller

Datel has announced the PM-5080, an intelligent panel-mount instrument for precision measurement and control of process variables.

The PM-5080 proves two voltage/current signal inputs, four programmable setpoint relays for ON-OFF control, and an optional analog output for linear control. Powerful user-defined maths algorithms and input scaling functions make the PM-5080 easily adapted to a wide variety of input/output tasks. When combined with a host computer via the standard RS-232 port, the PM-5080 forms a full-function operator station for real time process monitoring and control, data archiving and statistical analysis.

The PM-5080's two independent, isolated signal inputs – 0 to 100mV (or 0 to 20mA) and 0 to 10V – permit direct connection to standard process sensors and transmitters. Input signals are easily scaled to engineering units for display. Any two-character units descriptor can be displayed along side the numeric data. Data is clearly presented by a 6 character (5 digit) fluorescent display which can be configured to alternately display (at two second intervals) up to eight different 'system variables', including maths function values and input peaks and valleys.

For further information contact Elmeasco Instruments offices in your capital city, or phone (03) 879 2322.

Programmable generators

Tektronix has released two new programmable pulse/function generators that provide pulse, double pulse, sine, triangle and square waveforms from 0.012Hz to 12MHz in continuous, triggered, gated, burst, swept and AM/VCO modes. The instruments also generate DC outputs.

The two pulse/function generators, the PFG 5105 plug-in unit and PFG 5505 standalone unit, are new additions to Tektronix's popular '5000' line of modular instruments. These instruments have identical specifications and measurement capabilities.

The PFG 5105 and PFG 5505 are programmable and can store up to 99 front panel setups, reducing GPIB programming time and enhancing standalone bench applications. English-like GPIB commands also reduce software development time.

A special function key (SPCL) extends the functions of the front panel by enabling engineers to change GPIB addresses and/or terminators and alter display backlighting and contrast. Increment keys are used to scroll through the special codes for selecting desired operation.

In the continuous mode, accuracies to 0.005% are achieved with a synthesiser option, which locks the instrument's output to an internal quartz crystal.

For further information contact Tektronix Australia, 80 Waterloo Road, North Ryde 2113 or phone (02) 888 7066.

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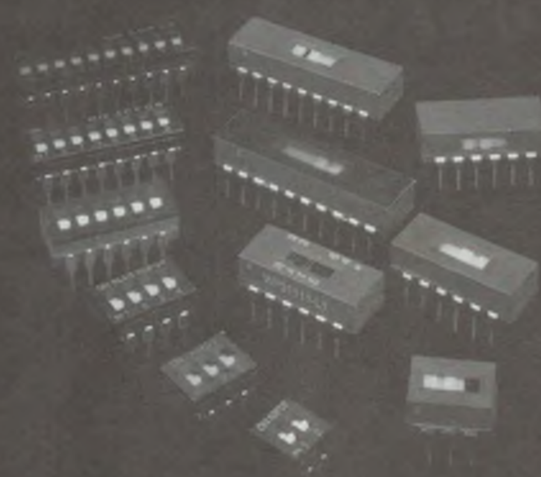

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Advanced Receiver Front Ends

This month let's look into some practical circuit details of low noise 'front end' sections of advanced superheterodyne receivers such as communications receivers and dedicated single-frequency receivers.

by BRYAN MAHER

Although the majority of radio receivers are probably tuned to local broadcast stations, receiving music and speech under ideal reception conditions, there are today an increasing number of receivers whose function is to receive important speech, coded and digital message signals.

Perhaps you regard as 'entertainment' two people having an informal chat via the CB (Citizens' Band) radio network. More serious uses of the air waves include the highly essential message handling between a ground controller and a distant or approaching aircraft.

Yet again an important use of some radio receivers involves receiving extremely weak signals from a far distant radio station, or perhaps a very low powered portable instrumentation transmitter. In these cases the radio receivers are working under most non-ideal conditions of reception.

The signal arriving at the antenna is apt to be partially or mostly drowned by atmospheric noise, receiver internal noise, interference noise from fluorescent lights and electrical machinery, unwanted powerful radio transmissions on adjacent frequencies, or radio stations on quite different frequencies appearing by error near the wanted station. What a mess! And as well the wanted signal may be fading up and down continually.

But do not despair, enthusiastic reader, if you are wont to use a radio receiver under such difficult conditions, it is quite possible to buy or build a receiver especially designed for receiving poor signals under such trying reception circumstances.

Communications receivers

These high quality receivers, if made for reception on a wide range of frequencies, are called 'communications receivers'. But for use in such applications as aircraft to ground communications we might call them 'dedicated receivers', capable of being switch-tuned to one of just a handful of special reserved frequencies.

In either case the construction and design principles invoked to make a receiver of high capability would be very similar. You can purchase, if you wish, a communications receiver carrying a price tag anywhere from $500 to $5000, or even more for the top professional models. Modern solid state integrated circuits have caused a reduction in size, weight and price compared to older models, and as well some state-of-the-art components have enabled amazing results. So let's get some details!

To start with we can list the desirable properties of a quality communications radio receiver:

1. Low receiver internal noise.
2. High receiver gain.
3. Stable tuning frequency.
4. Accurate frequency calibrations on dial or readout.
5. Fine increments in tuning and frequency indication.
6. Bandwidth narrow enough for the application, possibly using crystal or mechanical IF filters.
7. Absence of spurious reception problems.
8. Large dynamic range (of received signal strength).
9. Low intermodulation distortion.
10. Powerful and controllable automatic gain control.

A radio receiver satisfying all of the above would indeed be a fine instrument, but we might also wish for a few further embellishments, thus:

11. A calibrated signal strength meter.
12. Ability to receive Morse code.
13. Provision for single sideband reception.
14. Possible reception of FM (frequency modulation).
15. Digital tuning
16. Scanning facility
17. Crystal controlled synthesiser tuning
18. Noise squelch circuit.

An impressive list indeed, but do not be overawed. Each item is a straightforward fascinating piece of electronic practice. Let us consider the types of circuits employed to achieve such nice characteristics.

Low receiver noise

All electronic amplifiers generate some noise, which we call 'receiver noise' or *internal* noise to distinguish from *external* noise – that blanket of atmospheric noise and man-made interference which comes in via the antenna.

Measurements show that usually:

(a) On frequencies below about 15MHz, external electrical noise exceeds the noise generated in the receiver.

(b) Around 20MHz the external noise may be about equal to the internal noise of average good receivers, depending on your location.

(c) When you are receiving stations on frequencies above 25MHz, generally the external noise is less than your receiver noise.

(d) Above about 150MHz, external

noise is insignificant. Virtually all the noise heard is that generated by your receiver.

How can we reduce receiver-generated noise? In any active electronic circuit, for frequencies in the HF, VHF, or low UHF range, lowest circuit-generated noise is achieved by choice of the best transistor, the ideal quiescent operating current, and an appropriate circuit. Though every semiconductor junction generates noise (that's a fundamental law of nature), it behoves us to carefully choose transistors whose noise generation is least.

Low noise transistors

Among the low noise transistors for the frequency range below about 50MHz are the JFET types MPF102 and 2N4416, the MOSFET type 40673 and many NPN junction transistors, examples being the 2N4952, 2N3116, SE5051, 40478, 40242, and the cheaper types (with inferior noise characteristics) the 2N2222A or Texas Instruments types A5T2222.

For use on frequencies in the 50MHz to 300MHz range, there are others like the junction transistors 2N6604, MRF914, MRF961, MRF962, MRF965, 2N4934, 2N4935, 2N5179 and 2N2857, or Siliconix FETs types U31O or U300; while some of the above still work well up to 1.0GHz.

For lower noise at frequencies up to 500MHz there are the Motorola types BFR91 (with an exceptionally low noise figure of 1.9dB), or the 2N6603, MRF904 and MRF905.

For still lower noise at frequencies up to 1.0GHz, Motorola manufactures the gallium arsenide dual gate N-channel depletion mode FETs, types MRF966 and MRF967 (noise figure 1.2dB). For the same frequency range there are the NPN junction transistors types MRF571 and MRF572.

