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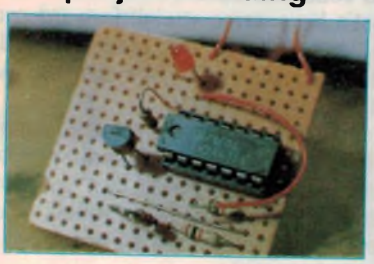
AUSTRALIA'S LARGEST SELLING ELECTRONICS MAGAZINE – ESTABLISHED IN 1922

May 1990

Philips' new digital TV

The 'Matchline' 28DC is part of Philips' new 'digital' range of TV receivers. With a 71cm screen, it offers PIP, teletext, remote programming and all sorts of other goodies. (See page 10)

Using Veroboard for project building



For quick 'one-off' projects, Veroboard has many advantages over printed circuit boards. Tom Moffat explains how to use it effectively, in our story starting on page 64.

On the cover

Setting the scene for this month's feature on opportunities for women in electronics, EA staff members Winifred Vincent (L) and Karen Muggleton are pictured checking out the new Advantest R4131B 3.5GHz spectrum analyser, from Elmeasco Instruments. (Photo by Leon Faivre.)

Features

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LETTERS TO THE EDITOR

Serviceman query

I write to advise of my surprise on reading the article 'The Serviceman,' who confronted trouble with what was described as the 'unfamiliar' Titan brand. (Page 80, January 1990.)

The Titan brand has been around for a number of years and I was surprised to learn of an experienced technician being caught with such a common fault. The Sharp component changes have been known throughout the industry for some time, at least three years that I am aware.

In addition, I would like to advise that the Electronic Services Industry Association (recently formed by a concerned group of service company managers) has access to a vast amount of technical information with regard to cross-references, modifications, spare part availability, import/distributor locations and the like. Membership fees in such circumstances are a small price to pay for time saving technical searches, such as the Serviceman encountered.

Ray White,
Admin.Manager, ESIA
Carlingford NSW

Comment: Apparently the Titan brand has been confined mainly to the Sydney area, Ray. But thanks for your interest and advice.

Receiver kits?

I am organising an electronics class at Christs College, Christchurch, New Zealand.

One of my aims is to teach the boys to go for their ham radio licence and to build up a working radio station. However, I am aware that to keep their interest, they will need more than single band equipment.

As it will be about a year before they can go for the test and there is need to hold their interest, the first part will be to build a communications receiver to 30MHz. After that it will be to build a ham bands receiver/transmitter set up, or a transceiver plus ancillary equipment.

I say 'build', because it is my opinion that to teach theory only is not worth the time, and the experience of building will be crucial to their understand. This brings me to the point of writing. I am trying to locate some company that has designs and possibly PCBs and components for this project. I am aware that this is an old fashioned idea and the number of kits available is minimal.

I am aware of some ham radio kits available so the most important thing is to locate a good SWL communication receiver design, preferably with digital read out.

Derek H Rout,
Christchurch, NZ.

Comment: You've come up with a rather tall order, Derek. We don't know of any kits available for an HF communications receiver, but if we hear of one, we'll pass the information on.

Amateur projects

Hurray for your forthcoming series of articles on simple modular amateur gear.

To my mind, ham radio operators using commercial gear are merely glorified CB'ers – they may be just as well off using Telecom or Australia Post for their communications.

Let's have some straightforward projects, hopefully in the main using discrete transistors that one can see and feel ones way through.

I am particularly interested in an HF SSB generator (hopefully with spacious circuit boards and tracks that you don't need a magnifying glass to follow – unlike for instance, your HF transceiver of a few years ago).

I have just renewed my subscription to your magazine in anticipation of the above.

Keep up the good work!
Paul Wraith, VK4ZWD,
Nerang, Qld.

Comment: Thanks for the support, Paul. We'll see what can be done about the SSB generator.

Solid state relay

After reading the February 1990 construction project 'Low cost solid state relay", I felt the opening question "Ever wondered why commercial solid state relays cost so much?" was never fully answered or justified.

Commercial PCB mount SSR's from US based Continental Industries, with comparative specifications to those of the *EA*/Oatley kit, are available now for $16 each (ex. tax) from Amtex Electronics.

While I am certain the project would be a worthy learning exercise, the costing comparisons made are highly questionable. Moreover, as automation techniques are employed to the fabrication of SSR's, the costs should continue to be eroded. This should allow the increased use of SSR's by *EA* project builders and the electronics/electrical industry in general.

David B Combe,
Amtex Electronics,
North Ryde, NSW.

Privatisation

What in the world is Jim Rowe on about?

In his Editorial Viewpoint for February, he talks about the sad effects of the 'privatisation' of the telephone system in the USA, and reckens *(sic)* that 'big business may be a little better off, while just about everyone else is much worse off.'

For Jim's information, the telephone system in the United States has *never* been government-owned (unless, like some other people, he confuses Ma Bell with the government), and it was federal government initiatives to break up what it regarded as monopolistic big business that resulted in the fragmentation of the industry and what some people see as the resulting poorer service (but still better and cheaper than Australia's).

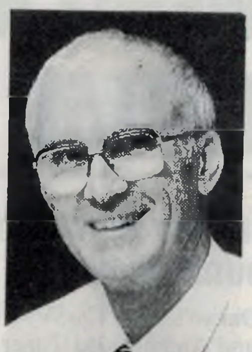
And Mr Rowe doesn't seem to want to consider the other side of the coin. Had the US government taken over Alexander Graham Bell's invention at an early stage and operated it as a state-owned utility, we would still have a telephone system that Fred Flintstone would recognise.

One of the reasons countries with relatively small populations, such as Australia, can move into high-tech telephony is that they don't have to pay for any research, most of which has been done by one very, very private enterprise organisation: Bell Labs.

David Call,
Ipswich, Qld.

Comment: You're quite right about the US telephone system having always been privately owned, David. I should have used 'divestiture' to describe their changes. But there are now 1200 telephone companies instead of one, and your claims that the service is better and cheaper are subject to a lot of debate.

EDITORIAL VIEWPOINT



The future for global electronics manufacturing

Having commented at various times on the difficulties faced by our local electronics manufacturing industry, and by our governments in seeking to help it, I've been very interested to read recent reports that overseas countries are facing very similar problems.

A few months ago the US Economic Policy Institute apparently published a report on *The Consumer Electronics Industry and the Future of American Manufacturing*. According to British author Barry Fox, writing in *New Scientist*, the authors of the report noted that "In one branch of electronics after another, US firms have failed to achieve commercial advantage from technical innovation, while the Japanese and the newly industrialised countries of Asia have caught up with, and in many cases surpassed, their US rivals".

Fox also reports that recently executives from the European electronics industry gathered in London for a conference called *The Japanese Electronics Industry and Britain*, sponsored in part by the Electronics Industries Association of Japan. Apparently Japanese firms now own over 40 consumer electronics factories in Western Europe, plus another 50 factories making either industrial electronics or components. They own even more plants in the US and Canada.

So it's a global phenomenon. As well as dominating in many *product* areas – particularly in consumer areas such as TV receivers, VCRs, camcorders and CD players, Japan and its Asian neighbours are also tending to export *manufacturing technology*. As Barry Fox suggests, in much of the Western world the struggle to maintain a local manufacturing industry has become little more than a tussle by competing countries and states, vying to win selection as the site for the next highly automated Japanese factory.

Obviously a lot of people are aware of this trend, and are trying to work out its implications for the future of electronics manufacturing, in both local and global terms.

Should we simply bow to the superior manufacturing expertise of the Japanese, Taiwanese and Koreans, and let them become the world's suppliers of all high volume electronics goods? Or should we strive to learn how they've become so good at manufacture, and make an all-out effort to catch up and compete? Either way, there are challenges to be faced, attitudes to be changed, and decisions to be made.

One clear difference between the Japanese and Asian manufacturing firms and those in most Western countries is that they have clearly defined, realistic *long-term* plans – whereas ours seem to spend much of their time either organising takeover bids, or trying to find investors who are prepared to wait more than 6 months before they get their money back.

But if ever there was a time for us to do some serious thinking and planning for the future of manufacturing, surely it's now. Otherwise we're likely to be simply swept along, by the tide of events. And we may not like where that takes us...

Jim Rowe

What's New In HOME ELECTRONICS

Cinema surround sound at home

Onkyo's new TX-SV90 Pro Surround Sound Audio/Video Tuner Amplifier incorporates a host of technological developments including Dolby surround sound, hall surround synthesised stereo, dynamic bass expander and a 20 pre-set digital synthesised AM/FMstereo tuner

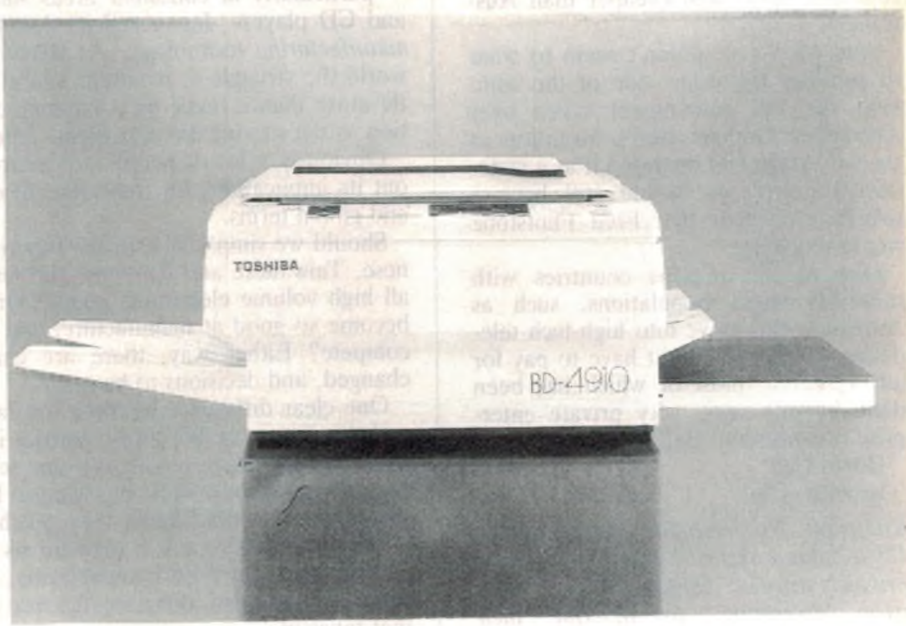
Selection of the surround mode offers Dolby pro-logic decoding, enabling true Dolby B encoded videos to be realised. Hall surround mode adjusts the sound delay to the rear speakers by either 15, 20 or 30 milliseconds, creating a pseudo 'hall' or 'auditorium' effect.

A matrix surround feature provides a pseudo surround effect from source materials that is not Dolby encoded. For stereo TV viewing a simulated stereo feature enables a wide sound effect from monoaural TV sound tracks. A dynamic bass expander feature is provided to enhance source material that lacks bottom end 'punch' or speakers that are 'bass shy.'

The tuner section offers digital synthesised AM/FM stereo tuning, with an auto memory feature that enables up to 20 stations to be stored.A battery backup can also store stations for up to three weeks in the event of power failure. Station selection is achieved by auto mode tuning and a muting mode enables total quietness between station selections.

For further information contact Audio Insight, 5 Skyline Place, Frenchs Forest 2086 or phone (02) 975 3011.

Copier with colour option



The new BD-4910 desktop copier from Toshiba is made for the medium-sized business. It has a bank of five preset ratio keys, 141% and 200% enlargements, same size, plus 71% and 82% reduction.

Other size ratios can be easily stored in the BD-4910's memory by simply pressing one key to lock in the special ratio and another to recall it.

The zoom function operates from 65% to 200% of the original in 1% increments and is clearly displayed on the operation panel.

Toshiba offers an optional colour developer unit which provides the desktop BD-4910 with further versatility. Easy to install, the unit uses red or blue to highlight important information and graphics.

Add to these features a speed of 16 copies a minute, edge-to-edge copying, 99 copies per run, A5 to A3 capacity, bypass tray, dual page copying and an increased black toner capacity of 40% over previous models.

For further information contact Toshiba, 84-92 Talavera Road, North Ryde 2113 or phone (02) 887 6054.

New amplifier features valves

Audio Innovations has launched the series 500 Integrated Amplifier, featuring a power output of 25 watts Class A operation per channel. The unit employs thermionic valves and is claimed to give superior linearity, stability and load tolerance.

A major feature of the Series 500 is its styling, described as 'stunning.' It has been given an eye-catching look by situating the thermionic valves in a semicircle on the top of the unit.

According to local distributor Audio Products, the Series 500 integrated amplifier offers truly outstanding sonic performance and looks to match, at a price that makes it obtainable to a large number of audiophiles and music lovers.

For further information contact Audio Products, 8 Tengah Crescent, Mona Vale 2103 or phone (02) 997 4666.

BASF challenging golden ear brigade

Cassette tape maker BASF has launched its 'CD Challenge' promotion in Australia. The promotion is designed to demonstrate that the performance of the firm's Chrome Maxima II tape is very close to that obtained from CD recordings.

A portable demonstration and testing unit is being set up by the firm in shopping malls, department stores, record bars and other venues. The unit allows instant A-B comparison between music replayed directly from a CD, and indirectly via a three-head tape deck using BASF's tape. The tape deck is fitted with the Dolby C noise reduction system.

As part of the challenge, and after a 'warmup', people are played ten 12-second excerpts. On a small form they are asked to indicate which of the excerpts are heard direct from CD, and which via tape. Their scores are then marked, to show whether or not they can detect any difference.

So far around the world the average score has apparently been around 40%, somewhat less than chance. This is not very surprising, as very few recordings involve more than 75dB dynamic range – well within the capability of a modern cassette machine using Dolby C in conjunction with a high grade chrome dioxide tape like BASF's Chrome Maxima II. However the 'CD Challenge' certainly seems an effective way of demonstrating this point!

New speaker

Audio Products has announced the arrival of the latest model in the Wharfedale 'Precision 5' speaker series, the 505.2.

Power handling is 100 watts per channel, with a frequency range of 42Hz-22kHz. With two drive units, the 505.2 has a sensitivity of 87dB.

The infinite baffle enclosure is made from rigid 18mm particle board. This together with additional bracing and a recessed rear panel helps to create a resonance free housing and consequently tight, extended bass performance. A 4-layer voice coil design ensures that the 505.2 is not easily damaged by inadvertent misuse. The 505.2 also features Wharfedale's new aluminium metal dome tweeter. Recommended retail price for the 505.2 is $799.00.

For further information contact Audio Products, 8 Tengah Crescent, Mona Vale 2103 or phone (02) 997 4666.

CD cleaner

The Philips CD Autocleaner will remove dust from compact discs, so it doesn't accumulate and damage your valuable CD player.

It has an internal motor and gear train controlled by an electronic circuit for automatic, one touch cleaning.

In a radial cleaning action, it moves a moistened chamois from the centre of the compact disc to the outer edge – an operation taking just 20 seconds from start to finish.

With its special cleaning fluid, to ensure that this action is non-abrasive, the Autocleaner is extremely effective and easy to use. It is powered by battery, or an optional AC adaptor, and retails at $49.95.

For further information contact Philips, 15 Blue Street, North Sydney 2060 or phone (02) 925 3333.

Home Electronics

Improved audio tapes

Philips has released its 'Touching Perfection' range of audio cassette tapes, said to incorporate 'significant improvements in performance and design.'

Improvements include reductions in hiss, wow and flutter, combined with an excellent print through ratio and improved temperature stability.

The range comprises four grades of audio tapes – FS, FSX, UCX and MCX – each inidividually colour

coded. The top of the range MCX offers chrome cassette high frequency response and dynamic range (65.5dB), with a high output level. It meets the needs of the most demanding musical recordings, and gives excellent results with quality cassette decks.

In contrast, the FS ferro cassette offers good performance at an economical price. This high output, normal bias tape is suitable for general purpose usage, and is particularly suitable for portable recorders and taping 'easy listening' music or speech.

The new tapes should be available via hifi and audio outlets.

For further information contact Philips, 15 Blue Street, North Sydney 2060 or phone (02) 925 3333.

CD-ROM 'book'

Reading a book is more than just gobbling up data. There is something to flipping pages that no television or other media can match. But if Sony has its way, by the mid 1990s, many of us will be scrolling the page instead.

At a recent consumer electronics fair in Tokyo, Sony showed off a prototype of a palm-sized 'electronic book' which the company believes will be competing seriously with paper-based books by the mid-to-late 1990's.

The system is built around a 3" CD-ROM and holds up to 200 megabytes of data which can be read on a small LCD display. The unit weighs less than 20 ounces.