Each of these devices should be operated at a voltage and current which results in lowest transistor noise. Most transistors generate less noise when passing lower current, down to a noise plateau value. But if the current is reduced below a 'critical current' value the noise becomes much higher (and quite often the gain drops as well). This critical current value lies somewhere between 2.0 microamps and 1.0 milliamp depending on the transistor, the load impedance and the frequency.

Signal to noise ratio

If all stages in a receiver generated equal noise, (but they don't) then only the noise generated by the first stage would be significant. This is because the noise level is judged by comparison with the signal level. It is the ratio of signal to noise which matters.

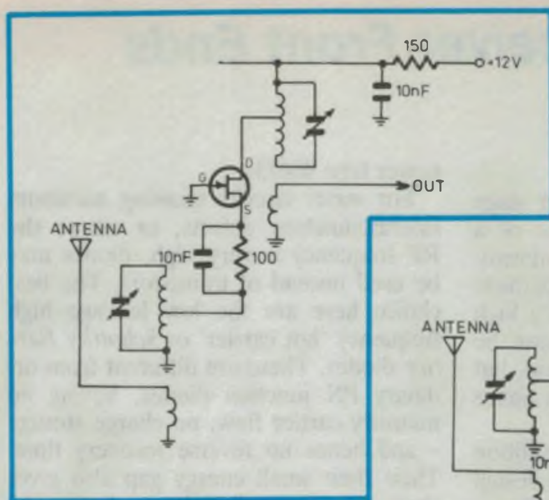


Fig.1a (above): A common-gate or source input tuned RF amplifier stage for VHF applications, using a low noise JFET. Low impedance tappings are used on the tuned circuits to give high Q.

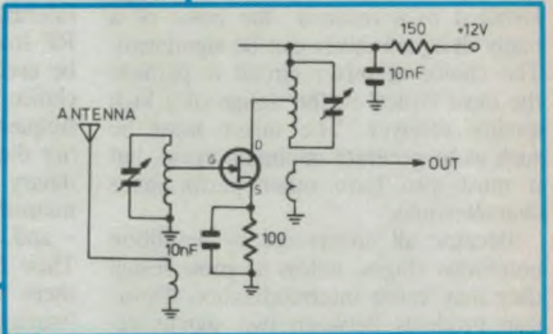


Fig.1b (below): A common-source or gate input tuned RF stage for MF/HF applications, again using a low noise JFET.

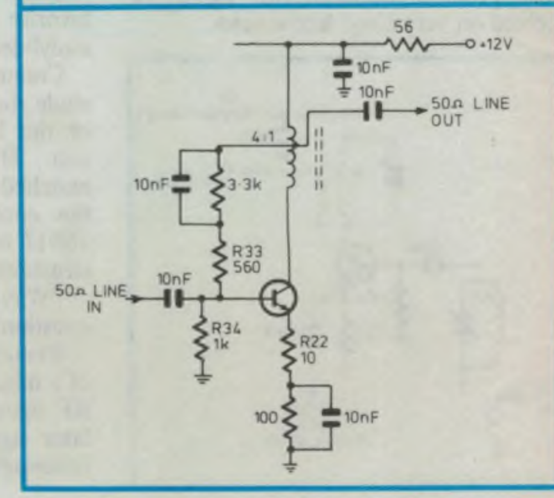


Fig.1c (right): An untuned broadband RF amplifier for HF applications, using a low noise bipolar transistor. The output transformer has a 4:1 stepdown turns ratio.

If a circuit consists of two stages, each generating the same number of noise microvolts, at the output of the first stage the signal and noise have both been amplified to a level greater than the noise level of the second stage. Thus the signal to noise ratio of the first stage dictates the signal to noise value for the whole circuit. And the same applies for circuits with more than two stages, so a low noise first stage is vital!

RF amplifiers

Because in general mixer stages are always noisier than amplifier stages, the highest signal to noise ratio in a receiver is achieved by adding a good low noise RF amplifier in front of the mixer.

When automatic gain control (AGC – also called automatic volume control or AVC) is applied to an amplifier, it changes the gain by changing the quiescent operating current. Therefore to keep the RF amplifier transistor working at the optimum current for lowest noise, AVC should not be applied to this stage.

Common gate tuned RF amplifiers as Fig.1(a) are often used to obviate the problem of gain reduction by capacitive negative feedback from drain to gate (Miller effect). This is particularly important at higher frequencies. Alternatively common source tuned RF amplifiers as in Fig.1(b) may be used, at lower frequencies.

Sometimes untuned RF amplifiers are used, as in Fig.1(c), which will exhibit a voltage gain of about 6.3 times or 16dB for RF frequencies below about 150MHz. Stability of this circuit is ensured by two sources of DC coupled RF negative feedback, one from the tapping on the output transformer to the base. The other is due to the signal voltage at the emitter generated by voltage drop across the unbypassed 10-ohm emitter resistor. However there is a disadvantage to using untuned RF amplifier stages, a point which we will discuss later.

Advanced Receiver Front Ends

Low noise mixer

Even with a quiet RF amplifier stage installed in a receiver, the noise of a badly designed mixer can be significant. The choice of mixer circuit is perhaps the most critical in the design of a high quality receiver. The mixer must be such as to generate minimum noise, but it must also have other performance characteristics.

Because all mixers are by definition non-linear stages, unless of good design they may cause intermodulation distortion products between two signals received on very close frequencies.

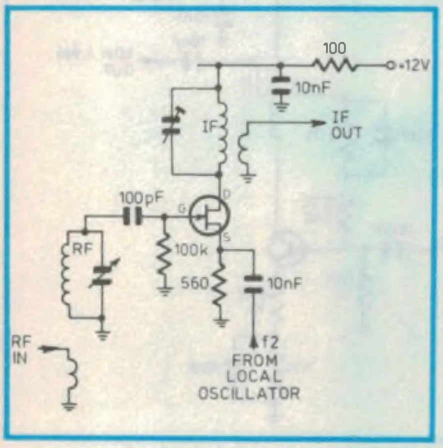


Fig.2a: A mixer stage using a low noise high-frequency JFET. The local oscillator signal is injected at the source.

The mixer circuit shown in Fig.2(a) uses the 2N4416 FET with tuned RF input at the gate and local oscillator input at the source. The mixer is driven into the required non-linear mode of operation by the drive from the local oscillator being quite a large signal, an RF sinewave of +/-5V amplitude.

The RF signal at the gate may be only some number of microvolts. Indeed we do not want a very large RF signal at the mixer, otherwise cross-modulation or intermodulation distortion will occur. The term 'strong mixer' denotes a mixer circuit which can handle large RF signal input without intermodulation distortion (IMD) occurring.

Bipolar junction transistors are not preferred for high quality mixer circuits. Rather JFETs such as the 2N4416 (Fig.2a) are used, or the GaAs N-channel dual gate FETs types MRF966, MRF967 or the silicon N-channel depletion mode MOSFET type 3N140 or the newer type 40673.

For mixer circuits showing minimum intermodulation defects, or where the RF frequency is very high, diodes may be used instead of transistors. The best choice here are the low leakage high frequency 'hot carrier' or *Schottky Barrier* diodes. These are different from ordinary PN junction diodes, having no minority carrier flow, no charge storage – and hence no reverse recovery time. Their their small energy gap also gives them low forward voltage drop. The 'barrier' is formed from a metal, the favorite choice being either chromium, molybdenum, tungsten or platinum.

Commercial hot carrier diodes include the Fairchild FH1100, the 1N5390 or the Hewlett Packard types HP2800 and HP2811. As an alternative, matched sets of fast silicon diodes like the common type 1N914, the faster 1N917 or the extremely fast Texas Instruments type TID778 may be used.

"Why diodes?" you may ask. Fair question!

Remembering that the prime function of a mixer is to 'mix' or multiply a small RF signal input with a large local oscillator signal, RF gain within the mixer (although an advantage) is not essential.

'Strong' diode mixer

The 'doubly balanced diode ring mixer' shown in Fig.2(b) uses four diodes, matched types HP2800 or 1N914 in a no-gain circuit which is 'strong', in that it can accept strong RF input signals before IMD becomes excessive.

Sadly, diode mixers can be noisier than the FET mixer shown in Fig.2(a), partly because they have no gain. (Double balanced mixers may also be constructed using two MOSFETs instead of four diodes.) The success of diode mixers depends on input and output impedance matching and selecting a set of matched diodes, and the HP2800 'hot carrier' diodes are preferred.

If silicon diodes such as the 1N914 are used as a cheaper substitute, one could purchase perhaps 100 of them (they are very cheap and the rest will eventually be used). Then by measurement, select the four with the closest voltage/current characteristics. A more superior test would involve matching of the RF characteristics, but this would be a more difficult task for the home builder. If you can purchase four HP2800s at reasonable cost, that's the way to go!

Diode mixers require large local oscillator injection voltage, as the circuit has no gain, rather an insertion loss. For use at UHF frequencies the diode mixer is a favourite, often using hot carrier diodes types HP5082 or HP2717. When these diodes are used as mixers at fre-

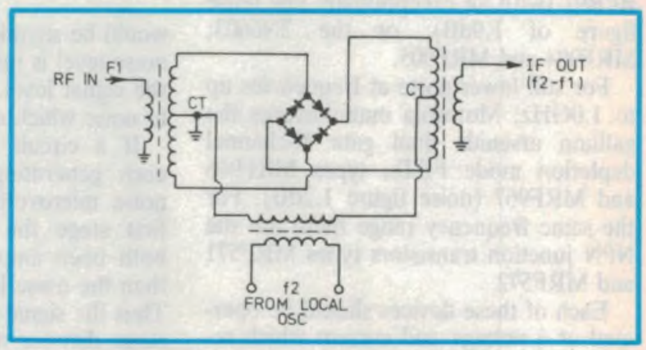


Fig.2b (right): A diode ring mixer, as used for VHF. Hot carrier or 'Schottky' diodes are preferred.

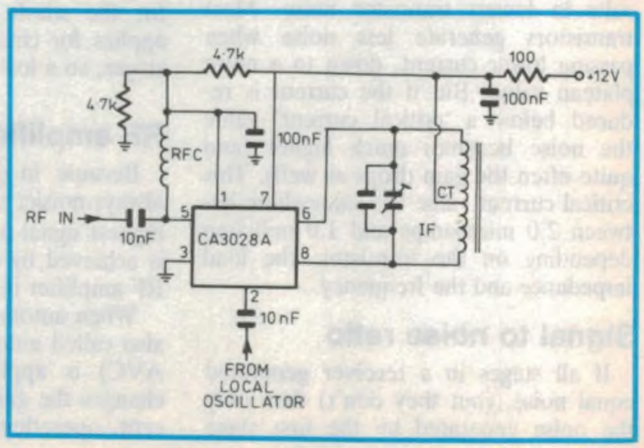


Fig.3a (right): The use of a CA3028A integrated balanced mixer IC. The balanced IF output appears at pins 6 and 8, which connect to the centre-tapped primary of the first IF transformer.

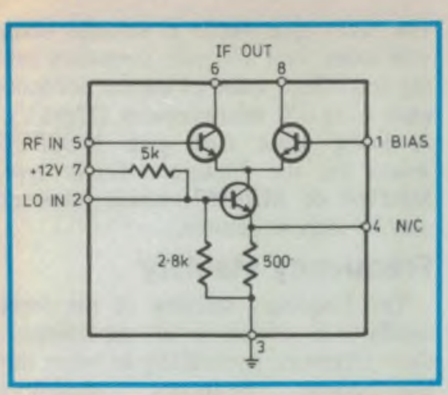


Fig.3b: The circuitry inside the CA3028A integrated mixer, which is essentially a balanced analog multiplier.

quencies in the gigahertz range, special 'strip' circuit components replace the coils and transformers we use down on VHF and lower frequencies.

IC mixers

Integrated circuits designed for use as mixers are available in the market place, and a circuit using one is shown in Fig.3(a), with the internals of the CA3028A integrated circuit shown in Fig.3(b). The circuit works as a multiplier, acting on f1 the input RF signal and f2 the local oscillator signal, to produce the required intermediate frequency (f1-f2).

Multiplication is achieved by the local oscillator signal at pin 2 varying the base current of the lower tail transistor, so changing the emitter current of both transistors of the long tail pair (upper section). This in turn varies the gain of the long tail pair, measured from the RF signal input at the base (pin 5) to the output signal developed across the tuned RF output transformer connected between pins 6 and 8. Thus the output is the product of the signals at pins 2 and 5.

The little bit of trigonometry used in the postscript of part 4 of this series (*EA*, October '88 pages 134-139) showed how a product of two cyclic signals gives rise to four signals of different frequencies, one being the required frequency (f1-f2).

Because integrated resistors are noisier than good quality discrete fixed resistors, some integrated circuit mixers produce more noise than comparable discrete component mixer circuits.

Local oscillators

In a simple superheterodyne receiver the local oscillator (LO – also called the variable frequency oscillator or VFO) is a sine wave RF oscillator (at frequency f2) supplying its signal to the mixer. In the mixer the LO signal beats with the incoming RF signal (at frequency f1) from the station being received. The frequency difference (f2-f1) in these two signals is the fixed *intermediate frequency* (or IF).

As the radio receiver is tuned across its frequency range, the local oscillator is also tuned across its own range. If the intermediate frequency is chosen at 455kHz, the local oscillator frequency is varied to be always either 455kHz above or 455kHz below the frequency of the received station.

The 'above' option is the usual in broadcast receivers, because of the low broadcast band frequency. But to improve oscillator frequency stability it is common in high frequency receivers for the local oscillator frequency to be 'below' the received RF input frequency.

The Hartley oscillator

The local oscillator circuit is basically a variable tuned circuit placed in the positive feedback loop of the RF amplifier transistor.

Fig.4(a) is a simplified version of the Hartley principle of positive feedback, via the tuned coil or inductance (L1+L2), (actually a tuned autotransformer), with the emitter joined into the signal path via a tapping on the inductance. Positive feedback comes about because like any tuned circuit C1/L1+L2 has a 180° phase change across its extremities from A to B.

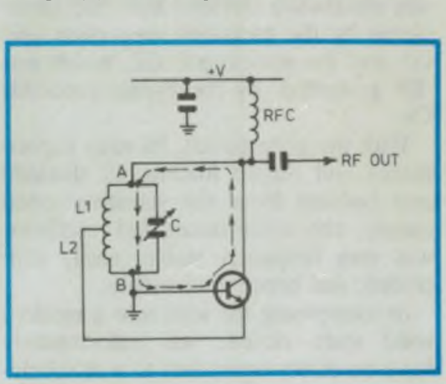


Fig.4a (above): A basic Hartley RF oscillator circuit, showing signal pathways.

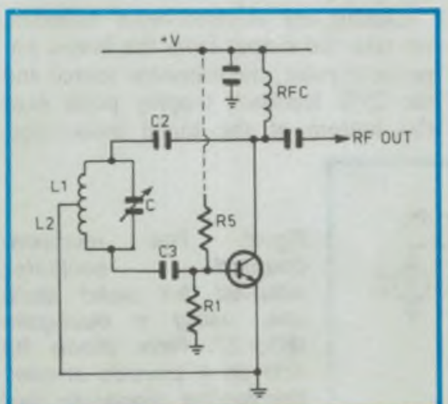


Fig.4b (above): A practical Hartley oscillator circuit, with all components shown.

As A and B are respectively connected between collector and base, the (A-B) 180° shift added to the 180° delay from base to collector of any transistor means a 360° (i.e., a full cycle) in the circular path base-collector-base. Thus any signal at the base is amplified and returned 'in phase' to the base, so that it reinforces itself.

This positive feedback can occur only at the frequency f2 to which the circuit is tuned. That frequency is given by:

$$f2 = 1/2\pi \geq (L1+L2)C$$

So the circuit oscillates, i.e., gives out RF energy, at that frequency. The practical Hartley circuit, Fig.4(b), must include provision of bias arrangements and a coupling capacitor C2 to interrupt the DC path from positive rail to base, while having almost zero impedance at RF.

On each positive signal peak C3 develops bias voltage, which continually leaks off via the 'leak' resistor R1, so establishing an equilibrium bias for the transistor. Resistor RS may be required to give starting bias.