Analysts said by showing the product now, Sony is trying to set some form of defacto industry standard in order to avoid the same kind of fiasco it suffered in the Beta-VHS video format standards battle.

The question, of course, is whether Sony, single-handedly or with the help of the rest of Japan Inc. can change people's reading habits. Many avid readers will surely snub at the idea of giving up their hard-bound literary works of art for some electronic gadget.

The best bet for this technology, in the early stages, would seem to lie in applications such as dictionaries, encyclopedia, and other data resources. In fact it may do very well. But for recreational reading, flipping pages will no doubt remain the standard for some time.

Monitor speaker for cars

Unlike other manufacturers who have been making speakers for cars, Fostex has taken a reference monitor speaker and made it possible to be fitted into some vehicles. The company claims that drivers can now have the sound of today's world class recording studios in their cars.

The Fostex RP Digital Series uses transducer design which has earned more than 20 international patents to date. In the RP system, a very fine aluminium coil is etched directly onto the surface of an extremely thin, polyester film diaphragm. The assembly is then suspended in a powerful magnetic field, formed from magnet pairs with opposing identical poles. A magnetic strength ten times that of Alnico – previously thought to be the best material for speakers – is achieved through the use of rare earth, samarium cobalt magnets.

This design, combined with a flat planar diaphragm/voice coil assembly 80% lighter than the typical dynamic element, results in very high phase uniformity. The Fostex RP system is thus said to operate in true piston motion with extremely fast transient response. Simplicity of design and careful construction techniques produce mid range and high frequency drivers capable of responding fully and completely to the demands of digital sound resources.

Further details from Tradepower, 294A Glenvale Crescent, Mulgrave 3170 or phone (03) 560 9111.

Product Review:

Philips' 71cm (28") 'Matchline' TV receiver

This new unit from Philips offers more than just a large screen format. It features full hifi stereo sound, 'PIP' (picture in picture), multi-standard reception, Teletext, and connections for almost any peripheral.

The 'high end' of the TV market appears to be a highly competitive area, with large sophisticated sets available from most manufacturers. If you take your viewing very seriously, or simply want to enjoy the 'state of the art' in television technology, these receivers certainly deliver the goods. As well as supplying large and clear pictures, each of the available brands seems to vie for a marketing edge by offering an ever increasing number of features.

In this respect, the Philips 'Matchline' model 28DC 2070, with an almost bewildering range of features, must rate amongst the leaders in this high end market. As with its competitors, the Matchline is a physically substantial unit – it weighs in at 45kg and has dimensions of 545 x 645 x 485mm. While it would certainly take a commanding position in any lounge room, in true European style the cabinet has a neat and uncluttered appearance, allowing it to blend with almost any room decor.

As you would also expect from an up-market receiver, virtually all user functions are controlled by an elaborate infra-red remote control unit, which accesses a multitude of on-screen menus and performance adjustments. The few front panel controls that *are* available are either hidden beneath a flip-down panel, or moulded to the shape of the fascia – it takes a close look to realise that they even exist!

The remote control itself is a little daunting at first, with its 66-odd buttons and (often quite esoteric) matching symbols. Nevertheless, after a short familiarisation period, and a little cross-checking with the operation manual, we were soon able to work through the Matchline's formidable list of features.

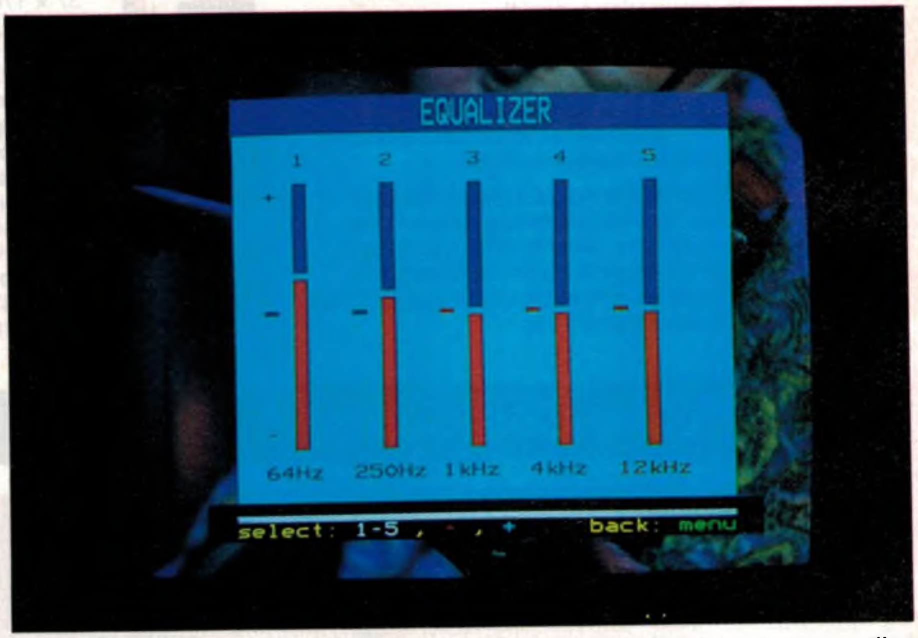
Pictures

The first and most obvious point of interest with a television receiver is the quality of its picture. In this area the Matchline offers excellent performance, with steady sharp images and well defined colour areas. While the sheer size of these large screens can be a little overwhelming at first, you soon begin to appreciate the benefits of the almost cinema-like viewing atmosphere. By comparison, the usual smaller screens seem to lack impact.

For optimum picture quality, the Philips chassis uses a number of electronic enhancement techniques, and a high contrast 'black-line' picture tube. Full adjustment is available through the 'picture' section of the main on-screen menu, which amongst the usual controls, offers a surprisingly effective sharpness adjustment and the ability to select and deselect Philips' DTI (Digital Transient Improvement) function.

As an additional, and increasingly popular feature, the Matchline has the ability to display an extra small image in the corner of the main screen. Slightly less than a quarter of the screen size, this area can be selected to display any of the main video sources – that is, the main TV signal or any external video input.

So a typical use for this PIP (Picture In Picture) feature might be to monitor the small screen image of say a test match (waiting for something to actually happen!), while watching a more stimulating signal from your VCR on the main screen. The PIP image is in fact a digital reproduction of the selected video source, and may be 'frozen' on



The Matchline's sound can be fine-tuned with an on-screen graphic equaliser – without having to leave the comfort of your favourite chair.

Large-scale viewing from Philips. The PIP (picture in picture) image can be called to the main screen at any time – even in Teletext mode. It can also be positioned in any of the four quadrants.

the screen at any time by a dedicated button on the remote control – which presumably just stops the digital memory's update process.

Other than that, the main and PIP images can be made to swap video sources at the push of a button, and the PIP screen moved to any corner of the main display to avoid blocking an important area. Note that the PIP screen will only display an alternative *video* source, and can't display a different off-air TV channel from the Matchline's own video signal – this would require an internal tuner for each channel, to produce two distinct video signals.

Nevertheless, it's quite a simple matter to arrange for a peripheral VCR to deliver the video signal of a different channel to that of the TV's internal tuner. In this case, the PIP screen's source selector is simply switched from 'TV' to say 'EXT2', where the VCR is connected. By the way, PIP screens may also be popped-up in the Teletext mode, but the two images cannot be swapped – there's probably little point anyway, since the Teletext information would be almost unreadable on the small PIP screen.

Sound

Continuing the current trend of improving the sound quality of television receivers in line with their picture quality, Philips' designers appear to have taken a great deal of effort with the whole audio chain of their Matchline set. Happily, their endeavours have been very successful, with the unit delivering a first class stereo sound.

There appears to be a couple of main reasons for this impressive performance. Firstly, the internal amplifier is based on Philips' very effective TDA1514A power amp chip, which can cleanly deliver up to 40WRMS into an 8 ohm load. As it happens, we can certainly vouch for the performance of these devices, having used the same chips in our own Playmaster 30-30 amplifier.

In the Matchline receiver, the chip's supply rails are set to around +/– 24V, which should yield an output power of around 30WRMS into 8 ohms. This is more than enough power in practice, with the set capable of delivering volume levels to rival the average home hifi.

The other significant factor in the Matchline's strong sound performance is the loudspeakers themselves. Each cabinet is a vented design composed of heavy duty moulded plastic, and contains a potent 100mm woofer and 25mm dome tweeter combination. The enclosures may be either attached to the side of the main cabinet on mounting lugs, or placed at some distance from the set itself for a wider stereo image.

Their sound is quite well balanced, and free of the cabinet resonances that are so often found in television speaker enclosures. While such small speakers can't be expected to deliver loads of deep bass, their low frequency response is surprisingly good, and seems to taper off in a controlled manner.

Just for the record, we tried connecting a set of high-quality bookshelf speakers in place of the standard units. The improvement in fidelity confirmed the quality of the power amplifier stage, and tended to expose any flaws in the original sound signal from the TV station itself.

In fact, we found that the sound from the various channels seemed to vary by a large degree – particularly with the 'stereo' option selected. The overall background noise level, tone and stereo separation seemed to be different for each station, and new program. Nevertheless, the Matchline's stereo decoder does *its* job very well.

We couldn't be so sure of the 'spatial stereo' option however. This presumably uses phase cancellation techniques to generate a simulated stereo, or widening effect for both mono and stereo signal sources. To our ears, the resultant 'spatial' signal seemed tizzy and distorted, with a rather disturbing out-of-phase feel about it. Needless to say, we left this option turned off...

The Matchline also has an additional set of loudspeaker terminals for two rear 'enhancement' speakers. When connected, we were again confronted by an apparent phase anomaly, particularly when standing in the centre of these two speakers. A quick inspection of the circuit diagram confirmed our suspicions – they were indeed out of phase.

It turns out that the two rear speakers are simply wired in series (with a direct connection between the negative terminals), while each of the positive terminals is connected to the main amplifier outputs. This is in fact quite a standard enhancement technique, where the rear speaker(s) simply respond to the signal difference between the two stereo channels. In this case however, the two speakers are wired out of phase. While we found the effect a little disturbing, this type of system can often provide a useful increase in the apparent depth of stereo signals.

To give you further control of the overall sound, the Matchline also provides a rather neat on-screen graphic equalizer. As with most other functions, this is accessed via the screen menu system and the remote control. Its operation is very simple, with five columns representing each of the available frequency bands. Another nice touch is an independent volume control for the headphone outlet, which (for example) would allow the hard of hearing to listen on 'phones at a higher volume to those listening to the receiver's loudspeakers.

Other features

And so continues the list of facilities and options of the Matchline 28DC 2070. It offers full Teletext capabilities, with user defined memories; Super-VHS compatibility; a fully synthesized scanning tuner; and the ability to decode all of the world's common transmission standards (NTSC, PAL, SECAM etc). There's also a 'sleeptimer', which shuts down the set after a programmed time has elapsed, and a 'Parental' mode where the front panel controls can be disabled – of course, all of these functions are under command of the remote control and the on-screen menus.

There is yet another complete menu system lurking in the Matchline, which is mainly used for the initial setting-up procedures. It's initially engaged by pressing a concealed button on the front panel, and then accessed by the remote control in the normal manner.

The picture menu with its 'slider' adjustments and the DTI (Digital Transient Improvement) selector. The sharpness control was quite effective.

This 'Installation' menu caters for the set's initial tuning adjustments, by offering fully automatic (frequency scanning) and manual methods of locking into the local stations. The station name (ATN7, SBS28 etc) can then be entered into the program list with its matching program number – up to 60 programs are available. The multi-standard ability of the Matchline's receiver even allows you to select different transmission standards for each individual program, or external input.

Other than that, the Installation menu offers a 'personal preference' option, which stores the current picture and sound adjustments. These in turn become the default settings when the set is first turned on – very handy indeed. Also, for those who are fortunate enough to have Teletext capabilities on a number of stations, this function is able to store a preferred teletext page for each of the set's program numbers.

Connections

In keeping with the Matchline's versatile programming system and range of functions, it also offers an unprecedented (in our experience) range of input and output connections.

Basically, two styles of connectors are available for peripheral units. These are the 21-pin SCART (or Euro) connector, and the new Super-VHS arrangement with a 5-pin mini DIN socket for the video, and RCA sockets for the left and right audio.

Amongst the forest of connections on the rear of the set, there are two SCART sockets (EXT1 and EXT2), and two sets of Super-VHS sockets – one for playback (also EXT2) and the other for recording. Also, there is another set of Super-VHS sockets under a flap on the front panel, which can be used to play back yet another external signal (EXT3). This would be a convenient position for connecting a portable video camera/recorder, for example.

These external sources may be selected by either entering a program number, where say EXT1 was initially keyed into the program list along with the TV stations, or accessing the 'source select' menu to choose 'EXT1' instead of 'TV'. This menu also offers a versatile 'recording selection' option, which allows either the TV, EXT1 or EXT3 signals to be sent to the EXT2 recording outlet.

Finally, the rear panel also features the front and rear loudspeaker terminals (the captive spring lever type), a standard antenna socket, and two RCA sockets to monitor the left and right audio outputs. This signal is sensibly tapped off at the amplifier's input, so when connected to an external audio system (say, your hifi), the remote volume control will still have the desired effect.

In use

With all of these features, options

and range of connections, you might be forgiven for thinking that the Matchline would be a monster to drive. Happily, that's not the case at all. The automatic searching function of the tuner makes station programming a simple task, and the remote control, while rather intimidating at first, is quite logical once you get the hang of it. Incidentally, the remote also doubles as a controller for the matching (no pun intended) Philips range of video recorders.

Which raises a rather awkward point about using the Matchline in Australia. While the set offers a healthy *number* of connections for peripheral units, you are restricted to using SCART or Super-VHS sockets – such is the case with most European receivers. Now, the majority of VCRs sold in Australia arrive with RCA-type video sockets, which can't directly connect to the above arrangement.

While this conflict of standards is really quite frustrating, a simple adaptor cable would solve the problem, as the SCART connector has input and output pins for both the video and audio signals. These could be connected by a SCART plug (available from a number of electronic stores) to four shielded cables, which would be terminated in RCA plugs. Unfortunately, this arrangement doesn't appear to be available from Philips as a pre-built adaptor cable.

So while the Europeans are quite happy to interconnect their units by (mainly) SCART connectors, we have to suffer with the unmatched standards from different parts of the globe. Mind you, we had a quick look at a typical audio/visual setup from a major Japanese manufacturer, and found that while the TV receiver was equipped with a SCART connector, the VCR had the usual RCA sockets for the video connection! Needless to say, the two were connected at an RF level via the antenna sockets.

This problem aside, the Matchline would make a fine control centre for quite an elaborate entertainment system. As well as offering comprehensive signal routing facilities and the ability to process almost any video source, it delivers a first rate picture and sound.

And the price? At $2499, it should be quite competitive in this decidedly up-market end of the TV receiver range. While luxury doesn't come cheaply, it's certainly nice when you have it!

For more information on the Philips Matchline 28DC 2070 receiver, contact Philips at 15 Blue Street, North Sydney 2060, or phone (02) 925 3333. (R.E.)

The Matchline's program menu which allows selection of the various channels and external video inputs.

Amateur radio to the 'rescue'

To make sure they can cope with emergency situations, a few adventurous radio amateurs like to take part in 'rescue exercises' with police, fire fighters and SES teams. If you're ever unlucky enough to find yourself lost, or caught in a disaster, you might be very grateful that they spent their weekends in this somewhat masochistic way...

by TOM MOFFAT

Amateur radio's ability to provide communications in the event of natural disaster and civil emergency is one of the main reasons it is allowed to exist. Despite commercial radio users clamouring for more and more frequencies, and bidding big money for them, it is hams' ability to 'fill in' in a pinch that makes them (us!) worthwhile, in official eyes.

However, from time to time, it's necessary to demonstrate that we can back up our promises. So exercises are set up to see if radio amateurs can indeed cope, when the chips are down.

One main radio exercise activity every year in Australia is the Murray River Canoe Marathon, and in Tasmania, amateur operators are becoming more and more valued as experienced radio operators during the big yacht races just after Christmas. But most activity still remains on land, with large search and rescue exercises held a couple of times a year.

These big 'S & R's' are an all-in effort, involving police, ambulance people, the State Emergency Service, helicopters, bushwalking clubs, horseriding groups, and of course radio amateurs, in the form of WICEN (Wireless Institute Civil Emergency Network).

The exercises are a good opportunity to spend a couple of days thrashing about in the bush in good places, with good company. They're hard work during the day, but at night everyone gets together for a good old wing-ding.

Every exercise is based on a 'scenario' – an imaginary situation usually involving a 'lost' bushwalking party. A really big exercise may involve several lost parties scattered throughout hundreds of square kilometres of bush. There will be a temporary police radio network operating, as well as a network for the SES, and the WICEN network.