Notice that in some Hartley configurations neither side of the tuning capacitor is grounded, requiring an insulated capacitor body and shaft – a practical disadvantage.

Practical Hartley oscillators may use MOSFETs, JFETs, junction transistors or integrated circuits of sufficient speed.

Colpitts oscillator

The fundamental Colpitts oscillator, Fig.4(c), works by the same idea of

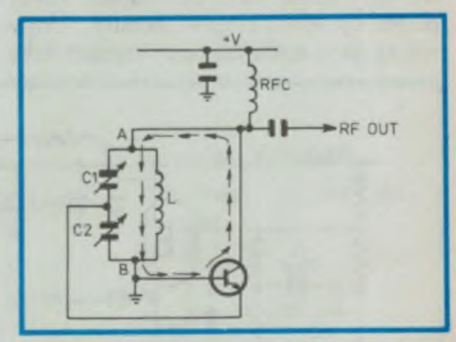


Fig.4c (above): A basic Colpitts RF oscillator, again showing the signal pathways.

Advanced Receiver Front Ends

positive feedback sustaining oscillations at one frequency only, but here the emitter is coupled into the signal path via the capacitive divider formed by C1 and C2.

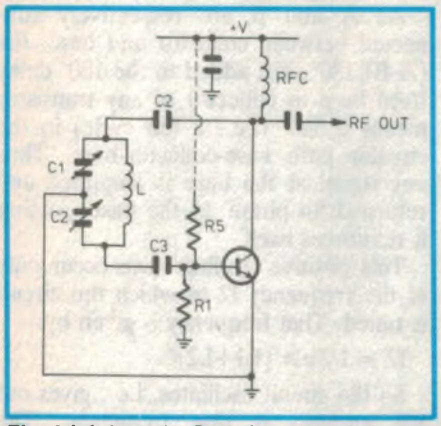


Fig.4d (above): One form of practical Colpitts oscillator, using a split stator tuning capacitor.

One practical Colpitts circuit is shown in Fig.4(d) and the same circuit description and comments apply to both Hartley and Colpitts circuits.

Notice that if we want to tune the Colpitts using a variable capacitor, we would require a split-stator variable capacitor, having one set of moving blades and two insulated sets of fixed blades. Alternatively we could tune either Hartley or Colpitts oscillators by varying the position of a ferrite slug within the inductance – i.e., changing the value of L.

The frequency f2 of a Colpitts oscillator is given by:

$$f2 = 1/2\pi \geq L.C1.C2./(C1+C2)$$

Electron coupled oscillator

Although all these oscillator circuits originated in vacuum tube (valve) days, the very name 'electron coupled' really points up this circuit's ancestry. Originating in a multi-element vacuum tube circuit, Fig.4(e), this oscillator formed a tuned circuit between grid and cathode, and the positive peaks of RF energy drove the grid G1 positive. Thus G1 acted like a pseudo-anode.

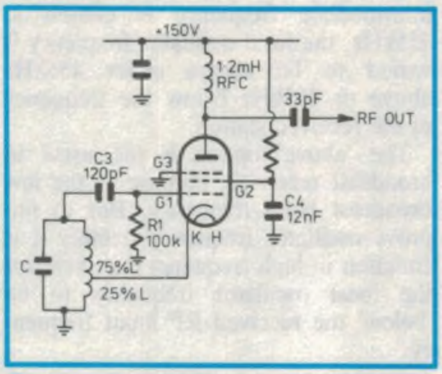


Fig.4e (above): The original vacuum tube version of the 'electron-coupled' oscillator, in basic form.

RF energy was coupled from the tuned circuit into the plate circuit only by the electron stream. Thus the plate was electrically shielded from the tuned circuit by the grounded suppressor grid G3 and the screen grid G2, which was 'RF grounded' by the bypass capacitor C4.

With the plate circuit, its stray capacitances and output loading all shielded and isolated from the sensitive tuned circuit, the electron-coupled oscillator was very frequency stable, easily controlled, and hence used widely.

In transposing the idea into a modern solid state circuit, we unfortunately have no direct equivalent to a multi-element vacuum tube. So we use the nearest available, the twin gate N-channel depletion mode MOSFET circuit shown in Fig.4(f).

Lacking any 'electron beam' isolation, we take the output from the lowest impedance point, the transistor source and the 25% feedback tapping point near the bottom of the tuned inductance.

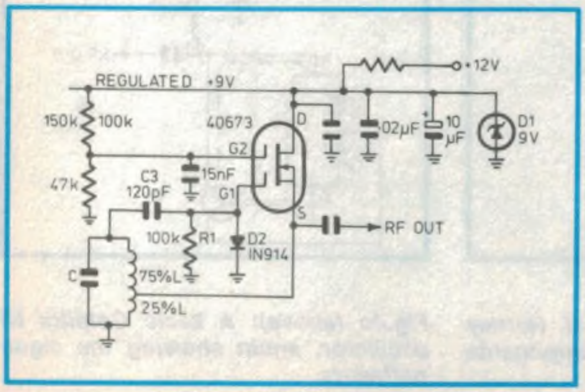


Fig.4f: The electron-coupled oscillator adapted for solid state use, using a dual-gate MOSFET. Here diode D2 acts as a 'pseudo anode', developing signal-derived bias in conjunction with C3 and R1.

The RCA type 40673 is suitable here, with more than adequate frequency rating and a high value of mutual conductance – 12,000 microsiemens (12ma/V). A lower noise dual gate MOSFET would be the Motorola GaAs type MRF966 or MRF967, which however may be more expensive.

Frequency stability

The frequency stability of the local oscillator is critical in all superheterodyne receivers, particularly so when the intermediate frequency amplifiers (which follow the front end) have narrow bandwidth. For this reason in communications receivers the greatest care is taken in concept, construction and design of the local oscillator circuit.

There are four possible causes of accidental frequency shift in the local oscillator:

1. Changes in temperature.
2. Changes in positive rail voltage.
3. Mechanical movement of the LC tuned circuit or connection wiring and/or poor bearings or mounting structure of variable capacitors.
4. 'Hand capacity' adding strays to the total tuning capacity as you place your hand on the tuning knob.

Temperature change in the oscillator transistor is minimised both by siting the transistor well away from any hot components and by operating the transistor at a low to medium current to minimise self heating.

Zener diode voltage stabilisation is often used to maintain a constant supply voltage despite mains fluctuations.

Changes in frequency due to small mechanical movements of the tuning capacitor or associated wiring are avoided by mechanically solid construction and providing smooth low-friction bearings (sometimes twin ball races) in the tuning capacitor. In high class communications receivers you will often see a solid cast aluminium chassis structure to prevent any unwanted movement.

Frequency shift occuring when the user places a hand on the tuning knob can be avoided by constructors ensuring that the metal shaft of the tuning capacitor is well grounded and by using a grounded metal front panel to isolate users' hands from the capacitor plates.

Oscillator 'pulling'

Frequency 'pulling' is an effect of accidental cross-coupling between the mixer and local oscillator tuned circuits. Such cross-coupling can occur within the mixer transistor as the mixer transistor loads the oscillator. The effect can cause the mixer tuned circuit to 'pull' the frequency of the oscillator towards the incoming RF frequency.

The cure is electrical isolation of the oscillator from the mixer, by interposing an RF buffer amplifier as depicted in the block diagram Fig.5.

The oscillator is operated at low level to minimise transistor heating, so enhancing its frequency stability. The following wide-band untuned amplifier lifts the oscillator voltage to the level required by the mixer. The overall result is a powerful output at the stable frequency generated by the oscillator.

Choice of LO frequency

In broadcast receivers, the local oscillator frequency is (of course) only 455kHz different from the incoming received RF frequency. But in high frequency receivers, especially those of short tuning range, often the local oscillator frequency is below and very different from the incoming RF frequency.

For example in a special purpose amateur radio receiver for the 14.0-14-.3MHz frequency band using an intermediate frequency of 10.7MHz, the local oscillator would tune between 3.3 and 3.6MHz. This much lower oscillator frequency contributes to greater local oscillator frequency stability.

Although in principle oscillator circuits can be constructed operating at any frequency, if suitable active devices are available, it is unwise to construct variable frequency local oscillators oscillating at frequencies above about 10MHz. Above this frequency the transistor's internal capacitances and strays are comparable with the circuit tuning capacitance value required, so the circuit frequency can drift alarmingly with temperature changes.

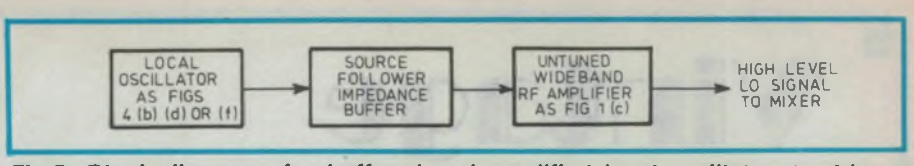


Fig.5: Block diagram of a buffered and amplified local oscillator, to drive a mixer requiring high level injection.

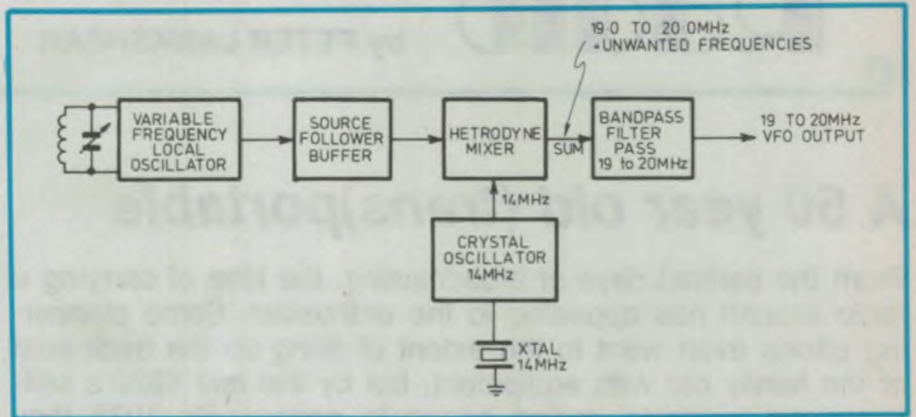


Fig.6: Block diagram of a 19 – 20MHz VFO, used as a local oscillator in a receiver tuning from 29.7 to 30.7MHz (10.7MHz IF).

For higher frequency reception a low frequency oscillator can produce a high frequency LO signal, by buffering with either frequency multiplication or heterodyning.

Frequency multiplication is only suitable for use in single-frequency receivers, applicable to such service as Army 'walkie-talkies', taxi two-way systems, aircraft navigation receivers and the like. Heterodyning is illustrated in the block diagram of Fig.6 and can be used in variable frequency and general purpose communications receivers.

Following sections

After the mixer follows the intermediate frequency (IF) amplifier, which amplifies the constant-frequency IF signal and provides most of the receiver's gain and selectivity. Following that comes the detector or demodulator, the automatic gain control (AGC) section, then lastly the audio amplifier and power supplies.

In many high class communications receivers extra embellishments also are added to facilitate reception under difficult conditions. All these circuit sections we must leave until a later instalment. Until then, 'bye.

Vintage Radio

by PETER LANKSHEAR

A 50 year old (trans)portable

From the earliest days of broadcasting, the idea of carrying a radio around has appealed to the enthusiast. Some pioneering efforts even went to the extent of filling up the back seat of the family car with equipment, but by the mid 1920's self-contained 'portable' radios began to appear. By 1938 they reached the fully practical stage, with valves whose 1.4V filaments could be operated from dry batteries.

'Portable' was a specific term in the days of valve radios. It referred to equipment which was powered by self contained batteries, had a carrying handle, and usually, a fabric covered wooden case. Note that I have deliberately omitted any reference to size!

Today, quite different classifications apply. Most radios, regardless of intended use, have internal batteries, and many are so small that they need no handles at all. The majority are so easily carried about that the term portable has become meaningless.

During 1930, the US Radio Industry followed a trend already set in Europe by introducing a range of battery powered valves with 2.0 volt filaments. These were a considerable advance on the existing 5.0 and 3.0 volt battery valves and became the American RMA (Radio Manufacturers' Association) standard for most of the decade. They could be lit from a single lead-acid secondary cell, but they were especially intended for use with the then-recently introduced air depolarised batteries.

Designed for applications requiring a modest current drain for long periods, 'air-cell batteries' as they were called, had two cells each producing 1.25 volts when new. They were about the size of a car battery and relied on atmospheric oxygen circulating through the carbon positive electrodes for depolarisation. Standard practice was to use two switchable resistors in the valve filament circuit to cope with the excess voltage, with a change to the lower value resistor as the battery aged.

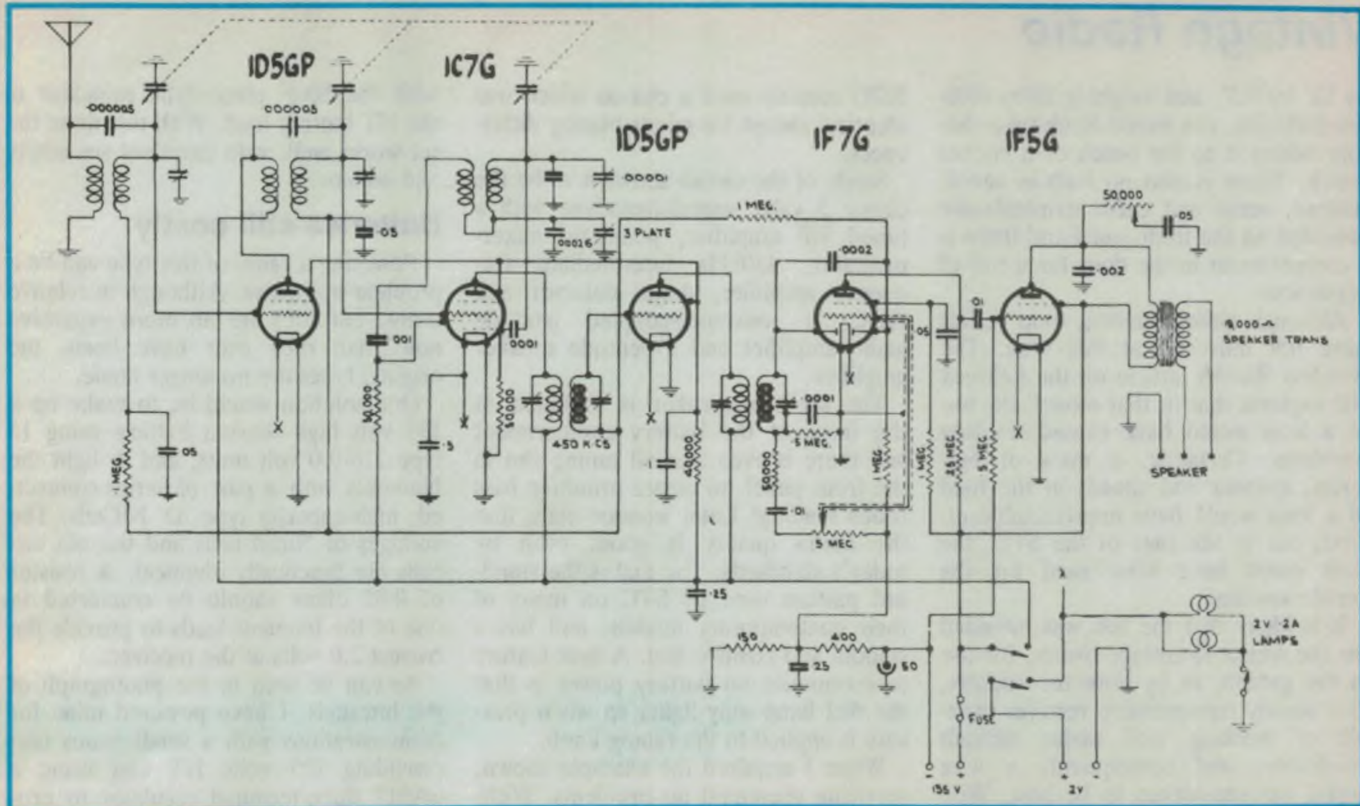
Ideal for fixed locations where their life matched that of a set of HT or 'B' batteries, air-cells were far too large for portable radios. On the other hand dry cells were not very suitable for 2.0 volt filaments. 1.5 volts from a single cell was insufficient, whilst two cells in series produced an uneconomic 50% excess voltage, and to cope with a drain in the vicinity of half an ampere, large cells were necessary for prolonged operation without voltage drop from polarisation.