WICEN people are also usually sent along as members of 'lost' parties, as a safety backup. If the party gets properly lost (which does happen) or somebody gets hurt, the amateur can get on his two-metre hand-held and yell for help.

The WICEN base station also operates as a position reporting service, which always knows the present location of every 'lost' party. If something goes wrong, such as a sudden snowstorm or an injury, the WICEN operator can immediately reveal the locations of all parties to the rest of the exercise participants.

Needless to say, in order to make the exercise realistic, the WICEN base must be set up well away from the police base, and a certain amount of secrecy must be maintained about party locations.

This all fell apart one year, when some sneaky police turned up at an exercise with scanners, so they could monitor WICEN channels. Their search parties could then pounce upon the 'lost' walkers with remarkable speed. But the practice was soon banned by senior police, since it destroyed the whole concept of the exercise.

Radio amateurs involved in these exercises are usually divided into two groups: those who are bushwalkers, and those who are not. The non-bushwalkers are assigned to the WICEN radio base, and to distant repeater sites which can be reached by car. The bushwalkers establish repeater sites which can only be reached by foot, and one bushwalking amateur is always sent along with each 'lost' party as the safety radio operator.

Personal 'incidents'

My own experience is as a bushwalker/operator, over several of these exercises. As we said, it's a lot of hard work but also a bundle of laughs.

I strolled into my first exercise not having a clue what would be required of me, but I soon found out. The exercise was in the northern part of Tasmania, in the central highlands and in a deep valley. The valley was accessible by road, and was soon the site of the Police base, the SES base, and the WICEN base. Since the WICEN station was 'in a hole', all communication had to be through temporary repeaters.

There was a road climbing out the west side of the valley to the plateau, so a car-borne repeater could be set up there. But the east side of the valley was a different story. It could only be reached by something called the 'horse track', which rose steeply to the plateau where there was a hut and a camp site. This is the northern entrance to the Walls of Jerusalem National Park, a truly mind-blowing place as anyone who's been there would know. And rising from the plateau was this big heap of mountain called Clumner Bluff, the site of the second WICEN two-meter repeater. There's no track up this mountain; the only way to get there is by some furious scrub-bashing.

At this time, about six years ago, hand-held radios weren't considered powerful enough to be used as repeaters, so the Clumner Bluff repeater was to be made up of a ten-watt mobile and a two-metre walkie talkie. The radios, cables, and antennas were all stashed in our backpacks, as well as food, clothing, tents, water bottles, and a few tinnies of beer. Each pack would have weighed a good thirty kilograms, maybe more. We strapped them on, and then prepared for a few hours hard slog up the steep horse track.

Just as we were leaving, someone said "Here, Tom, carry this...".

"That's a car battery."

"Yes."

"You want me to carry a car battery?"

"Yes."

"Up that mountain?"

"Yes."

A car battery. Power for the repeater transmitter. I was the biggest, so I was elected. But this disgusting burden was shared around; as each person flatly refused to carry it any further, someone else took over.

We spent that night at the camp, considerably lightening our load by devouring lots of food and dispatching all the tinnies. Next morning we fought our way up Clumner Bluff, car battery in hand, and got the repeater going in short order.

The repeater concept was fairly simple. The big mobile was for the transmitter, with its antenna lashed as far up a tree as we could get it. The receiver was the walkie-talkie, slung up another tree. The two radios were about 100 metres apart, joined by a pair of wires rolled out on the ground, to carry the receiver's audio to the mobile for retransmission. The big separation was necessary so that the transmitter wouldn't overload the input of the receiver.

The repeater worked fine, although it turned out that a ten watt transmitter wasn't really necessary; a one-watt hand-held would do nicely. Less transmitter power means less electric power, so that was the last time a car battery was humped up a mountain by the human pack horses from WICEN.

The ham actor

On another memorable exercise, the scenario involved the usual lost party, but with one of its members getting separated and thus lost from both the party and the searchers. The fellow chosen to go missing, named Phil, was himself a policeman from Launceston search and rescue, as well as a keen bushwalker and a well-known radio amateur. I had two jobs in this exercise; one was as an official photographer for the police, and the other was to accompany the missing solo walker as his 'safety man'.

I was told by the police to expect plenty of action and to photograph anything that moved. They had obviously seen this missing 'victim' in action before. We were again in Tasmania's central highlands, in a somewhat barren area above the tree line, dotted with little lakes. With so little vegetation up there you could see several kilometers in any direction.

It took several hours of walking to get to the spot where it was intended that the 'victim' be found. Every 30 minutes we used a two-metre walkie talkie to call into WICEN base, so they always knew where we were. But not the police.

The place was swarming with search parties, and every time we spotted a line of dots marching along in the distance, we had to hide behind rocks, or flat on the ground, usually in a swamp. It wouldn't be good to be found prematurely, before Phil had time to put his makeup on.

Makeup: the stuff is known as 'moulage', used mostly for advanced first aid training. There is a fine assortment of ghastly things such as compound fractures, disembowelments, and head wounds which one can stick on to one's body and then decorate with plenty of artificial blood. I once had a 'moulage' hanging eyeball, which was good fun for wearing to parties. For this exercise, Phil chose a colourful compound fracture of the leg, with plenty of 'blood' to pour on his clothes and the surrounding ground.

After hours of dodging search parties and tiger snakes, we got Phil into his position, at the bottom of a pile of rocks which he had 'fallen off of'. After a concentrated session with the moulage, Phil's body was a twisted mess with a broken bone jutting from his leg and blood strewn everywhere – it looked like a ritual murder had taken place. We then told WICEN we'd be off the air for a while, so the chattering walkie-talkie wouldn't give the game away. I then went to another pile of rocks and hid, camera at the ready, to await the next search party.

A few minutes later they came along, passing about 50 metres away. It looked like they were going to miss Phil, so I whispered to him to let out a little moan or something. What we got was a blood-curdling scream. The search party raced over, led by a tough old nursing sister from the Launceston General Hospital. As they approached Phil began weeping and sobbing.

The nursing sister knelt down, went a bit green around the gills, and then began gently tearing Phil's trousers leg away from the wound. This set Phil off nicely:

"Don't you touch me, you &*/!!?*x! If you touch that ?%*&@!-ing leg I'll gouge your ?*$&-ing eyes out!"

The nursing sister rose quickly into the air, legs pumping in reverse, and

came down running backwards several feet away. This is legitimate, she thought; that guy is really hurt! Why else would he be swearing like that? As Phil lay there alternately screaming and sobbing, the search party tried to decide what to do. Every time anyone would come close, Phil would lash out with his arms and shriek abuse at them.

Eventually the searchers used their own radio to call in a helicopter. As they were waiting for it to arrive I moved closer to take some more pictures. And did I cop it from the search party!

"Get out of here, you ghoul! Can't you see this man's in pain? Go on, get that camera out of here!"

Well, what could one say? Couldn't give the game away, not yet. So I just ignored the abuse and took more pictures, which infuriated them even more.

When the helicopter arrived the ambulance man riding with it settled Phil down and got a splint onto his leg. Although he didn't let on, the ambulance guy obviously knew the whole thing was a big fake. And as Phil was carted toward the helicopter on a stretcher, he was asked if there was anything that would make him more comfortable.

"Yes!", he bellowed, "A cold beer!"

It was a remarkable recovery.

More actors

Ah, what a strange way to play radios. Tramping through the bush, playing hide and seek with cops and searchers, and making life for them as miserable as possible. How about another example...

This time the exercise was at Lake Leake, another lovely spot in the wilds of Tasmania. There was no need for a portable amateur repeater this time; there was a permanent repeater on Snow Hill, overlooking the exercise area. Perfect coverage everywhere. Search headquarters was on the shore of the lake, and the missing included some parties in boats, as well as bushwalkers. I was to get 'lost' with a young Army cadet.

There was the usual routine of hiding from searchers until we were in the prearranged place, so we spent a long time walking and hiding, walking and hiding.

We were particularly pleased with the way we outsmarted one party, only to be sprung from the rear by a horse squad. They wanted to practice their rescue skills on the 'injured' Army cadet, strapping him to the back of a horse on a stretcher. Off they went with their prize, bouncing along the track as he moaned with each jolt. It certainly looked uncomfortable, and I'll bet the cadet was more injured at the end of the journey than he was at the start.

As for me, I had to walk back, as usual, until I hopped a ride in a police Land Rover. They let me off outside the ambulance station at search headquarters, where I took off my boots to ease my burning feet. I soon found why one foot was burning – a leech! It had first filled up, with my blood, and then burst as it was ground up inside my boot. There was blood everywhere, so I couldn't let that opportunity go to waste.

I let out a bellow, to draw a few young ambulance cadets out of their headquarters, and then pulled the boot right off. Blood gushed out and turned the ground red, and the ambulance cadets turned green. A bit of on-the-job training for them, for real. Leeches inject an anti-coagulant when they bite, so plenty of blood flows from what's just a pin-prick wound. But it certainly looks impressive.

While the young ambulance bods were recovering from their shock, the police were busy interrogating 'rescued' victims to try to get any information that might help them find the people still missing. Another amateur operator, a 'victim' of one of the boat mishaps, came up with a novel way of frustrating his own interrogation. He forgot how to speak English. The fellow was fairly proficient in French, so every question from the police resulted in an unintelligible babble of French.

That's one of the ways that a bit of lateral thinking from radio amateurs has helped make search and rescue exercises more realistic. No one had considered the possibility that somebody they needed to question might not be able to speak their language. Perhaps future exercises, and real incidents, might include interpreters.

All this goes to show that amateur radio activities can go far beyond a bunch of old geezers standing around waffling about what DX they've worked. These joint exercises give amateurs in Australia a good chance to mix it with the professionals, to pick each other's brains.

Many amateur radio ideas such as portable repeaters are now standard practice in police, fire, and other 'public safety' areas. And many amateurs now know what kinds of hassles police and search parties have to put up with. Not only that, but the exercises are jolly good fun!

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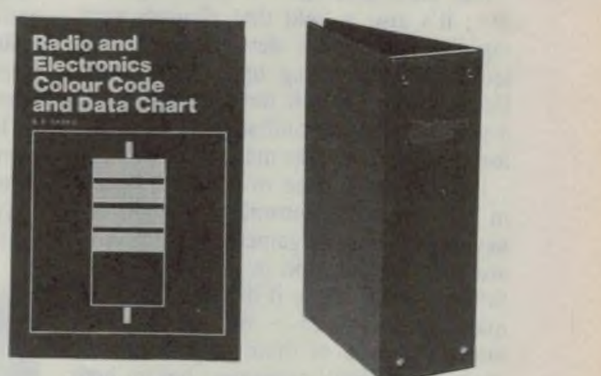

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Opportunities for women in electronics – 1

Women have entered and are excelling in many traditionally male fields, and electronics is no exception. However the number of women in the industry is not as high as either the Government or industry organisations would like. In an attempt to understand the underlying problems, *EA*'s news editor – herself a qualified engineer – has been interviewing women who are already in the industry, at levels ranging from tradeswomen to engineers.

by WINIFRED VINCENT

In so-called 'developed' countries like Australia, electronic equipment is now an established part of almost every aspect of our lives. Our homes are generally well stocked with electronic appliances, from microwave ovens and microprocessor controlled washing machines to televisions, VCR's, amplifiers, CD players, home computers and so on. Similarly our offices have fax machines, word processors, computers and telephone answering machines, while many of our factories now have automated machines, process controllers and computerised testing equipment.

But electronics is not just all-pervasive; it's also a field that changes very rapidly, with new developments and technologies popping up all this time. Both qualities give it the potential to be a very challenging and satisfying career, for women as well as men.

In order to be free to choose a career in a field like electronics, though, it's necessary to have gained the appropriate prior preparation in terms of education. This can make it difficult, for both males and females – but more so females, because of their preparation for more 'traditional' roles even before high school. It's taking a while for our educational systems to shake off the sexist philosophies of the past.

Of course even when women *are* able to choose electronics as a career, things aren't always easy. There can be discrimination, in both training courses and the workplace, and there can also be sexual harassment – despite laws making such things illegal.

But despite these problems, more and more women are choosing careers in electronics, and establishing themselves firmly in the industry. This article is about some of the women who have taken this step forward – those who are already in the workforce as electronics tradeswomen and engineers. Our intention in presenting their story is to attract more women into the field.

Although most of our readers are currently men, we hope that they will circulate this article around for reading by their female family members and friends. Both male and female members will hopefully be interested in the interviewees' comments on their work, working conditions and workmates.

Women with university degrees still tend to lack some of the practical experience which their male counterparts mainly have, mainly because of the difference in upbringing. The psychological barrier that follows can widen the gap as the years progress. If both men and women recognise this problem, maybe a solution can be found soon.

There are a number of success stories with women holding university academic and research positions. While their contributions to the industry have been significant, it's interesting to speculate whether they would have coped with an industrial environment if they had been forced to work there. Traditionally universities and other academic organisations have provided a certain degree of 'asylum' for educated women. How effectively their knowledge can be used by industries is yet to be determined, since by comparison not that many university trained women engineers are working 'outside' in the industries concerned.

Currently, the Australian Department of Defence is taking an aggressive stand in hiring women and educating the men around them to accept this. In a few years' time we will hopefully be hearing great success stories from that direction.

I was able to interview a couple of women working in the Australian army. One is a private soldier taking an electronics workshop training, and the other an officer with a degree in Electrical Engineering.

GEC Plessey Telecommunications allowed me to talk to female Engineering Managers, Engineers, a Technician and a Leading Hand. A visit to their factory showed that most of their employees are in fact females. To have women working at every level of management, design and assembly is impressive indeed.

Telecom was also willing to partici-

Pvt Kerri Hobbs

Lt Liesl Kneuker

Pvt Kerri Hobbs busy at the workshop with a colleague watching.

pate. They've been employers of women for a long time, and it was interesting to learn what their employees have to say about present day working conditions.

But let's begin, by looking first at the women I found working in the Army.

In the Army

Craftsman(!) **Kerri Hobbs** is with the Royal Australian Army, and has so far done 18 months of trade and basic army training out of the usual 3 years. At the time I interviewed her, it was nearly one month since she had joined the electronics division, where she will be working on compasses, night sight and instrument testing units. She has the firm belief that once you set your mind on something, you are half-way there.

Soldier Hobbs is pleased with the way the army is treating women. She is not at all worried that they are not allowed on the field, and says that it is to protect them – "after all, that is what army is all about". She has great respect for traditional values and is planning to have a family of her own after about 10 years.

Kerri's ambition is to go to the Officers' School, to become an Officer and to get a degree in Electrical Engineering. Her enthusiasm shows that she has already created good vibrations, and she looks set to have a satisfactory career with the army. The army has a reputation for giving excellent training to its personnel.

Just to put things in perspective, by the time Craftsman Hobbs is 19 years old she will be earning $28,000 pa – with medical and other expenses covered. She mentioned this as a promotional issue. Maybe more women will think of joining the army, not only for the pay but also for suitable application of their talents.

Another person I interviewed with the army was Lieutenant **Liesl Kneuker**, who obtained her Bachelor of Electronics Engineering degree from the University of Western Australia last December. Liesl was recruited by the army during her third year at university and has been sponsored since then. She was accompanied at the interview by another officer, Lieutenant **Ngarie Grenda**, who is actually a mechanical engineer. By talking to them I learned that at Officer level one is expected to display some management skills; university education is presumably quite relevant here, because as a student, one generally has to learn to manage time very well.

Lieutenant Kneuker is in charge of contract repairs in the vehicles section. She enjoys this because she would like to get a Mechanical Engineering degree as well. Her career ambition is to achieve overseas posting and full use of her degree. Army officers are rotated around to do varied jobs; it is their ability to cope with new situations that the army values.

My ignorant reaction at the beginning was "Why an electronics engineer in the vehicles section?" After a little reflection, though, it made more sense. Lt. Kneuker is planning to spend more than the compulsory five years with the army. This compulsory period is because she was sponsored by the army to go to university – ordinary soldiers don't have this period of obligation.

Talking to Lt. Grenda helped me in assessing the direction in which Liesl Kneuker is heading. Lt. Grenda has been with the army for the last eight years – six years' part time and two years' full time. In contrast with Kerri Hobbs, she thinks that the Army's policy of not allowing women in the field limits the kind of training they get, and may put them behind their counterparts working for industry. It is a genuine concern, for like men, some women officers may well wish to leave after a time and work in industry.

Both Lts. Kneuker and Grenda believe they were privileged to have joined the army.