For portables, rechargeable lead-acid cells were used. Although standard in Europe, at best they were inconvenient. Not only did they perversely need recharging at the wrong time, but they were heavy, large, and had short lives if neglected.

1.4V filaments

The real breakthrough as far as truly portable battery-operated valve radios were concerned came in 1938, with the introduction of the first series of 1.4 volt low consumption valves. A single large dry cell could now power the fila-

Portability, 1939 style! The batteries were housed behind the speaker grille. Instead of a loop aerial, a coil of wire was unwound and suspended from a suitable tree or building.



The circuit schematic for the STC model 506 5-valve battery portable, released in 1939. It used the older-style 2V filament valves, in a fairly standard superhet configuration.

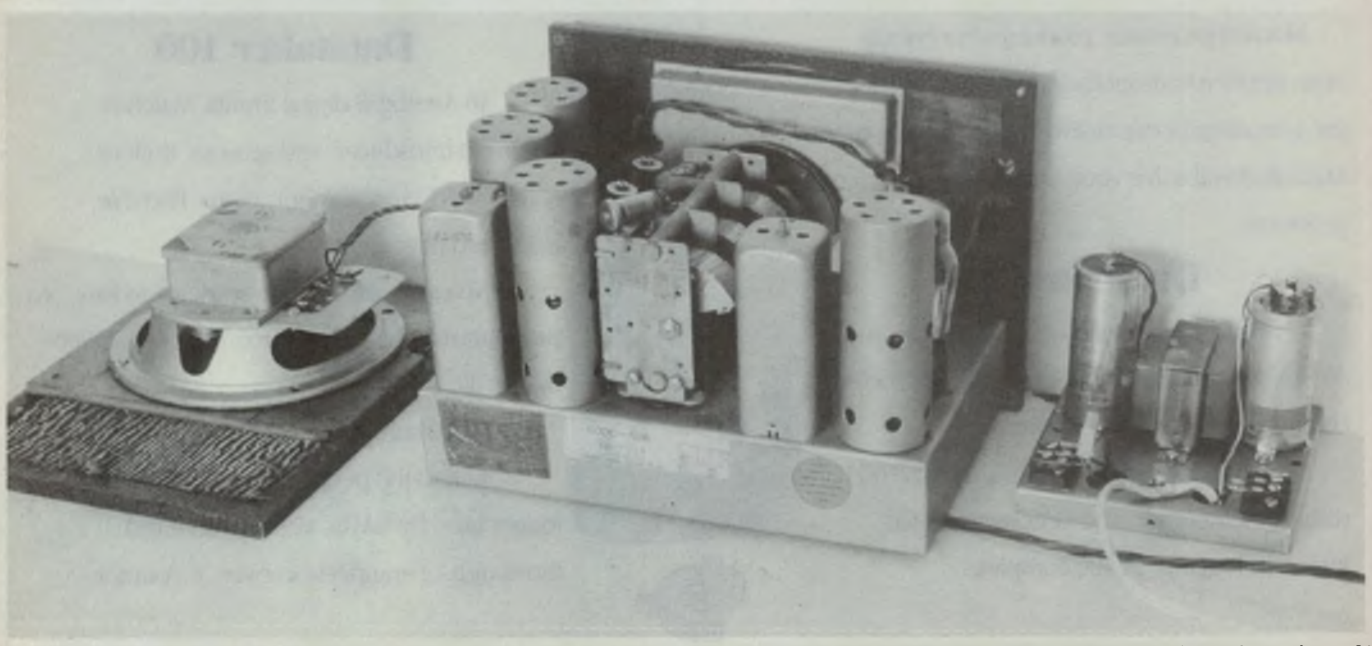
ments, and portable receivers at last became a reasonable size and weight.

Australian radio manufacturers responded with a wide range of portables. The Australian Trade Annuals tell the story. For 1937, there is mention of only one portable, the Lekmek 402, a 4 valve kitset featured at the time by *EA*'s ancestor, *Wireless Weekly*. The following year two portables were included, but the 1939 Annual details no fewer than 15 different models, including the STC model 506 featured in this article. However, a few manufacturers, including STC, did not use the new valves.

The reason for the delay is not certain, but all of the STC battery receivers for 1939 retained the 2.0 volt type. As the Australasian distributors, STC used Raytheon valves, and there may have been delays in the supply of the 1.4 volt series from America.

No loop aerial

The STC 506 is in reality, one of the old style 2 volt battery portables. At 15″



Inside the case there was this compact and neat chassis, using full-size components and a substantial loudspeaker. At the right is the author's mains power supply.

by 12" by 9.5", and weighing 20lbs without batteries, you would think twice before taking it to the beach or a cricket match. There is also no built-in aerial. Instead, aerial and earth terminals are provided on the front panel and there is a compartment in the door for a roll of aerial wire.

Although quite common, loop aerials were not universal at this time. The *Wireless Weekly* article on the Lekmek 402 explains that in that model, the use of a loop would have caused tracking problems. Certainly, a mass of batteries, speaker and chassis in the field of a loop would have unpredictable effects, but in the case of the STC, the door could have been used for the aerial mounting.

It is likely that the 506 was intended for the weekend cottage owner, for use in the garden, or by itinerant workers, as a readily transportable receiver capable of working well under difficult conditions, and consequently a wire aerial was considered to be best. With an outside aerial, the performance is quite impressive and equal to a good domestic receiver. In fact, the STC 507G console used a chassis which was identical except for minor biasing differences.

Study of the circuit shows it to be the classic 5 valve superheterodyne with a tuned RF amplifier, pentagrid mixer-oscillator, 450kHz intermediate frequency amplifier, diode detector and AGC, a resistance-coupled pentode audio amplifier and a pentode speaker amplifier.

The six-inch speaker is mounted at the front of the battery compartment and there is even a small tuning slot in the front panel, to create primitive bass reflex loading! Little wonder then, that the audio quality is good, even by today's standards. The dial is the standard pattern used by STC on many of their contemporary models, and has a smooth and positive feel. A neat feature to economise on battery power is that the dial lamp only lights up when pressure is applied to the tuning knob.

When I acquired the example shown, servicing presented no problems. Without exception, the 'Chanex' paper capacitors fitted had developed low insulation resistance and were replaced, along with the 50uF electrolytic capacitor in the HT battery lead. With this done the set works well, with excellent sensitivity and volume.

Batteries still costly

Powering a radio of this type can be a problem nowadays. Although in relative terms, batteries are no more expensive now than they ever have been, the original types are no longer made.

One solution would be to make up a 135 volt high tension battery using 15 type 216 9.0 volt units, and to light the filaments with a pair of series-connected, high capacity type 'D' NiCads. The voltages of Nicad cells and the old air-cells are practically identical. A resistor of 0.82 ohms should be connected in one of the filament leads to provide the correct 2.0 volts at the receiver.

As can be seen in the photograph of the internals, I have powered mine for demonstrations with a small mains unit providing 135 volts HT and using a uA317 three-terminal regulator to provide a well filtered 2.0 volt supply from a 6.3 volt transformer winding and rectifier.

Information centre

Conducted by Peter Phillips

Timers, pianos and cats

Quite a mixture this month. More on controlling the Earth's weather, how to tune a piano with the EA stroboscopic tuner and a tale concerning a demented cat. Oh yes – some technical discussion as well!

As I've already pointed out, like many other magazines we have a lead time of almost two months, meaning you will be reading these words some eight or nine weeks after I've typed them. For this reason we are only now getting replies to some of the points we've raised in previous editions of this revised section.

I am hopeful that as time passes, we will get more and more correspondence to make this section as lively as possible. My role in this column is to select those letters I feel will interest readers and to edit them to suit our usual style.

And sometimes I throw my opinion in as well, for better or worse. I don't regard myself as a sage, and fully anticipate that I will be taken to task by those of you who disagree with me. That's the whole idea of this section – a technical clearing house with some arguments thrown in.

So please correct me if you think my comments (or those of other writers) are inaccurate. I enjoy being taken to task, and don't really mind if I'm proven wrong. I just go and beat up the cat...but that's another story.

Controlling the weather

Readers may recall a previous letter suggesting controlling the earth's weather by altering the length of the sun's rays in the upper atmosphere. Here's a reply...

I'm writing in response to D.B. of Darwin (EA Jan '89). The Earth's seasons do not depend upon the distance from the sun, but rather the tilt of the planet. The Earth's orbit is in fact almost circular, with the distance from the sun changing by only 5 x 10^6km, or 3%.

If D.B.'s theory was true then both hemispheres would have their seasons at the same time. The sun is the same distance away from us in winter as it is in summer.

Perhaps a better idea would be to build solar-powered ozone producers, then park them on the south pole? (J.H., High Wycombe WA)

Re-reading D.B's letter, I get the impression that he does not infer the earth's orbit is elliptical. He simply states that the sun's rays are lengthened by tilting of the planet. Perusing an encyclopedia entry on the Earth's seasons, I gather that the angle of inclination of the sun's rays to the Earth determines (in part) the amount of heat received by that part of the Earth.

If so, D.B would seem to be correct, although rather than lengthen the rays, we merely need to bend them. The suggestion by J.H. of a solar powered ozone producer seems reasonable to me as well.

If any *EA* readers can just come up with the hardware, then we may go down in history as having saved the Earth!

Answer to last month's Why??.

Last month we asked why reducing the output power of an amplifier by half did not appear to please those claiming noise pollution.

It all comes down to dBs of sound level. A dB is the least perceptible change in sound level, from the human hearing point of view. In fact, a change of 3dB is hardly perceptible as well, although a trained ear might hear it.

Assume the power level is 50W (P1) to start with. Then reducing the power level by half gives 25W (P2). The change in dBs is calculated with 10log P1/P2. Actually the equation 10log P2/P1 will give the same answer, but negative.

The result of P1 divided by P2 equals 2 (or 0.5 for the second equation). The log of 2 is 0.3010 (-0.3010 for 0.5), which when multiplied by 10, gives the 3dB (-3dB) change.

So halving the power level only makes a 'barely noticeable' difference to the perceived level of sound.

DePussy gets revenge

This is a true story, garnished only a teensy bit. It concerns a baroque music lover, his old valve amplifier, and Pentode – a cantankerous tom cat.

Pentode and his owner, whom we'll call Howard, apparently enjoyed a love-hate relationship that existed on continual one-upmanship. You know the type of thing – cat gets let in, purrs, then sharpens its claws on the curtains. Owner chases cat, which responds by climbing the curtains so it's out of reach, then jumps down onto owner's head. Owner kicks it out for the rest of the night, and laughs when there's a thunderstorm.

During a truce, it seems Howard let Pentode inside, and dispensed the usual plate full of PussyPal. Then, contented and seemingly quite happy, Pentode settled down for a snooze, while Howard cranked up the hi-fi for a spot of music.

The amplifier, so the source of this story informs us, was a home made unit featuring a valve output stage. Howard had built this unit during his apprenticeship as a gas fitter, and had resisted all attempts to either replace it or beautify it. "Who needs a case – it makes it int'resting and keeps it cool."

Readers may be aware that valve amplifiers need a high DC voltage to operate. Readers may also be aware that certain fluids conduct electricity, and that this conductivity is directly related to the acidity of the fluid.

During a particularly pensive passage, Howard nodded off. Howard thinks, on reflection, that *the event* happened during the allegro con moto, but can't be sure. After all, a cat in full yowl mode is fortissimo enough, but when combined with the sounds of breaking glass, hissing steam and general mayhem, a lapse of musical awareness is forgivable.

Howard woke – no, was catapulted into reality – to see Pentode suspended in mid air over the amplifier, akimbo, expanded to nearly three times full size and generating a sound level of around 110dB.

It turns out that Pentode, in a fit of pique, decided he didn't like the music. What better way to stop it than to piddle on the amplifier. Poor Pentode... How could a cat know the finer scientific facts of electricity.

The amplifier was totally destroyed, and could not even be claimed on insurance. Pentode has been renamed Triode, and is no longer the cat he once was.

What made the wretched animal respond so? It turns out Howard was playing the Toccata and Fugue in D minor by – you guessed it – Bach!! What else could a self respecting cat do?

Stroboscopic tuner

This great little tuning aid (*EA* July 88) has proven very popular. The first letter is from a constructor who has experienced problems in getting the unit to operate. Our reply to this letter may interest all users. Of interest also is a discussion on using the tuner to tune a piano. But first the problem...

After constructing the EA Stroboscopic Tuner, I have experienced the following problems:

1. *When the unit is switched on, the LEDs come on (they are pulsing, which can be seen by selecting the lowest frequency). They come on brightly for approximately 6 seconds, and then go dim. If the speaker is turned on the LEDs go off.*
2. *When tuning my guitar, there are three LEDs in line that appear to move, or stay still when the tuning is correct. These show very dimly, and can only be seen effectively by looking straight down on top of them.*

I have fitted the ICs into sockets and have also replaced ICs 1 and 2 because of suspected incorrect operation, but with no change in the operation. Some basic measurements I have taken (with the speaker off) are:

(1) Battery voltage (new battery) = 7.5V.
(2) IC1 pin 2 = 1V.
(3) IC1 pin 3 = 3.5V; and
(4) IC1 pin 6 = 3.2V.
(J.W., Seven Hills NSW)

The following reply is from Mark Cheeseman, the circuit designer:

It would appear that the 9V battery you are using is a little on the low side. We do not recommend operating the tuner from a 9V '216' type battery as the current drain of the circuit is quite high, due to the LEDs, and this type of battery will not last long. As suggested in the article, a pack of 6 AA size cells should be used.

However, when powering the prototype from a single 9V battery, the battery voltage remained at 9V, not 7.5V as you have measured. This suggests that either the circuit is drawing far more current than it should, or the battery is nearing the end of its useful life. As the unit appears to be otherwise performing correctly, it seems the battery is at fault.

A high impedance meter, such as a DVM should be used when measuring the voltages at pins 2 and 3 of IC1, as the impedances concerned are quite high (500k and 1M respectively). An analog meter would probably load these pins excessively. The voltage at pin 6 seems a bit high, which could explain why the LEDs remain on dimly instead of going out in the absence of a signal.

We suggest you check that R1 and R2 are the correct values, as they determine the DC bias at the non-inverting input of the op amp, and thus the quiescent voltage at the inputs of the inverters which drive the cathodes of the LEDs.

Also make sure that the contacts in the input socket short out the input when nothing is plugged in, as the input impedance is quite high and hum pickup will also cause the LEDs to turn on when they shouldn't.

Our next correspondent wants different information, and the answer may be of interest to quite a few readers.

I am interested in building the Stroboscopic Tuner for checking the tuning of a piano. A piano is mentioned fairly frequently in the original article, but no information is given about how this can be done, and I do not wish to spend $50 without knowing if the tuner is suitable for this task.

Some pianos are manufactured having different pitches, in which middle C on one instrument is different to that on another. Can I adjust the reference signal in the tuner to compensate, as damage can occur to a piano that is tuned to a higher pitch than it is designed for? (M.B., Toukley NSW).

OK, good questions. To answer the first one, I took the prototype home and gave my piano a quick tune to see how the tuner would perform. Just to put readers minds at rest, this is an area I am familiar with – I have tuned many a piano with various kinds of electronic tuners over the years, and claim some knowledge in the area.

Professional tuners either hate electronic tuners, or use them only in conjunction with their ear and years of training. Piano tuning is an art, and electronic tuners are only useful if you know how to (1) 'stretch' the octave and (2) 'set' the pin. The other important point is the resolution of the tuning aid – can it resolve the null beat between the reference and the input signal effectively?

Answering the last point first; the *EA* tuner has the resolution required, unlike many tuners that employ an analog meter movement. However, there are two important points about this tuner that should be made. The first is that the tuner requires a fairly strong input signal to make the LED display visible. I resorted to amplifying the microphone's output by first passing it through a tape recorder.