Telecom ladies

Sue-Ann Burton is a communications engineer with Telecom, who obtained her Bachelor of Engineering (Electrical) from the University of New South Wales in 1985 and has been working for Telecom since then. She is happy that she chose this field, and says that her lecturers at the university and her colleagues were always supportive. She doesn't think the choice of her career

Lt Ngarie Grenda

Sue-Ann Burton

Philippa Morrissey

Patricia Fernando

Elena Segal

Pauline Powell

has affected her interpersonal relationships.

Sue-Ann has worked on both software and hardware design of a control card for interfacing real-time telephone circuit occupancy information from several exchanges. Now she is working on network planning of communications for digital exchange development. These involve ISDN (Integrated Services Digital Network), network signalling and increased network intelligence, the development of broadband networks, future mobile networks using digital techniques, fast packet switching techniques and queued packet synchronous exchanges, and synchronous optical networks.

Sue-Ann says she enjoys providing the facilities for improved service to Telecom's customers, and says that the most enjoyable aspect of electronics is when the final product or service is achieved. She had electronics as a hobby during her teenage years, not to mention her interest in go-carts and mechanical devices as a child. She thinks there are only subtle differences between electrical, mechanical and civil engineering, because they all involve design and a certain kind of thought pattern. So there is no need to think of any one branch as 'softer' or more 'feminine' than the other, she believes.

Sue-Ann does not think she has deviated from the 'normal' by choosing this career, even though other people may think so because of their lack of knowledge. If the overall level of electronics knowledge of women is raised, she believes, there will be more moral support for women pursuing electronics as a career. She believes electronics should be an available option for girls as well as boys at school level. Sue-Ann is a member of the Telecommunications Society, and her career ambitions are to achieve good promotion in an interesting field – plus more money!

Philippa Morrissey completed her Electrical Engineering degree at Sydney University in 1986. She worked for STC for two years doing hardware design, then worked for Honeywell for eight months as a Systems Engineer. Now she is working as a Systems Engineer with Telecom. She says that at university she was not treated differently from anyone else, and at the various places she has worked she got a lot of encouragement from her colleagues.

Philippa really enjoys working in electronics. For her the most enjoyable aspect is solving problems. She says that of all the engineering fields, electronics is perceived as cleaner. Furthermore software engineering, being a continually changing field, does not have an established male tradition and therefore she believes it puts her at the same level as her male counterparts.

During her spare time Philippa 'pulls things apart' and 'fixes things'. Should she have children, she hopes that her experience and training will benefit them in terms of their career options. She comes from a family where her mother had a career and her father shared the work around the house. She went to a public school, where her senior maths and physics teachers were very supportive.

Philippa did hardware design and testing when she was with STC. Later when she was with Honeywell she programmed EPROMs to automate airconditioning systems for buildings. Now with Telecom she is involved in developing a commercial system – which has to be kept secret. She is optimistic about her chances of promotion to a management position.

Philippa is taking courses for an MBA degree, and the management at Telecom actively encourages this further study.

According to Philippa the present laws are adequate for women to find jobs in technical fields; still, she thinks that should discrimination or harassment exist at a workplace, it would be extremely undesirable to have a public courtcase about it. Even though she is in a male dominated field, she does not think this has caused her any problems.

It is Philippa's ambition to invent something really novel. She also hopes that throughout her career she will have been involved in products that serve humanity.

At GPT

Patricia Fernando works as a Leading Hand in the Sydney production plant of GPT (GEC Plessey Telecommunications). She has been with this company for the last 17 years. Before that she worked for Morris Roche in Sri Lanka for eight years, making portable radios.

Patricia showed interest in radios during her early teens, by collecting a few broken down radios and making one complete radio out of the components (radio parts were hard to come by in Sri Lanka). She also fixed lights around the house, which she considers was trivial.

To Patricia the most interesting aspect of any work is starting on a new product. There are 10 ladies working for her on the production line. She starts the day by giving out jobs and by the end of the day books in the completed work. She spends a lot of time with the people she works with. She says her husband is proud of her achievements, and believes that their children benefit from her knowledge of electronics.

The main product turned out by Patricia's group is the MTR 8000 tranceiver. GPT's radios are used by various transport and emergency services, with modi-

Helen Wong

Therese O'Sullivan

fications made to suit the requirements of the customer. She thinks electronics is very different from other branches of engineering, and believes people from all walks of life should change their attitudes, for the work environment for women to become more enjoyable. She advocates electronics education for both girls and boys at an earlier age.

Elena Segal has been a Technician with GPT for the last six years. She obtained her Electronic Technician certificate from a technical college in Rumania, and worked there in this field for eight years before coming to Australia. Her area of specialisation is telecommunications. Her husband also works in this field and they help each other in the workshop at home.

Elena works in the production area and is involved with repairing boards from different equipment which the company builds – like Digital Data Network and Time Division Cross Connection units, and other telecommunications equipment. She finds her education in electronics and her previous work experience are a great help, and thinks that women in GPT get a lot of support with their work.

Elena enjoys the challenge electronics provides, and would like to develop her knowledge so that she can stay up to date with new electronic products. She does not think her children (when she has them) will benefit particularly from her electronics knowledge, because they may choose some other field. She thinks women have a great future in electronics.

Pauline Powell is an Assistant Drawing Office Manager with GPT. She has been with GPT for the last four years, specialising in printed circuit board design. As soon as she left secondary school in England 39 years ago, she went to train as a Telephone Operator with Telephone House.

Pauline believes her career in electronics started in 1962, when she went to work for Hewlett Packard as a production worker, wiring and soldering electronic equipment. There she became a Production Supervisor and then a Training Officer, finally moving into the R&D laboratory to train as a PCB designer. She was with HP for 13 years. Later she worked as an Assistant Production Manager with Fortronic and also worked for Chessells.

Prior to coming to Australia, Pauline worked for Marconi Space and Defence for 13 years. She joined GPT as a Draughtsperson/PCB Designer and now at her present position she is responsible for the documentation of company drawings, procedures etc. She attributes her career success to the wide knowledge of electronics she has gathered over the years.

Pauline admits that devotion to her career may have taken some or her attention away from her children, and she says she's grateful for their patience and understanding. She may not have been too bad a mother, though, considering that one of her daughters has a PhD in Microbiology.

Pauline says that her own mother, even though she may not have prepared her for a career, did prepare her for life.

Helen Wong is a Hardware Engineer with GPT. She graduated from the University of New South Wales with an Electrical Engineering degree a year ago, specialising in VLSI design. Now she is working on PABX electronics, which involves designing or redesigning electronic circuits, building and testing prototypes. She is also studying for a master's degree at the university.

Helen says she wasn't aware of any discrimination at the university, except for an occasional comment from her classmates that as a female she was getting preferential treatment. She didn't let that bother her, though, because she didn't think her lecturers were really treating her any differently.

At work, if anything bothers her she talks to her workmates directly and says they are always receptive. Helen's career ambition is to become an R&D manager.

Helen showed interest in mechanical as well as electrical things from her early teens. She has repaired a vacuum cleaner, unclogged a refrigerator, pulled apart and repaired a fish tank pump and even fixed water taps around the house. Even now she repairs instruments and builds projects during her spare time. Her husband is proud of her achievements.

Helen thinks electronics is different from other engineering fields, because physically it is dealing with smaller scale work. She derives most enjoyment out of her work when an actual design is put into application. She believes that more women should be involved with electronics.

Therese O'Sullivan is a Test Engineer with GPT. She obtained a degree in Electronic Engineering from the National Institution of Higher Education in Limerick, Ireland five years ago. Before coming to Australia she worked as a Development Engineer with Delta Communications, introducing new products to the factory floor via the test department.

Therese has been with the PABX division of GPT for the last 10 months, and is responsible for all aspects of testing, from PCB level to system level. She is developing new tests and improving the existing test structure and plan. She says that the engineering degree she has provides a very good technical basis for the job, and that without this electronics knowledge she would not be in this job.

Therese has two brothers who are engineers, one of them also being an electronics engineer. While she was growing up she followed the latter into the family workshop and learned whatever he was doing. She believes that girls as well as boys should be taught electronics at school, at an earlier age, and also believes that the experiences of the women already in the field will be beneficial to future generations – because a path is being made for them.

Therese sees that unlike the other engineering fields there is not much 'stigma' associated with electronics, because it is relatively new. She says that she is getting a lot of support from her colleagues. This is very encouraging, because she is very new to this country. She would like to thank her parents and former classmates at the university for her achievements so far.

Carol Moreland is Product Centre Manager for GPT. She has plenty of qualifications, some of which she does not want to disclose. She obtained her Bachelor of Science in Electrical Engineering from the University of New Mexico, USA some 12 years ago, supported during her engineering course on a basketball scholarship.

Studying for the degree was effortless for her – she was one of those students who left the tape recorder on in the class and went out to do something else in the meantime. She was popular enough with classmates for them to turn off the recorder at the end of the lecture and return it to her.

While Carol was in the United States she worked for IBM, where she did computer design; Schlumberger Oil Field Services, where she did oil well analysis through cable communications; Aerospace Corporation, where she did consulting to the US Air Force on satellite projects (radio communication con-

Carol Moreland

trol); and Boeing, where she developed electronic control systems.

In Australia, Carol has worked for AWA's Telephone Section (which later became Exicom), doing small business system telephone design and modifications. At GPT she is involved in technical management of payphone section design and modifications. She organizes tasks related to electronic projects; schedules and plans new projects; troubleshoots problems in electrical products, both in the development phase and as they effect production; she also delegates employees to tasks and follows progress.

Carol's 'American spirit' shows in her admission that she has contacted the Human Rights Commission on issues relating to possible discrimination and harassment (but not at GPT). I have interviewed women from seven different countries, yet Carol was the only one who admitted to seeking this kind of advice. Either the others have been very lucky, or they are for some reason unwilling to seek advice when problems arise.

Carol has a workshop of her own at home. She displayed interest in electronics even during her early childhood, which was further developed during her teenage years. Nowadays she 'tinkers' about the house a fair bit. Her career ambition is to become the Managing Director of a large corporation. She is presently working towards a master's degree in Business Administration.

Summarising

It seems clear from the people I've talked to so far that the Australian electronics industry offers quite a range of opportunities for women, and at most levels. The women I interviewed are involved in design, manufacture and management, and seem to be happy and confident about both their achievements and career prospects.

Whether or not it's as easy for women to take advantage of the opportunities, as for men, is of course another question. It seems unlikely, because of the differing emphasis still evident in our educational systems. However the steadily growing ranks of women in the industry show that more and more, women are prepared to accept the challenge.

Looking more closely, a few trends are evident. At present there do seem to be fewer women working at the middle 'trade and technician' levels of the industry, than at either the process worker or engineer levels. It's not exactly clear why this is so, but perhaps it's at these middle 'hands-on' levels that women are facing the greatest difficulties. I'm proposing to do some more research in this area, but in the meantime I'd be interested in comments from readers.

Another noticeable trend is for women engineers to be found specialising more in areas of *software* design and development, rather than in hardware. Again one can speculate as to why this is so; I suspect myself that it may be because software is a newer and more rapidly changing field, with more opportunities and fewer established 'traditions'.

Are women working in electronics subject to discrimination and sexual harassment? Most of the women I interviewed claimed this wasn't a problem. But in one or two cases, I got the distinct impression that although there *had* been problems, the woman concerned had chosen not to 'make a fuss' or make any official complaints, in case this might prejudice either their current job or future career. This area also seems to need further investigation.

On the whole, though, it seems that there might be fewer problems and more opportunities for women in electronics, than in other industries. In such a rapidly changing field there is certainly a need for more trained people at all levels, and employers seem just as interested in filling the positions with women as men – providing they have the appropriate qualifications and experience.

All we need to do is change our educational systems, so they encourage more girls to choose electronics as a career – and provide them with the foundation of subjects so that they can make the choice. But I suppose how we achieve *that* is another question!

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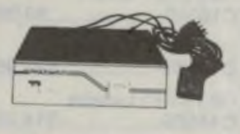

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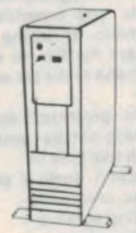

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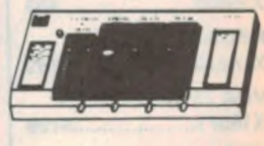

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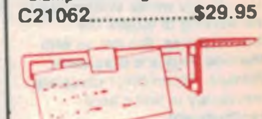

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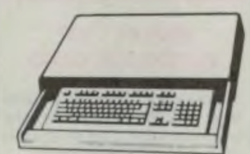

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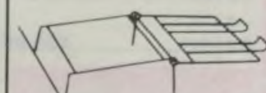

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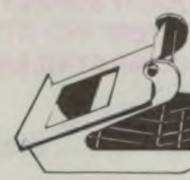

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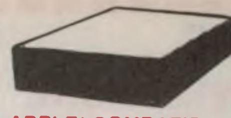

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- IBM* AT* compatible

Cat C11906 .... $225

3½" 1 M/BYTE DRIVE
- 720K formatted
- Double sided, double density
- 5¼" mounted

Cat C11909 .... $269

3½" 2 M/BYTE DRIVE
- 1.44 M/Byte formatted
- Double sided, double density
- 5¼" mounted

Cat C11911 .... $299

20 M/BYTE HARD DISK

- Drive with controller card, IBM* compatible, 3 month warranty

X20010............only $499

40 M/BYTE VOICE COIL HARD DISK

- IBM* compatible, 28 msec access, 3 month warranty

Without controller...$895

80 M/BYTE VOICE COIL HARD DISK

- IBM* compatible, 25 msec access, 3 month warranty

Without controller.$1,495

330 M/BYTE VOICE COIL HARD DISK

- IBM* compatible, 18 msec access, ESDI, 3 month warranty

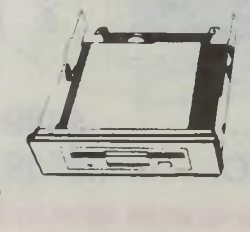
Without controller.$2,995

"SUPER AMAZING SPECIAL"
3 1/2" DRIVE KIT

- JAPANESE 3.5" 1.44/1.2/720/360 drive
- 5 1/4" Mounting bracket
- Power supply adapter
- Floppy Disk controller card which controls 1.44/1.2/720/360 drives
- Cable adapter

Complete instructions to install a 3.5" drive in your existing computer.

.......................ONLY $355



★★★★★★★★★★

VGA 14" COLOUR MONITOR

FEATURES:
- High resolution CRT.
- With tilt/swivel base.
- Used for VGA card.

SPECIFICATIONS:
- Picture tube:
  a. Size and Deflection: 14 inch, 90 degree deflection
  b. Dot Pitch : 0.31
  c. Phosphor : P22
- Input Connector: 15p D-Type
- Input Singal:
  a. Analog video input
- Display Colours: 256. colours
- Video bandwidth: 40 MHz
- Resolution:
  31 KHz: 720 x 480 (Max.)
  35 KHz: 800 x 600/ 1024 x 768 (Max.)

X14530.....................$695

JUKO MINI XT 10MHZ MOTHERBOARD

(NEST N3)

DIMENSIONS:
212X 217mm

SPECIFICATIONS:
- 8 bit high speed CPU either 8086 or V30
- 3 speed CPU selectable
- Support 8087 coprocessor
- Dynamic bus speed control
- 8 I/O slots
- 8 interrupt channels
- 3 DMA channels
- Parity check enable/ disable by jumper selection
- 10MHz 0 wait state memory access
- Memory configuration: 256K 4 DRAM (1 M/ 640K /512K on board)
- Parity check selectable
- Speed: 4.77/ 7.16/ 10MHz hardware/ Software selectable.

X18034.....................$149

ROD IRVING ELECTRONICS

"NEW"

AUTOMATIC TELEPHONE ANSWER/ CALL CARD

TURN YOUR IBM* PC, XT, AT INTO A FULLY FUNCTIONAL ANSWERING MACHINE!!!

- A Sophisticated Voice coil mail system
- Auto answering / Dialing
- 100 voice mail boxes
- Password protection
- Message mailing
- Auto redialing
- Beeperless remote control
- Toll saver
- Call screening
- Electronic phone book
- Works in background
- Menu driven software
- Simple and concise operation

Traditional telephone answering machines are obsolete with the release of the NEW Voice Mail Card.
Not only can this card turn your computer into a 24 hour personal receptionist, but can answer with different phone messages for particular callers.

X19084..........ONLY $245

"NEW"

ONSIGHT VIDEO AND AUDIO/ VIDEO MONOTORING SYSTEMS

DEPENDING ON THE CAMERA'S PLACEMENT, YOU CAN SEE AND/ OR HEAR IF YOUR CHILD IS AWAKE, SEE AND TALK WITH THE PERSON AT THE FRONT DOOR, OR SEE IF SOMEONE IS IN THE POOL.
WITH ITS BUILT IN INTERCOM, THE VM200 ONSIGHT LETS YOU CONVERSE WITH THE PEOPLE IN THE ROOM WHERE THE CAMERA IS MOUNTED.
OPTIONAL CAMERA'S, MONITORS, AND SWITCHERS ALLOWS YOU TO MONITOR SEVERAL LOCATIONS AT ONCE.