The second point applies to most electronic tuners, in that notes in the extreme octaves are more difficult to tune with an electronic tuner than those in the middle octaves, as the display becomes less discernible. The *EA* tuner is typical in this regard, and may be found somewhat difficult to use for these octaves. However, with practice, tuning these octaves could still be accomplished.

But now back to the first comments I made, starting with octave 'stretching'. A correctly tuned piano will have beatless octaves, that is middle C will not beat with any other C on the piano. However, because of inharmonicity with the strings (I won't further explain this, it's too complex), the mathematical relationships between octaves is not a simple one of double or half the next octave. What it all boils down to is that higher octaves need to be tuned *sharper* than the theoretical value, and lower octaves *flat* compared to the theoretical value.

But assuming you can handle all that, and tune each octave so that it doesn't beat against the temperament, it is all pretty useless if the piano is out of tune the next day. The art of 'setting' the pin requires tuning the string slightly sharp, then letting the string tension pull the tuning pin into place. Usually a bit of loud note repetition is required for this, which may explain the headache after a complete tuning job.

So, in my opinion, the *EA* tuner is as good as many electronic tuners I have used, and even better than some. It is not as good as the expensive types, and may prove difficult to use in the extreme octaves. Like all electronic tuners, it is only as good as the operator, for the reasons I've just described. I still pay a piano tuner, even though I have all the gear to do it myself.

There is no easy way of adjusting the reference signal in the tuner to compensate for pianos not tuned to A-440. However, A-440 became the reference during the 1920's, raised from A-435, and most instruments conform to this standard. Very early pianos, particularly those with wooden frames cannot handle being pulled into concert pitch and I suggest you tune it one semitone low, (which gives A-415.305) as the tuner can still be used without wrecking the piano.

Super timer

The next letter is commentary on the circuit of the Super Timer published in *EA* (Dec 88). I disagree with the author, but the points raised are most interesting. Here's the letter, in part...

I wish to draw attention to what I believe is a serious design flaw in your Super Timer project.

The fault lies in the dividing down of the 1MHz master clock that gives the different display clock rates. In the circuit, the counter modules are cascaded from the MSB counter output to the following counter input. The clock pulse to the following stage is given on the binary count of 8 (1000) when the MSB bit changes from a 0 to a 1.

This bit then returns to 0 another 8 pulses from this time when the counter wraps around to 0. This would then mean that each 4 bit stage would be actually dividing by 16 and not 10 as is the desired result.

To make each counter a decade counter would involve adding logic to decode the 9th state (1001) by ANDing it with the clock input to give an output that will reset the current stage and produce the carry output. But this solution would add another seven ICs overall to the design. A better solution would probably be to re-design the circuit with true BCD decade counter such as the 7490. (B.M., Wavell Heights Qld)

We referred this letter to the project's designer Ian Page, who has supplied the following answer:

The 4518 CMOS IC is listed as a dual decade synchronous counter, both by Don Lancaster in his CMOS Cookbook and the RCA CMOS databook. Both books also describe how the counter can be positive- or negative-edge triggered. The configuration used for cascading the counters in the timer circuit is in fact that shown in the RCA databook (ref. p323).

However, to prove the point, I checked the timer over a period of first 1 hour (3600 seconds) then finally over a 4 hour interval. I used the M output (1 second count) and in both cases the value displayed was correct, exactly as it was during the original testing. In fact, if the counter string was dividing by 8, the final digit would be running at 3.81Hz, not 1Hz, and would be immediately apparent as a fault. (I.P., Mangawhai NZ).

Just throwing my tuppence worth in here, I have to agree with I.P., but for slightly different reasons. Certainly B.M. is mistaken in believing the 4518 counter is anything other than a decade counter – all the data books I can find list it as such.

What makes this counter interesting is that it can be a positive *or* a negative-edge clocked device. For positive edge operation, the clock is applied to the CL input and the EN input held high. For negative edge response the clock is applied to the EN input and the CL input held low.

When negative edge clocking is used, the next stage will only increment when the MSB (bit 3) of the preceding stage goes from a high to a low. Because the device is a decade counter, this occurs when the preceding counter goes from nine to zero. It is this point that B.R. has missed, as he suggests clocking occurs on the positive edge, where the circuit configuration is for negative-edge clocking.

Even so, bit 3 still only produces one positive edge excursion per count-by-10 cycle, and a subsequent stage could be clocked with this edge. This would give rather strange relationships between the counters, although a divide by 10 sequence would still result.

Why??

Why does a transistor, when used in a common-emitter amplifier application, have a frequency response that makes it appear that the input capacitance of the transistor is much higher than the specified value? For example, the specifications state that C_{bc} (base-collector junction capacitance) and C_{be} (base-emitter junction capacitance) are both only around 6pF for a particular transistor. Yet my calculations suggest this value is more like 600pF. What's going on?

NOTES AND ERRATA

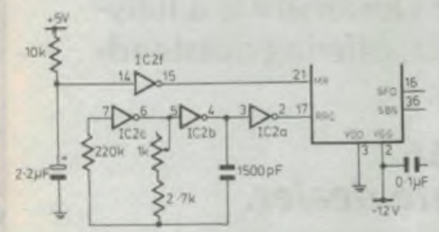
ANNUAL INDEX
(December 1988): Due to too much Christmas cheer(fulness) we inadvertently omitted the listings in our annual index for the December Circuit & Design Ideas and Construction Projects, (pages 154/155). They are as follows:-

LOW DISTORTION AUDIO OSCILLATOR – 2
(March 1989): The parts list on page 107 should read:

Capacitors; 2 x 1000uF and 2 x 2200uF 25VW PC electrolytic not 4 x 1000uF

Resistors; 2 x 100 ohm 5% 1/4W not 1 x 100 ohm

SERIAL TO PARALLEL INTERFACE
(January 1989): The circuit shown for the serial to parallel interface in Circuit and Design Ideas has an error. The oscillator circuit around IC2 is incorrect in that the 220k, 2.7k resistors and the 1500pF should not have been connected to earth. The circuit should have appeared as shown herein.



Letters to the Editor

Continued from page 7

are to be believed.

I have enough information now from one of these inventors, to build such a machine. Before I go ahead though, and spend a lot of time and money (both of which I have little) I wanted to write to you and see what the staff at EA, or your readers know about these machines.

Some of these machines, their inventors, and where to obtain details are as follows:

Joseph Newman – Magnetic Motor – ('Beyond Economic Treadmill' by A.R. Jones); John Ecklin – Homo Motor – (PO Box 245, Concord West 2138); Bessier – Magnetic Motor; Muller – Uni-polar HF Motor Alternator; Bedini – Free Energy Generator – (EPM Power Systems, Box 255, Ivanhoe 3079); R Muray – Energy Device.

All the publications from the inventors contain circuit diagrams, parts lists, construction details, principles of operation, etc.

Would you please investigate their claims, and inform us (your readers) of your findings?

O. Girvan
Esperance, WA.

Comment: We know next to nothing about these machines, Mr Girvan, and frankly we're pretty skeptical. A 'perpetual motion' machine really isn't possible, and these sound suspiciously like attempts to produce one. But if we can dig up any information, we'll try to evaluate them. Are you sure these aren't schemes to give the 'inventors' an income, from supplying books and plans?

China Electronics

Continued from page 127

Wanbao research pundits are already at work on other electronic products. Telecommunications equipment and office machines like microcomputers, faxes, photocopiers and electric typewriters are all being considered, although more likely to be seen in the immediate future is a series of Wanbao colour TVs. Discussions are already being conducted with suitable joint venture partners for the manufacturer of state-of-the-art digital portables and table model monitors.

This development can't come soon enough for Wanbao. While a substantial number of sophisticated sets would be allocated for the export market, the electronic giant would be able to attack an ironic domestic situation.

Due to a somewhat higher level of income and the proximity to Hong Kong wholesalers, Japanese sets are common in Guangzhou and as well as throughout the province. Buyers, consequently, often opt for high imported style rather than moderate domestic price.

If Wanbao can respond with fashionable and competitively priced colour sets acceptable to increasingly worldly local consumers, then this showcase company group will have taken a major step towards establishing itself as a new contender in the global electronic marketplace of the 1990s.

EA marketplace EA marketplace

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