VIDEO ONLY..................$489
AUDIO / VIDEO............$589

PRINTER PAPER

COMPUTER PAPER

Quality paper at a low price!
2,000 sheets of 60 gsm bond paper

- 11 x 9 1/2"

C21001......................$41

- 15 x 11"

C21011..................$59.95

POWER SUPPLIES

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

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

X11096 .... $129

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

DEC OUTPUT:
+5/16A, -5V 0.5A
+12V/ 5A -12V/ 0.5A

X11097 .... $199

PRINTERS

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...............$489.95

STAR NX1000 PRINTER

- 144 CPS Draft
- 36 Near Letter Quality

C22049......................$475

STAR NX1000C COLOUR PRINTER

- 120 C.P.S, Near letter quality
- Colours- Red, Violet, Blue, Green, Yellow, Orange, Black

C22045......................$695

DISK DRIVES

5 1/4" 360K COPAL DRIVE

500K unformated
IBM XT* compatible

C11901 .... $175

5 1/4" 1.2 M/BYTE COPAL DRIVE

1.6 M/Byte unformatted
IBM AT* compatible

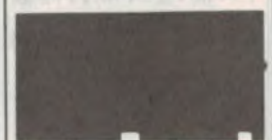
C11906 .... $225

EXTENSION CARD

IBM* PC*/ XT* EXTENSION CARD

This board 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 motherboard for easy access.
Standard IBM* PC*/ XT* bus edge connector.

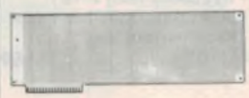
H19115 .... $54



IBM* PC*/ XT*/ AT* WIRE WRAPPING BOARD

This is a half sized wrapped board suitable for research and development.
- Standard IBM* PC*/ XT* bus edge connector
- Tinned plated through holes 2.54mm spacing
- 19.4cm x 10cm wire wrapping area.

H19130 .... $89.95



IBM* PC*/ XT* WIRE WRAPPING BOARD

H19117 .... $39.95

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 for expansion to other interfaces via ribbon cable.

H19120 .... $90

IBM* PC*/AT* DECODED I/O CARD

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

H19125 .... $84

COMPUTERS

IBM* XT* 640K RAM TURBO COMPATIBLE COMPUTER

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

640K RAM TURBO COMPATIBLE COMPUTER

2 x 360K Disk Drives, Multi-function Card, Colour Graphics, Disk Controller, 1 Serial, Parallel Port (Clock)......................$895

WITH 20 M/BYTE HARD DISK:
& single 360K Disk Drive..$1,195
& dual 360K Disk Drives...$1,395

WITH 40 M/BYTE HARD DISK:
& single 360K V.C. H.D......$1,575
& dual 360K V.C. H.D.........$1,725

BABY AT* COMPATIBLE COMPUTER! 2M/B RAM $1,695

- Final assembling and testing in Australia!
- 4 M/Byte Main Board, 2 M/Byte fitted
- 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.$1,995
With 40 M/Byte V.C. H.D. ..$2,125
With 80 M/Byte Hard Disk.$2,795

"PLEASE QUOTE THIS ADVERTISEMENT FOR THESE PRICES"

"PLEASE QUOTE THIS ADVERTISEMENT FOR THESE PRICES"

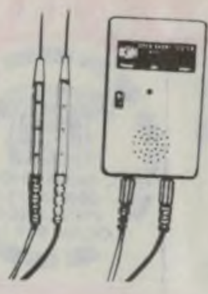
ROD IRVING ELECTRONICS

TEST EQUIPMENT

MULTIMETER (YF-100)

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

Q11264......................$69



SHORT TESTER

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

Q11276................$22.95

MULTIMETER (YF-3000)

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

Q11268.....................$110

LOGIC PULSER (LP-540H)

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

Q11274................$42.95

DIGITAL METER (YF-120)

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

Q11270................. $79.95

SAVE $15.00

MULTIMETER (YF-2100)

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

Q11266.....................$199

LOGIC PROBE (LP-2800)

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

Q11272................. $19.95

NEW CRO'S

20MHZ DUAL TRACE OSCILLOSCOPE

CRT DISPLAY
- 150mm rectangular

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

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

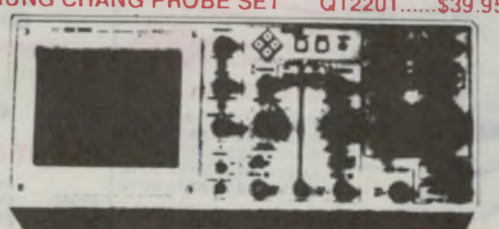
TRIGGERING
- Sensitivity Int: 1 Div or more
  Ext: 1Vp-p or more
- Source: INT, CH-B, LINE or EXT
- Triggering Level: Positive and Negative, continuously variable level; Pull for Auto
- Sync: AC, HF Rej, TV (each + or -) at TV Sync: TV-H (line) and TV-V (Frame) sync: are switched automatically by SWEEP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

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

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

$695.00

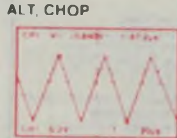
HUNG CHANG PROBE SET Q12201......$39.95



40MHZ READ-OUT OSCILLOSCOPE

CRT DISPLAY
- 150mm rectangular

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



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

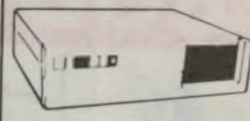
SAVE $200

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

~~$1,695~~

$1,495

CASES



IBM* XT COMPATIBLE CASE WITH AT* STYLING

Features security key switch, 8 slots, and mounting accessories
Size: 490(W) x 145(H) x 400(D)
X11091........................$99

BABY AT* STYLE COMPUTER CASING

Small footprint. Features security key switch, 8 slots and mounting accessories
Size: 360(W) x175(H) x405(D)mm
X11093.......................$99

rie

ROD IRVING ELECTRONICS

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Stanmore 2048
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Phone: (03) 663 6151

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Fax: (03) 543 2648

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Phone (03) 543 2166 (3 lines)
Fax: (03) 543 2648

ORDER HOTLINE 008 33 5757 (TOLL FREE)
STRICTLY ORDERS ONLY

LOCAL ORDERS & INQUIRES (03) 543 7877

POSTAGE RATES:

$1 - $9.99	$3.00
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$25 - $49.99	$4.50
$50 - $99.99	$6.00
$100 +	FREE

The above postage rates are for basic postage only. Road Freight, bulky and fragile items will be charged at different rates.

Errors and omissions excepted. Prices and specifications subject to change

VISA MasterCard

SAVINGS + RANGE + SERVICE = ROD IRVING ELECTRONICS!

ROD IRVING ELECTRONICS

RS232 WIRING ADAPTOR BOX

- Male to female
- 25 Detachable plug on leads
- 2 mini jumpers
- Ideal for experimenting or temporary connections

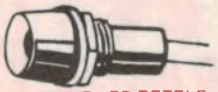
Cat. X15665

Only $19.95

CAR ANTENNA BOOSTER

- In-line instalation
- 12V boosts 100%

Cat. A12073 $7.95



CHROME LED BEZELS

9mm hole, available 3 colours

Cat No	Description	Price
S14030	Red	$1.20
S14032	Green	$1.45
S14034	Yellow	$1.45

HEATSINK COMPOUND

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

Cat. H11800 (10g) $2.00
Cat. H11810 (150g) $14.95

CODE KEY PAD

- Telephone type digital keypad
- Four digit, changeable code
- Over 5000 possible combinations
- Power consumption: 5mA standby, 50mA alarm
- Two sector LED and 1 arm LED
- Wrong number lockout
- 12V DC operation
- Relay output
- Panic button
- Normally open tamper switch
- Dimensions: 145 x 100 x 37mm
- ACP3 compatible

Cat. A13014 R.R.P. $79.95
SPECIAL, ONLY $69.95

MINIATURE BUZZER

5-15V White or black

Cat C15062	1-9	10+
	$2.50	$2.25

2¼" MINI SPEAKERS (57mm)

Cat No.	1-9	10+
C10610	$1.95	$1.75

CRYSTAL LOCKED WIRELESS MICROPHONE AND RECIEVER

MICROPHONE SPECIFICATIONS:
Transmitting Frequency: 37.1MHz
Transmitting System: crystal oscillation
Microphone: Electret condenser
Power Supply: 9V battery
Range: 300 feet in open field
Dimensions: 185 x 27 x 38mm
Weight: 160 grams
RECIEVER SPECIFICATIONS:
Recieving Freq: 37.1MHz
Output Level: 30mV (maximum)
Recieving System: Super heterodyne crystal oscillation
Power Supply: 9V Battery or 9V DC power adapter
Volume control
Tuning LED
Dimensions: 115 x 32 x 44mm
Weight: 220 grams

Cat. A10452 R.R.P. $113
Our price, $99

ULTRASONIC TRANSDUCERS

Designed to transmit at 40kHz (L19990) and receive at 40kHz (L19991) with up to 20V I/P on the transmitter. These units can't be heard and so are ideal for TV remote controls, water level detectors, burgalar alarms, motion detectors and information carriers as they can be either pulsed or used in the continuous wave mode.
Full specifications below for design purposes.
Maximum Input Voltage: 20V rms
Centre Frequency (kHz): 40 ± 1.0
Sound Pressure Level 10V RMS 110dB min
Sensitivity (dB/v/ubar) min -65 min
Bandwidth (kHz)
Transmit: 4.0 (at 100dB)
Receiver: 5.0 (at -73dB)
Impedance
Transmit: 500
Receiver: 5000

Cat. L19990 (Transmitter) $4.95
Cat. L19991 (Receiver) $4.95

RS232 BREAK OUT BOX

A simple way of monitoring RS232 interface lead activity. Interface powered, pocket size for circuit testing, monitoring and patching. 10 signal powered LED's and 2 spares. 24 switches enables you to break out circuits or reconfigure and patch any or all the 24 active positions.

SPECIFICATIONS:
Connectors: DB25 plug on 80mm ribbon cable and DB25 socket
Indicators: Tricolour LED's for TD, RD, RTS, CTS, DSR, CD, TC, RC, DTR (E)TC
Jumper Wires: 20 tinned end pieces
Power: Interface power
Enclosure: Black, high impact plastic
Dimensions: 85 x 95 x 30mm

X15700 $94.95

FOOT SWITCHES

- Momentary or on off models to choose from
- Cord length 2.5 metres
- 6.3mm plug

A17000 Momentary operation
A17005 Push On Off operation
each $19.95

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 50-0/50uA	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

TOGGLE SWITCHES

Cat No	Descript	1-9	10+
S11010	S.P.D.T.	$0.90	$0.80
S11020	D.P.D.T.	$1.10	$1.00

CENTRONICS GENDER CHANGERS

- Female to Female
- Saves modifying or replacing non-mating Centronics cables
- All 36 pins wired straight through

Cat. X15663 **Male to Male**
Cat. X15661 **Male to Female**
Cat. X15664 **Female to Female**

Normally $33.95
Only $24.95

QUALITY 3mm LEDS

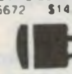
Cat. No.	Col.	1-9	10+	100+
Z10140	Red	$0.15	$0.12	$0.10
Z10141	Grn	$0.20	$0.15	$0.12
Z10143	Ylw	$0.20	$0.15	$0.12
Z10145	Ora	$0.20	$0.15	$0.12

QUALITY 5mm LEDS

Cat. No.	Col.	1-9	10+	100+
Z10150	Red	$0.10	$0.09	$0.08
Z10151	Grn	$0.15	$0.12	$0.10
Z10152	Ylw	$0.15	$0.12	$0.10

ECONOMY TRANSFORMERS

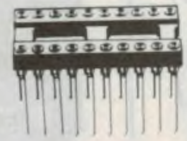
	1-9	10
2155 240V 6-15V 1A Cat. M12155	$9.95	$8.95
2156 240V 6-15V 2A Cat. M12156	$14.95	$13.95
2840 240V 9V CT Cat. M12840	$5.95	$4.95
2851 240V 12-6V CT 150mA Cat. M12851	$5.95	$5.50
2860 240V 15V CT 250mA Cat. M12860	$5.95	$4.95
6672 240V 15-30V 1A tapped Cat. M16672	$14.95	$13.95



ELECTRET MIC INSERTS

With pins for easy board insertion

Cat. C10170	1-9	10+	100+
	$1.20	$1.00	$0.90



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

MINIATURE HOBBY VICE

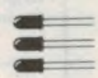
- Lever operated suction grip base for instant mounting and portability
- Mounts on smooth non-porous surfaces
- Ideal for holding components and other small/light objects

Cat. T12458 $6.95

PC BOARD HOLDER

Better than an extra pair of hands! a must for all PCB work

Cat. T12444 $9.95



FLASHING LEADS

Red, 5mm

	1-10	10+
Z10159	$1.10	$1.00

MOSFET SPECIALS

	1-9	10+
2SJ49	$7.50	$7.00
2SJ56	$10.00	$9.50
2SK134	$6.90	$6.50
2SK176	$9.50	$8.90

8087 CHIPS

Genuine Intel chips with manual and data sheets packed in boxes!

8087-3	(4.77MHZ)	$175
8087-2	(8MHZ)	$265
8087-1	(10MHZ)	$395
80287-6	(6MHZ)	$295
80287-8	(8MHZ)	$395
80287-10	(10MHZ)	$495
80387-16	(16MHZ)	$795
80387-20	(20MHZ)	$895
80387-25	(25MHZ)	$1,095

MEMORY

	1-9	10+
1 M/B 80NS	$24.95	$22.95
4164-15	$2.95	$2.75
4164-12	$3.95	$3.50
41256-15	$7.50	$7.00
41256-12	$8.50	$8.00
41256-10	$9.50	$9.00
41256-08	$9.90	$9.50

DATA TRANSFER SWITCHES

If you have two or four compatible devices that need to share a third or fifth, then these inexpensive data transfer switches will save you the time and hassle of constantly changing cables and leads around.

- No power required
- Speed and code transparent
- Two/Four position rotary switch on front panel
- Three/Five interface connections on rear panel
- Switch comes standard with female connector

2 WAY RS232 X19120 ONLY $49
4 WAY RS232 X19125 ONLY $59
2 WAY Centronics X19130 ONLY $49
4 WAY Centronics X19135 ONLY $59

DB25 CONNECTOR SPECIALS!

		1-9	10+
P10884	DE9P	$2.50	$1.90
P10885	DE9S	$2.75	$1.90
P10890	DA15P	$1.00	$0.80
P10891	DA15S	$1.00	$0.80
P10892	DA15C	$2.50	$1.90
P10894	DA15P	$2.50	$1.80
P10895	DA15S	$1.00	$0.80
P10900	DB25P	$1.00	$0.80
P10901	DB25S	$1.00	$0.80
P10902	DB25C	$1.00	$0.80
P10904	DB25P	$2.50	$1.90
P10905	DB25S	$2.50	$1.90

MIDRANGE HORNS

Use these quality, all metal Piezo tweeters for great top end sound in your band speakers, disco sound system, etc. Rated at 30 watts RMS in a system they will handle over 100 watts RMS.
Two sizes to choose from:
Size: 4" x 10½"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 1.5kHz - 14 kHz
Dimensions: 102 x 267 x 177mm
Cat. C92082 Normally $49.95
This month only $39.95

Size: 3" x 7"
Impedance: 8 ohms
Rating: 30 watts RMS
Response: 2kHz - 15 kHz
Dimensions: 76 x 177 x 145mm
Cat. C92084 Normally $29.95
This month only $24.95

SUPER HORN TWEETER

- Requires no crossover and handles up to 100W
- Sensitivity: 100dB/0.5m
- Frequency Response: 3kHz-30kHz
- Impedance: 8 OHMS
- Size 96mm diameter

C12102 Normally $12.95
SPECIAL, ONLY $9.95

10W HORN SPEAKERS

White durable plastic, 8 ohms

Cat. C12010 Normally $11.95
SPECIAL, ONLY $9.95

UTILITY BOXES

Plastic boxes with aluminium tops and available in four sizes. Very popular for projects and very economical!

H10101	150x90x50mm	$3.25
H10102	195x113x60mm	$4.50
H10103	130x68x41mm	$2.75
H10105	83x54x28mm	$1.95
H10110	120x65x38mm	$2.95
H10112	120x65x38mm (Metal lid)	$2.95

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 $8.95

FREE STANDING, FOLD UP MAGNIFIER

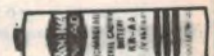
An economically priced "hands free" magnifier, lets you take care of all those tricky fine detailed jobs so often encountered in electronics, or any of many other practical uses such as home, work, hobbies etc.

Cat. T10020 Normally $14.95
SPECIAL, ONLY $12.95

UNIVERSAL BATTERY CHARGER AND TESTER

Save money on expensive batteries with this universal battery charger. Features include meter tester and provisions for D, C, AA, AAA, N, button and cell batteries, 9V and 6V (square types). Comes complete with detailed instructions.

Cat. M23533 $29.95



NICADS!

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

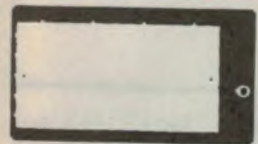
Size	Desc.	1-9	10+	100+
AA	450 mA.H.	$2.95	$2.75	$2.50
C	1.2 A.H.	$9.95	$9.50	$8.95
D	1.2 A.H.	$9.95	$9.50	$8.95

PLEASE QUOTE THIS ADVERTISEMENT FOR THESE PRICES

GIFT VOUCHERS AVAILABLE!

WE HAVE OVER 6,000 ITEMS AVAILABLE

GENERAL COMPONENTS



BREAD BOARDS

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

- 100 holes
P11000....................$2.75
- 640 + 100 holes
P11007..................$14.95
- 1280 + 100 holes
P11010.................$26.95
- 2560 + 700 holes
P11018.................$69.95

HEAT SHRINK TUBING

- Price per metre

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

GOLD INSERT LOW PROFILE IC SOCKETS

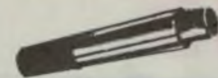
- Gold machined pins
- Extremely high quality
- Anti-wicking
- Ideal for professional use or where field service components is required.

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

LOW PROFILE IC SOCKETS

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

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



CANNON TYPE CONNECTORS AT SPECIAL PRICES !!

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

12V DC FANS

80 x 80 x 25.4mm
12V DC, 1.7 Watt, 0.14 Amps
T12469.................$12.95
10+ fans only $11.95 each

FANS

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

240V	4 5/8"	T12461	$14.95
115V	4 5/8"	T12463	$14.95
240V	3 1/2"	T12465	$14.95
115V	3 1/2"	T12467	$14.95

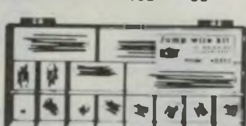
10+ fans (mixed) only $13.95 each

RECTANGULAR LEDS

	1-9	10-99	100+
RED	20c	15c	9c
GREEN	20c	15c	9c
YELLOW	20c	15c	9c
ORANGE	20c	15c	9c

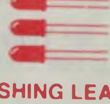
BUY IN BULK & SAVE

	10-99	100+
BC547	10c	8c
BC548	10c	8c
BC549	10c	8c
BC557	10c	8c
BC558	10c	8c
BC559	10c	8c



JUMP WIRE KIT (KS-350)

Contains:
14 kinds of length from 0.1" to 5" with different colors
Q11278...................$19.95



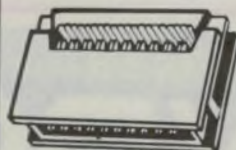
FLASHING LEADS

- Red, 5mm

	1-10	10+
Z10159	$1.10	$1.00

INCREDIBLE IC SPECIALS !

	1-9	10-99
1488	60	50
1489	60	50
LM301	60	50
LM308	60	50
LM3086	60	50
7812UC	60	55
7815UC	70	60
7905UC	70	60
7912UC	70	65
7915UC	70	65
LM339	60	50
LM348	$1.00	90
LM3915	$2.80	$2.50
LM394CH	$3.90	$3.70
LM396K	$16.50	$15.00
5534AN	$1.50	$1.40
8212	$1.50	$1.20
8255	$2.50	$2.00
81LS95	$1.60	$1.50
6845	$9.00	$8.00
7404	40	35
7406	25	20
7407	50	45
7416	50	40
7445	90	80
7474	50	45
7497	$1.50	$1.20
74123	50	40
74154	$1.20	$1.00
74LS74	50	40
74LS162	50	45
74LS169	$1.00	90
74LS195	60	50
74LS243	$1.20	$1.10
74LS273	80	70
74LS293	60	55
74LS393	70	60



CARD EDGE CONNECTORS

1" SPACING

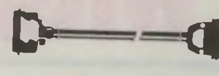
		10+	100+
P12060	10 pin	$3.95	$3.50
P12062	20 pin	$4.25	$3.75
P12064	26 pin	$4.50	$3.95
P12066	34 pin	$4.95	$3.95
P12068	40 pin	$5.95	$4.95
P12070	50 pin	$6.95	$5.95

CRYSTALS

1/2 PRICE OFF ALL CRYSTALS

Y11000	1MHz	$11.50
Y11003	1.8432MHz	$7.50
Y11005	2MHz	$6.90
Y11007	2.3040 MHz	$6.50
Y11008	2.4576 MHz	$6.50
Y11009	2.7648 MHz	[illegible]
Y11010	3MHz	[illegible]
Y11015	3.5795[illegible]	[illegible]
Y11018	3.9[illegible]	[illegible]
Y11020	[illegible]	[illegible]
Y11022	[illegible]	$3.90
Y11023	[illegible]	$4.90
Y11[illegible]	[illegible] MHz	$4.90
Y11[illegible]	[illegible].75 MHz	$4.90
Y11[illegible]	4.9152 MHz	$6.90
Y110[illegible]	4.9562 MHz	$4.90
Y11030	5MHz	$4.90
Y11033	5.0688MHz	$4.90
Y11042	6.144 MHz	$4.90
Y11050	8.00 MHz	$4.90
Y11055	8.86723MHz	$4.90
Y11070	12.00 MHz	$4.90
Y11072	14.318 MHz	$4.90
Y11080	16.00 MHz	$4.90
Y11085	18.432 MHz	$4.90
Y11090	20.00 MHz	$4.90

LEADS



PRINTER LEAD

- Suits IBM* PC/XT, compatibles
- 25 pin "D" plug (computer end) to Centronics 36 pin plug
- 1.8 metres
P19029.................$14.95
- 3 metres
P19030.................$19.95
- 10 metres
P19034.................$39.95

CABLES

FLAT GREY RIBBON CABLE

- Flat cable for IDC connectors
- m = metre

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

COMPUTER CABLE

- Six conductor shielded computer interface cable
- m = metre

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

METEX 4500H MULTIMETER

10A, 4 1/2 digit multimeter with digital hold, transistor tester and audible continuity tester.

CHECK THESE FEATURES...
- Readout hold
- Transistor Tester
- 4 1/2 digit x 1/2"(H) LCD
- Audible continuity tester
- Quality set of probes
- Digital readout hold
- Built in tilting bail
- Instruction manual
- hFE test
- Diode Tester
- Vinyl case

Q91560 .... Normally $175
Special, only $159

METEX 3530 MULTIMETER

Compact, rugged, battery operated hand held 3 1/2 digit multimeter

Features
- 1/2" high contrast LCD
- Automatic over-range indication with the "1" displayed
- Automatic polarity indication on DC ranges
- Capacitance measurements to 20uF
- Diode testing with 1 mA fixed current
- Audible Continuity Test
- Transistor hFE Test

SPECIFICATIONS
Maximum Display: 1999 counts 3 1/2 digit type with automatic polarity indication
Indication Method: LCD display
Measuring Method: Dual-slope in A-D converter system
Over-range Indication: "1" Figure only in the display
Temperature Ranges: Operating 0-C to +40-C
Power Supply: one 9 volt battery (006P or FC-1 type of equivalent)

Cat. Q91540 .... Normally $139
SPECIAL $109

NEWS HIGHLIGHTS

'SUPERCOMPUTER ON A CHIP'

TRW and Motorola have built the world's first multi-million-device SuperChip, the two companies announced recently. The team has fabricated, tested and proved functional the CPUAX SuperChip, an advanced microelectronic chip containing approximately four million 0.5-micron devices and able to perform 200 million floating point operations per second.

"Two hundred million operations per second mean the CPUAX is the computational equivalent of some supercomputers that fill an entire room, require elaborate refrigeration systems, and weigh several tons." reports Dr Thomas A Zimmerman, Director of TRW VHSIC programs.

In fully packaged form, the CPUAX is 2.1 inches square and weighs 1.5 ounces.

When used in conjunction with the TRW-Motorola Universal Processor (UP) – a tiny 'satellite' chip of 36,000 devices which tests, monitors, and con-

figures the on-chip assets of the CPUAX – the CPUAX is able to repair itself. "The self-repair abilities of the CPUAX make it possible to work around the inevitable flaws that occur during fabrication," states Dr Zimmerman. "Also, they enable the CPUAX to repair itself should any failures occur on the chip during operation."

Short for "Central Processing Unit – Arithmetic Extended," the CPUAX was fabricated by Motorola at its Advanced Products Research and Development Laboratory in Austin, Texas, using a proprietary 0.5-micron CMOS process.

Dr Charles S Meyer, Motorola's VHSIC program manager, pointed out that "the half-micro process was extremely challenging since it required lithography at the limits of current optical technology on a very large die and employed advanced process modules, such as triple-level metal and salicide." Motorola was also the primary contact for the reticle subcontractor, DuPoint Photomasks Inc of Round Rock, Texas, USA.

The CPUAX is the finished product of the TRW-Motorola contractor team's effort on the US Department of Defense's advanced Very High Speed Integrated Circuits (VHSIC) Phase 2 program. It represents the culmination of TRW and Motorola's ten-year-long role in all three phases of the VHSIC program. In the final phase, the TRW-Motorola team built a chip 150 times as complex as those of the program's first phase.

PCB'S WITHOUT CFC'S

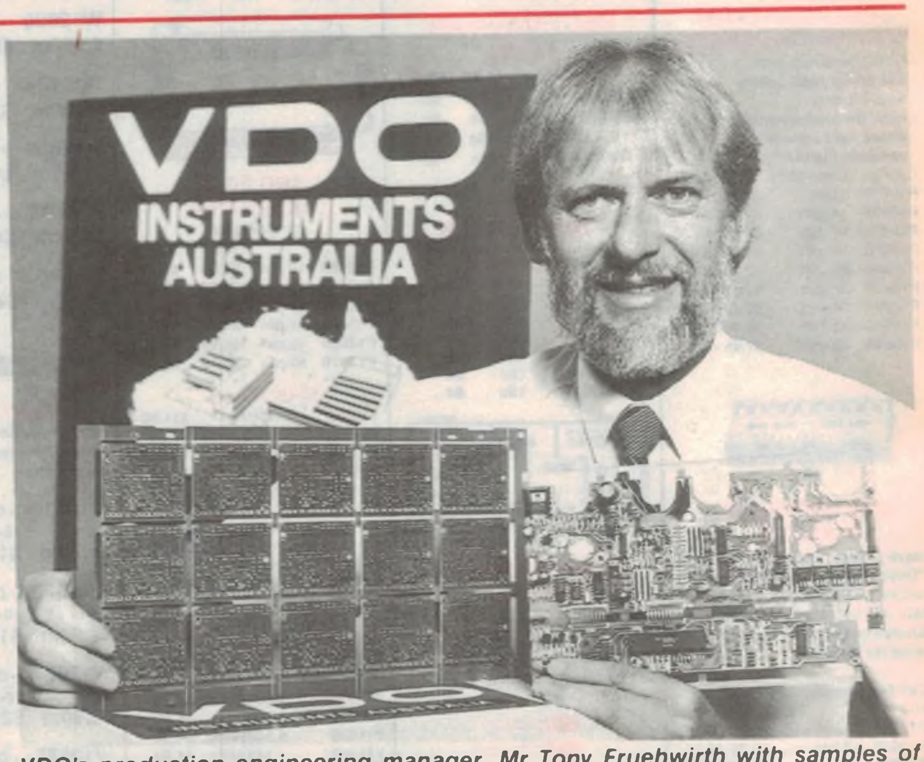
Electronic instrument manufacturer VDO Instruments, claims to have stolen a march on the Australian electronics industry by developing an environmentally friendly process for the manufacture of its circuit boards.

The company is apparently the largest supplier of original equipment automotive instruments in Australia, with more than 70% of the local market. All of the instruments supplied by VDO use circuit boards made by the company at its Victorian manufacturing complex.

VDO has now purchased a system (the first in Australia) that requires no chlorofluorocarbons (CFCs) to clean the circuit board assemblies after soldering.

The key to the success of the new process is the use of a nitrogen-filled soldering chamber, which eliminates all traces of oxygen. The solder is kept completely free of any impurities, and as a result, the boards need no cleaning afterwards.

VDO's new system is state of the art with microprocessor control of all important parameters.



VDO's production engineering manager, Mr Tony Fruehwirth with samples of the first circuit boards manufactured by the company using a chlorofluorocarbon (CFC) free process.

INTEL TO BUILD PLANT IN IRELAND

After investigating a number of possible sites for its main European manufacturing plant, well-known US chip maker Intel Corporation has decided on Leixlip, in County Kindare, Ireland. Over a 10-year period the firm is to spend IR£300 million in capital investment, and a further IR£250 million in research, development and training.

The first phase of development will apparently be a systems manufacturing plant making computers on an OEM basis. This will be followed by a wafer fabrication plant for VLSI and high-volume devices, followed by a finishing and test centre.

The plant is expected to employ over a 1000 people by 1995, rising to 2600 on completion. Approximately 25% of these will be graduates.

INNOVATION IN ELECTRONICS TRAINING

Victoria's Outer Easter College of TAFE in Wantirna South is taking an innovative approach to electronics training. The college is the sole Australian agent for an American system (developed by the College of San Mateo) of interactive electronics training, which uses technology to teach technology.

The system complements electronics theory with hands-on experience. It adds to theory training by using an interactive video, microcomputer and a range of test equipment typically found in the workplace. It can teach electronics at a fundamental and advanced level including DC and AC electronics, semiconductor devices and digital electronics.

Following the system's successful incorporation with electronics training at OECT's Wantirna and Lilydale campuses, it has also been developed as part of a training program for NEC (Australia). A workstation has been located at NEC's Mulgrave manufacturing plant. The workstation comprising video, microcomputer and test equipment can be used by employees around the clock, to accommodate various production shifts. NEC's Training and Development Manager, John Ring, sees this as a way of converting employers who have interest and aptitude but no experience, into skilled technicians in electronics.

Further details of the training system are available from Kevin van Leeuwen or Pat Jones at Outer Eastern College of TAFE on (03) 881 8888.

NEWS BRIEFS

- GSA Technology, the voice security company, has acquired the data encription business of Ran Data Corporation. The merged business, called ***GSA Ran Data***, specialises in security for telephones, facsimiles and computers. It is located at 1 Hall Street, Hawthorn 3133, phone (03) 822 7858.
- ***George Brown Group*** has been appointed as distributor for both the French company Thompson LCC and the Californian company Waferscale Integration.
- European office automation and computer companies ***Triumph-Adler*** and ***Olivetti Office*** have amalgamated in Australia.
- Tasmanian-based ***Critec*** has become the distributor for America's IPM range of uninterruptible power supplies (UPS), which will compliment the company's Australian designed and manufactured products. For further information, contact them at PO Box 536, Hobart 7001 or phone (002) 73 0066.
- Australian data communications specialist ***Datacraft*** has brought to 17 the number of its offices in the Asia-Pacific region, by establishing a new subsidiary in Thailand.
- ***Anitech's*** controls, instruments and components divisions have been acquired by ***Bell-IRH***.
- 'The Competitive Edge' is the theme for Australia's ***International Engineering Exhibition***, which will be held at RAS Showground in Sydney from 21-25 May. For further information phone (02) 332 3233.
- A conference called ***Oceans Australia 1990*** will be held on 10-11 May at the World Congress Centre, Melbourne. The topics include ship building, remote sensing and other aspects of marine engineering. For further information contact the Marine Section of DITAC – phone (062) 761 205.
- The Power and Switchgear division of ***Utilux*** has moved from Kingsgrove to Badgally Road, Campbelltown. The firm's Industrial and Electronics division will remain at Kingsgrove, NSW.
- ***Soanar*** has moved its head office and warehouse complex from Box Hill to Maroondah Highway, North Croydon 3136.

NEC MAKING CELLULAR PHONES IN MEXICO

NEC Corporation is building a cellular-phone production plant in Mexico. The new company, Technologies NEC de Mexico, was established as the subsidiary of fully-owned NEC de Mexico, and NEC affiliate which currently produces transmission and other communication equipment.

After beginning production in this month, the new company will supply cellular phones to Central South America including Mexico, as well as the US and Canada, and will produce pagers in October.

ERICSSON WINS $173M TELECOM CONTRACTS

Ericsson Australia has been awarded two large contracts, worth $173 million, from Telecom Australia for the national cellular mobile network and the public telephone network.

The $150 million public telephone contract covers AXE digital equipment for new local, transit and trunk exchanges, as well as already existing exchanges in all states.

The AXE equipment will be manufactured at Ericsson's Broadmeadows facilities in Melbourne for delivery this year and in 1991.

The $23 million mobile telephone contract is for radio base station equipment.

STANILITE TO MAKE RADIOS FOR ANZAC FRIGATES

AMECON, prime contractor for the ANZAC frigate project, has awarded a major sub-contract to Australian electronics firm Stanilite Pacific for the supply of internal and external communications equipment. The contract is worth over $100 million, and will involve the employment by Stanilite of some 90 additional staff at its Sydney headquarters.

The contract covers the design and fitout of radio communications, computerised control systems, data links and telephones for the 10 MEKO-designed frigates being made for the Australian and New Zealand navies. Design of the equipment is a joint effort between Stanilite and West German communications company Hagenuk GmbH, which will share subsystems and design services.

NEWS

RAMTRON & NMBS TO DEVELOP 4Mb DRAMS

Ramtron Australia's US subsidiary Ramtron Corporation has expanded its October 1988 DRAM co-development alliance with NMB Semiconductor (NMBS) of Japan. The two firms are to develop a second generation of high speed CMOS 4-megabit (4-Mb) dynamic random access memories (DRAMs), 40 nanoseconds maximum access times, a low power standby mode with extended refresh times and space-saving 300 mil packaging. Ramtron will grant an exclusive manufacturing and sales licence to NMBS whilst retaining ownership of the product.

The new 4-Mb DRAMs will be sold worldwide exclusively by NMBS' recently formed joint venture with Intel Corporation, the world's market leader in microprocessors. The new joint venture, Intel NMBS Fabrication Company, will have available to it Intel's established worldwide sales force of 1500 people. The new 4-Mb DRAMs are expected to be made commercially available during the second half of 1990.

TV EQUALISATION SET TO PROCEED

Minister for Transport and Communications, Ralph Willis, said in late February that there would be change to the government's commercial television equalisation policy.

Mr Willis met regional commercial television broadcasters in December and agreed to consider a number of concerns raised by the broadcasters at the meeting.

"I have now considered their submission, and have also had discussions with representatives of the networks and other licensees involved in the equalisation program," Mr Willis said.

"By no means are all regional operators opposed to the Government's plans – indeed, as Townsville-based QTV has stated publicly, claims by a small number of regional television operators that the government's policy is threatening the viability of regional TV are wildly exaggerated."

"On the basis of all the information available to me, including the submission put at the December meeting, I see no requirement to change the policy."

FIRST COMBAT RADIOS DELIVERED

The Australian Defence Force (ADF) has accepted delivery of the first Australian-made RAVEN combat radio from the manufacturer, Plessey Australia, at a handover ceremony in Sydney.

RAVEN was officially presented to Major General Duncan Francis, Assistant Chief of the General Staff-Materiel, by Mr Edwin Matiuk, Chief Executive Officer of Plessey at a ceremony at Plessey's Meadowbank factory.

The RAVEN combat radio system was developed in conjunction with major subcontractor Plessey Defence Systems of the UK. Several thousand state-of-the-art RAVEN combat radios are being produced by Plessey following the transfer from Plessey Defence Systems of manufacturing technology.

The Australian Army, as the main user of the equipment is procuring RAVEN at a cost of approximately $400 million for itself and on behalf of the Royal Australian Navy and the Royal Australian Air Force. It will replace a number of different radios currently being used by the ADF, which are difficult and expensive to maintain.

RAVEN is one of the most technologically advanced combat radios available in the world today. It is a fully supported and integrated lightweight single channel radio system designed to provide a communication, security and electronic counter counter-measures capability on the modern battlefield. The system, which also offers significant export earning potential, will be issued to units of the ADF later this year.

AUST ASTRONOMERS TO USE HUBBLE 'SCOPE

Following a committment by the Australian Government to contribute $70,000 in funding over three years, Australian scientists have been allocated 5.5% of the total viewing time for the first year of operation of the USA's Hubble Space Telescope – which was due to be launched by NASA in April. Only the astronomers of the USA itself and the EEC have been allocated greater access to the telescope, which represents an investment of over US$2 billion by the US Government.

According to Barry Jones, Minister for Science, Customs and Small Business, the preference given to Australian astronomers results from the excellence of the research program proposed by the team, led by Dr Michael Dopita of Mount Stromlo and Siding Spring Observatories. The team is to use the telescope to investigate a broad range of topics in modern astrophysics.

The 11.3 tonne, 13 metre-long Hubble telescope will orbit above the Earth's atmosphere, and provide images of far greater clarity than those available from the largest terrestrial telescopes.

USA TO USE AUST COMPUTER TESTERS

An engineer at Prime Australia in Sydney has developed a device for tracing hard-to-find computer faults that has so impressed Prime's US parent, it has placed an initial order for 31 units for international distribution.

The devices, called Controller Activity Tracers (CATs), will be assembled for Prime Australia by Sydney company Qualitech, and will use PC boards from Sydney-based NuTech. Prime expected to fulfill the US$150,000 order by April.

Twelve of the CATs will go to Prime Inc in the US, with the remaining 19 shipped to Prime subsidiaries in Canada and Europe, including the UK, Germany, Italy, Holland and Norway.

Prime Australia believes CAT's ability to improve customer service productivity will lead to further export orders, especially after subsidiaries finish evaluating their first units.

VIATEL IS DEAD, LONG LIVE DISCOVERY!

Telecom Australia has replaced its Viatel videotex service with Discovery, a new broad-range videotex service managed by Telecom's wholly owned subsidiary Telesoft Communications. The change follows a $150,000 market research study commissioned by Telecom, which was concerned at high subscriber attrition and low usage rates for Viatel.

The study found that subscribers found much Viatel information to be poorly presented, out of date and incomplete, with a lack of co-ordination resulting from its origination from many different service providers (SP's). The service itself was also found to be poorly marketed, user unfriendly, slow and frustrating in its inability to handle information or exchange files in standard ASCII form.

In contrast, the new Discovery service is being managed by Telesoft as essentially an integrated group of electronic 'magazines', with a consistent presentation format and user interface. It is also being marketed in an integrated fashion, with subscription, 'user friendly' personal computer terminal software and (if necessary) datacomm modem available as a complete 'kit'.

In addition to the 40-character text format and chunky graphics of Viatel, Discovery offers 80-character text format. It also offers the ability to send fax and telegrams, plus bulletin boards and file transfer facilities. The data services include financial and stock exchange databases, news services, community information, banking and shopping facilities, white and yellow page telephone directories, travel schedules and booking facilities, leisure services, sporting and racing news, real estate listings, and information regarding entertainment, accommodation and restaurants.

Further details are available from Telesoft on (02) 956 9900 or (03) 412 1634.

ABB SUPPLYING EARTH STATION PLANT FOR AIRPHONES

Public telephones in overseas and interstate aircraft – this is the new dimension in satellite communications to be available soon for airlines operating worldwide routes. In addition to telephony, high speed data links will provide passengers with message transfer facilities from their aircraft via on-ground computer links.

This will all be possible with new aeronautical satellite technology developed by Inmarsat, the global satellite enterprise based in London which operates a system of eight geostationery satellites for maritime, land mobile and aeronautical communications.

OTC Limited, Australia's worldwide communications company and founding member of Inmarsat, will provide the new aeronautical services through its two earth stations now under construction at Gnangara in WA.

The two OTC earth stations will have access to the Inmarsat satellites in orbit over the Pacific and Indian Oceans providing aeronautical and maritime communications. Both will be fully equipped with highly sophisticated satellite transmission equipment supplied by EB Nera, a member of the Asea Brown Boveri high-tech group of companies.

It is Asea Brown Boveri's first move into satellite communications systems in Australia. The company is recognised as a world leader in the electrical engineering industry.

When I Think Back...

by Neville Williams

The rise and fall of thermionic valves or 'tubes' – 1

While radio/electronic technology has given birth to a bewildering array of components, it is probably true to say that, more than any other, thermionic valves provided the key to its early development. The story of valves remains a fascinating one, even though their circuit functions have now been largely taken over by solid-state devices.

As noted in the biography of Professor Sir Ambrose Fleming, thermionic valve technology dates back at least to Thomas Alva Edison, one of the pioneers of reticulated electric power and lighting.

In the early 1880s, worried by a cumulative blackening effect within the bulb of his carbon-filament lamps, Edison reasoned that minute, possibly charged, particles were being emitted from the incandescent filament.

To confirm this, he sealed into a number of lamps a small metal plate with a lead-out wire attached. Sure enough, when the lead-out wire was connected to the positive side of the DC filament supply through a galvanometer, it registered a flow of current through the circuit – therefore across the evacuated space inside the lamp. Curiously, when connected to the negative side of the supply, there was no current.

The exact nature of the particles and the polarity-sensitive current was not to be explained until April 1897, when Professor J.J. Thompson of Cambridge University propounded the *electron theory* to the Royal Institution, picking up in the process decades of scientific 'loose ends'.

In the meantime, in October 1884, Edison had taken out a patent to authenticate his discovery – suggesting, as a practical application, that his modified lamp, used in conjunction with a galvanometer, could serve as a means of monitoring the line voltage. It was a rather pointless application because, with Edison's DC mains, the same result could have been achieved by using a series resistor instead.

Ironically, John Howell in Edison's Harrison laboratory later realised that the modified lamp could also function as a rectifier, and his findings were written up in the *Transactions* of the AIEE (American Institute of Electrical Engineers). Used with AC mains, it would usefully have complemented the 1884 patent, but Edison did not support it with a further application – presumably because of his near-fanatical opposition to the alternating current systems being promoted by Nicola Tesla and George Westinghouse.

The Fleming diode

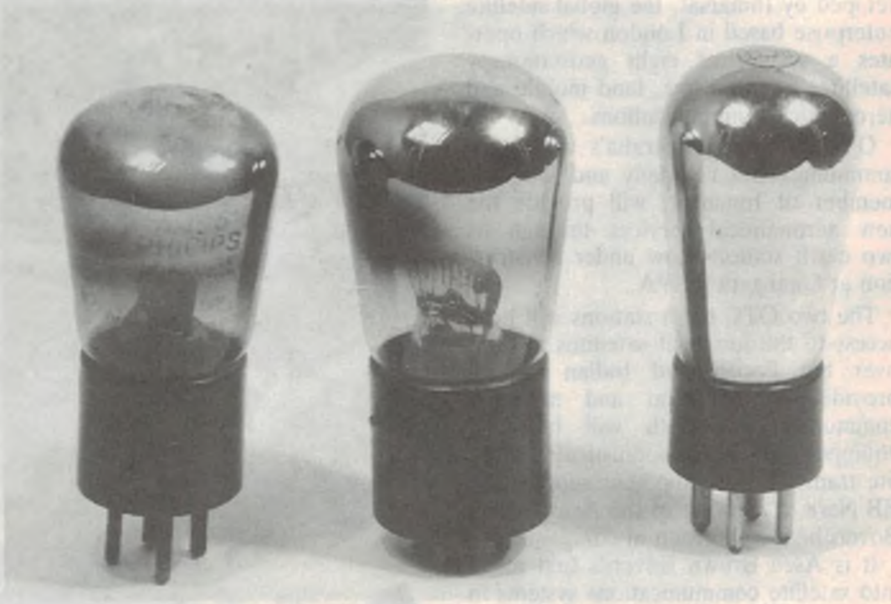
It was left to Ambrose Fleming (1849-1945) to exploit the rectifying capability of Edison's modified lamp by adapting it to serve as a rectifier – or detector – of incoming high frequency (Hertzian) signals in wireless telegraphy receivers. (See Fig.1 and panel).

Despite the original Edison patent, prior publication of the rectification effect by Howell, and a parallel application by Wehnelt a few months earlier, Fleming was granted a patent for his thermionic high frequency detector in November, 1904. It was assigned to British Marconi, however, under the terms of Fleming's contract as a paid consultant to that company.

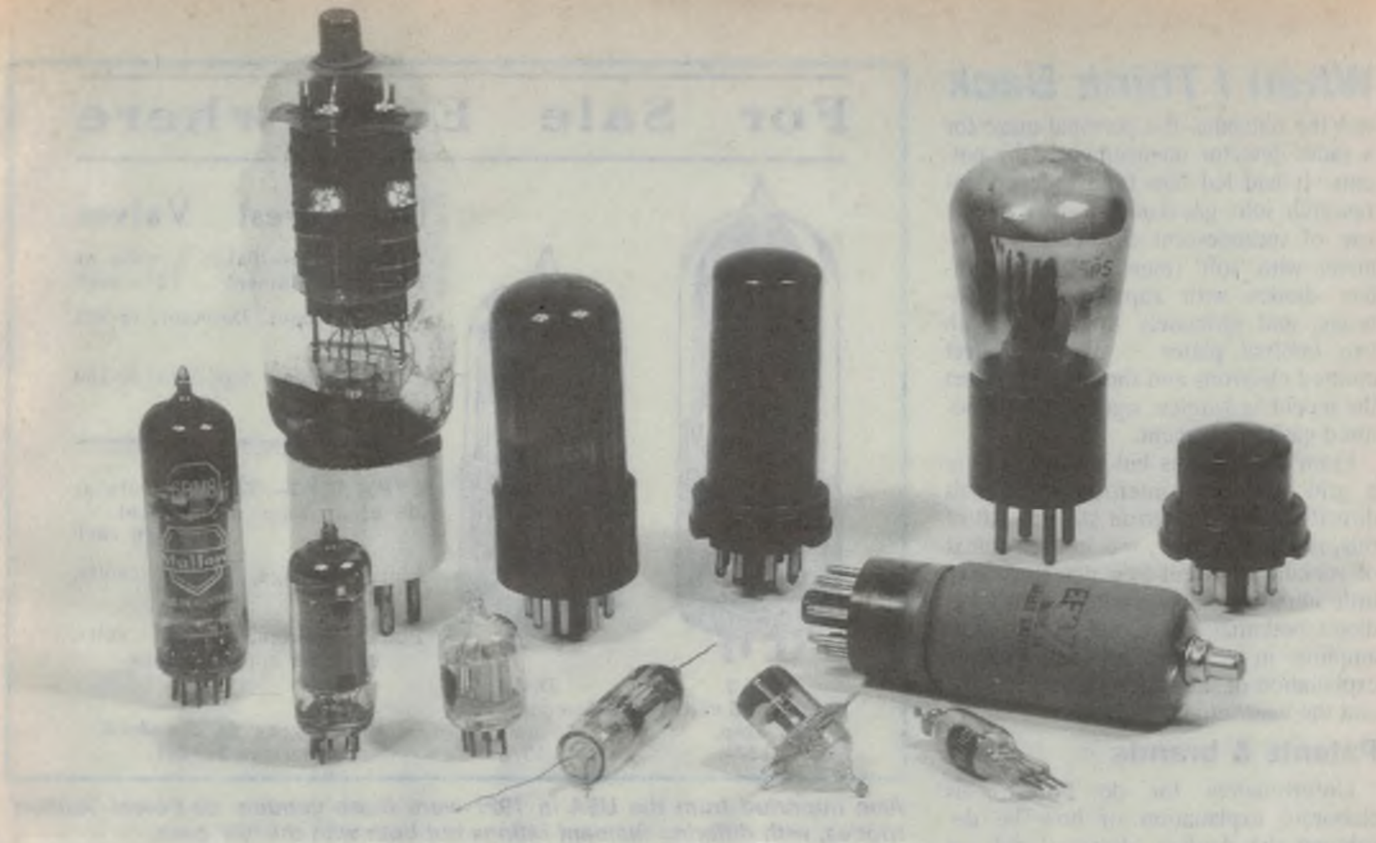
Fleming's detector went into production in 1907 – a device still based on lamp technology, but deliberately exploiting electron emission for the first time to process wireless/radio signals.

For his part in translating the 'Edison Effect' lamp into a thermionic diode detector, Fleming has been widely acclaimed as the 'father' of radio valves – 'tubes' or 'toobs' in American parlance – but not without argument by those who feel that some of the credit belongs to others, as mentioned.

Another body of opinion supports the subsequent contribution of the American pioneer Lee de Forest, who introduced the three-element 'Audion' (triode) in 1906. This ultimately enabled



Three early battery valves. Left, a Philips A425 triode (higher-mu version of the A409), with the 'B4' base; centre, a Condor PR41 triode with the 'UV' base; and right, an RCA type 30 with the 'UX' base.



Valves came in a wide variety of shapes and sizes, as this montage demonstrates. At rear left is a large 807 beam tetrode output valve for audio and HF use, while the tiny valves at front right were used at UHF.

the electronic processing of radio signals to take over from the inefficient and essentially mechanical methods to which it had previously been limited.

De Forest's 'Audion'

Triode valves and others which evolved from them could directly generate spectrally clean and continuous radio signals for wireless telegraphy, modulate them for wireless telephony, amplify them in receivers, detect or demodulate them and amplify them again at audio frequency, to achieve an adequate listening level from headphones or loudspeakers.

This, along with other roles in electronic test equipment, contributed enormously to an understanding of wireless/radio technology and set in train the electronic revolution that now permeates all facets of modern scientific research.

With hindsight, the triode was probably inevitable as a successor to Fleming's elementary diode, with parallel development by Lieben and Reisz in Vienna (ref. *Communication Through the Ages*, Alfred Still, Rinehart & Co Inc, 1946). Even so, de Forest is commonly credited with the step that opened the technological flood gates.

Typically, the October 1923 issue of the *Australasian Wireless Review* carried a front-cover picture of Dr Lee de Forest, by then Professor of Physics at Cambridge University, UK. The supporting article outlines his contribution to communication and broadcasting, adding: 'without Dr Lee de Forest's valve, all this would have been impossible and the world is very much enriched by his genius'.

In the article, as elsewhere, de Forest is quoted as claiming that his discovery

THE DIODE – rectifier or detector

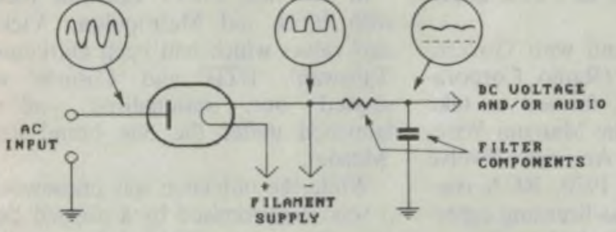


Fig.1: In modern terms – and very briefly – the action of a thermionic diode as a rectifier or detector can be explained as follows:

The AC voltage is typically fed to the plate (or anode) via an isolating transformer in the case of a mains voltage, or a high frequency transformer or capacitor in the case of a radio signal.

During each positive-going input half cycle, electrons are attracted away from the heated filament (or cathode) the cyclic loss of electrons appearing as a sequence of positive-going pulses at the cathode, as indicated.

These can be merged into a continuous DC voltage by the use of a series resistor (or inductor) and a storage capacitor serving as an electrical filter. Relatively large values are necessary to filter the pulses from 50Hz mains into pure DC to power electronic equipment.

Where a diode is being used to rectify (or demodulate or 'detect') amplitude modulated radio signals, the filter components are normally much smaller values, selected so that they will smooth out the pulses of the high frequency carrier without unduly attenuating the much lower frequency voice (or code) modulation.

In practical equipment, diode rectifier detector circuits are configured in a variety of ways for design convenience, but the basic principles remain as shown.

For Sale Everywhere

De Forest Valves

D.V.5
Filament 5 volts
.25 amp.
12/-.

D.V.3
Filament 3 volts
.06 amp.
13/6

TYPE D.V.5—Takes 5 volts at ¼-amp. on filament 12/- each

Plate Voltages, Detector, 18-22½ volts.

Plate Voltages, Amplifier, 60-150 volts.

TYPE D.V.3—Takes 3 volts at .06 of an amp. on filament. —13/6 each

Plate Voltage, 16-22½ volts, Detector.

Plate Voltage, 60-120 volts, used as an Amplifier.

Both Types fit Standard American Socket.

Also imported from the USA in 1927 were these genuine de Forest 'Audion' triodes, with differing filament ratings but both with the 'UV' base.

was the outcome of a personal quest for a radio detector unencumbered by patents. It had led him from independent research into gas-flame devices to the use of incandescent filaments, experiments with 'soft' (inert gas) Edison effect diodes with supplementary batteries, and ultimately to a lamp with two internal plates – one to collect emitted electrons and the other to inject the incoming wireless signals into the ionised gas environment.

From there it was but a short step to a 'grid' of wire to interpose the signals directly into the electron stream. All of this, it would appear, was in the context of seeking a patent-free detector, with little immediate appreciation of the Audion's potential as a signal generator or amplifier in its own right. (For a simple explanation of the triode valve see Fig.2 and the associated panel).

Patents & brands

Unfortunately for de Forest, his elaborate explanation of how he developed the Audion 'detector' did not impress the court. The Audion was held to be a significant improvement on the Fleming diode – a ruling that left de Forest and Fleming/Marconi with interlocking patent obligations.

With a high level of sensitivity about patent rights in the infant wireless communications industry, the end effect of the ruling was to inhibit production and research into thermionic devices, both by the patent holders and by independent companies that might otherwise have become involved under a less ambiguous licence situation.

With the outbreak of war in 1914, the critical need for improved communications gradually overtook patent restrictions to the point where US authorities legislated immunity from patent obligations for any indigenous manufacturer able and willing to produce 'tubes' for military use. Apart from encouraging new manufacturing techniques, the invitation made it necessary to standardise tube types and specifications needed for military and other essential equipment.

After the war (1919) the US government was keen to see the American radio industry retained as an independendent, self-sufficient entity, with radio tube manufacture as a core activity.

With this in view and with Government blessing, RCA (Radio Corporation of America) was formed to take over the interests of the Marconi Wireless Telegraph Co of America. Twelve months later, in July 1920, RCA concluded a landmark cross-licensing agreement with AT&T (who had earlier acquired de Forest's patents), GE, and subsequently Westinghouse, setting the scene for the production of standardised American radio tubes by the above companies and by independents under licence. The agreement had important ramifications worldwide, and certainly for Australia, right up until the end of the valve era.

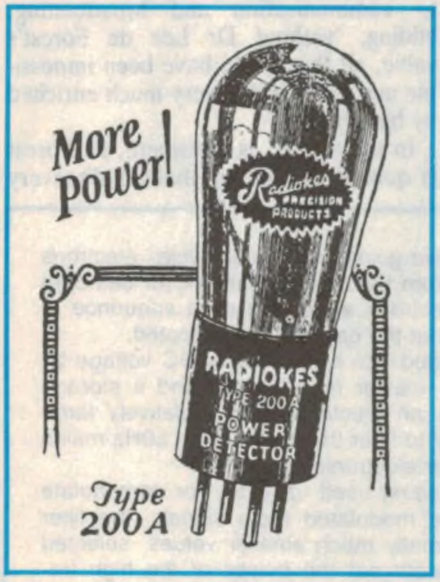
In Britain

The British valve industry, on the other hand, was far less structured. This resulted in a confusing proliferation of valve types, in sharp contrast to the American marketing scene.

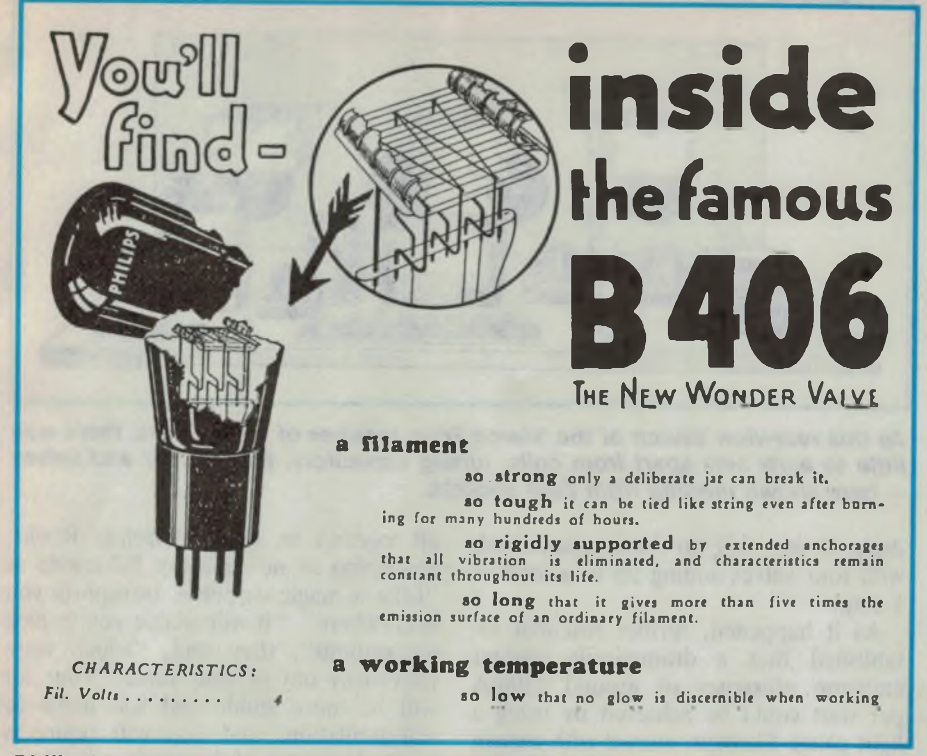
Fleming's thermionic detectors – arguably the first-ever wireless valves – were assembled by the Edison and Swan Electric Light Company (Ediswan). During the war and into the 1920's, other companies got into the act, all producing valves reflecting their independently evolving technology – with different design, different type numbers and different specifications.

In the late 1920's Ediswan merged with BTH and Metropolitan Vickers, and valves which had been marketed as 'Ediswan', 'BTH' and 'Cosmos' were phased out, rationalised and relaunched under the one brand name: 'Mazda'.

While the objective was praiseworthy, it was compromised by a dogged determination to establish and maintain a standard range that would be uniquely British. One anomalous result was the adoption by Mazda in the mid 1930's of an octal (8-pin) base that looked identical at first glance to the American octal, but with dimensions sufficiently different to render them incompatible. In the



Radiokes claimed that its type 200A detector offered 'more power', in this advertisement from the July 29, 1927 issue of 'Wireless Weekly'. It would have been imported, probably from the USA.



Philips' were rather proud of their B406 Dutch-made 'wonder valve' in 1927. Note the internal construction, and the modest amplification factor. Like the A425 it used the European 'B4' base.

marketplace, it was interpreted as yet another example of British 'bloody-mindedness'.

The end result was that the British valve market finished up as confused as ever, with the uniquely British Mazda range, Mullard with overseas connections but mainly following the lead of Philips in Eindhoven, and the STC/IT&T group making and marketing American types under the 'Brimar' label. Over and above these were a dozen or more independents still doing their own thing, plus an assortment of other brands and types coming in from across the Channel.

It may well be that other nations had similar problems, but Australian enthusiasts were conscious of the British and American scene because, up until the early 1930's, most of our valves came from those two sources.

If I appear to be more than usually conscious of the diversity of valve types, it is not without reason.

Back in the mid 1930's, one of my jobs in the Applications section of the Amalgamated Wireless Valve Co was to keep track of every valve type mentioned in technical literature, irrespective of age, application or country of origin. The Company reasoned that, so informed, they would be in a better position to help customers contrive substitutes for unfamiliar valves in overseas equipment.

In this computer age, the task would be reasonably manageable with a PC and an ordinary database program. But in the 1930's, it required manual entries in a jumbo-size loose-leaf journal, and was one of the most tedious tasks one could possibly inherit. But I'm getting ahead of myself.

Personal memories

As a lad in the country, during the 1920's, the only wireless receivers I saw were traditional battery sets, assembled on a baseboard and black bakelite panel, and housed in a polished wooden box with a hinged top lid.

Lift the lid and you'd be faced with a couple of tuning condensers (capacitors), tuning coils (if not mounted on the front panel), a couple of interstage audio transformers and two or three rheostats (variable resistors) controlling the filament voltages. More importantly, there'd be the *valves*, always the glamour components: three in a small

THE TRIODE – signal amplifier

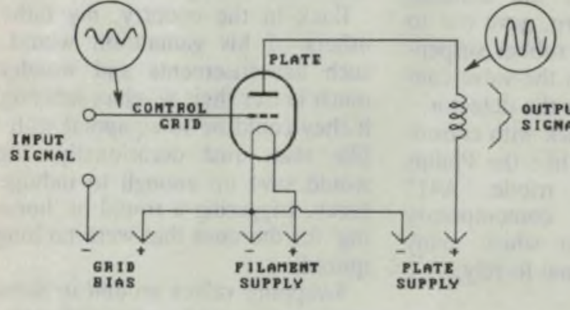


FIG.2

Fig.2: Triodes require an appropriate filament supply voltage, a considerably higher DC ('HT') voltage for the plate, and provision to maintain the grid at a suitably small negative potential (or 'bias') relative to the filament. The voltages vary with the valve type and the desired operating conditions, and are normally specified in valve makers' manuals and charts.

Incoming low or high frequency signals, applied to the grid via an input transformer or coupling capacitor, are superimposed on the bias voltage, causing it to vary in cyclic fashion around its mean value.

Typically, a positive-going half-cycle of signal reduces the negative bias, allowing more electrons through to the plate. The extra plate current through the output load – a transformer or resistor – results in a downward half-cycle in plate voltage.

Negative-going signal excursions produce exactly the reverse effect.

Assuming that the circuit is operating as normal, the overall output waveform will be a replica of the input, but much larger in amplitude and effective power level. In short, the input signal will have been *amplified* without significant waveform distortion, allowing it more effectively to drive a loudspeaker, or excite an aerial system in the case of a transmitter.

As mentioned in the text, triode valves can also be used to sustain oscillation in resonant circuits, thereby generating relatively pure signals over a wide range of audio and radio frequencies.

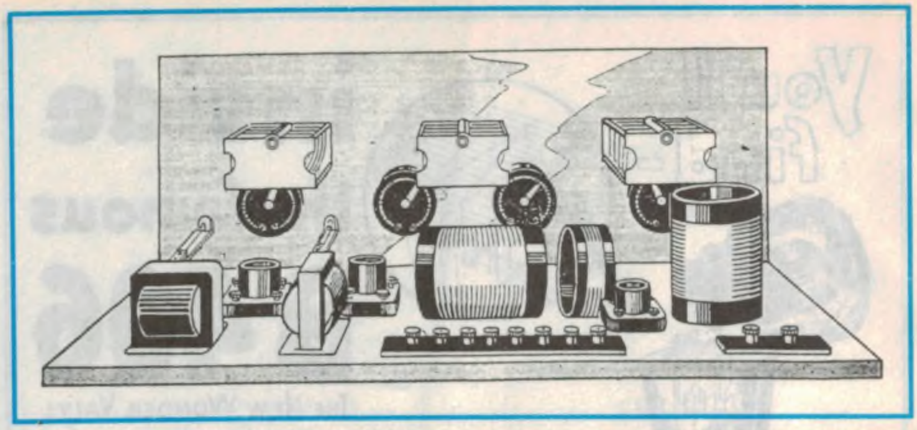
set, four in the average family model and five or more where the owners could afford that many and the cost of the batteries to run them.

The most impressive valves at the time were those with clear glass envelopes, gleaming metallic electrodes and a filament that lit up like a torch globe. They certainly looked the part, but they also consumed a lot of energy from the 'A' (filament) battery, necessitating frequent visits to the local garage to have it re-charged.

I was to learn later than those early 'bright emitter' valves used pure tungsten filaments, which had to be run at white heat to ensure sufficient electron emission. They needed 4 to 5 watts of power to reach the required temperature, and were only able to produce an emission current of around 1 milliamp per watt – enough for detectors and general purpose amplifiers, but insufficient for valves called upon to drive a loudspeaker. So-called 'power' valves required an even larger and hungrier filament.

Then, in 1923, a fortuitous production error at the American GE factory resulted in a batch of general-purpose triodes being fitted with a filament fashioned from the tungsten normally used for lamp making – which contained a small quantity of 'thoria', a slightly radioactive rare earth. To everyone's surprise, the flawed tubes exhibited a marked increase in emission efficiency.

Subsequent investigation showed that 'thoriated' tungsten had a potential emission efficiency of 25mA per watt – but, against that, it was extremely sensitive to the presence of residual oxygen in the envelope. Before it could be used in valves, GE had to include a pellet of magnesium to serve as a 'getter' to absorb stray oxygen molecules. When the pellet was vapourised during final evacuation, a thin layer of metallic magnesium condensed on the inner surface of the bulb, giving these valves a characteristic mirror-like appearance.



As this rear-view sketch of the 'Marco Four' receiver of 1927 shows, there was little to early sets apart from coils, tuning capacitors, transformer and valves – here shown missing from their sockets.

Lower drain

In Australia, the best known type using a thoriated tungsten filament was the 201-A, a general-purpose triode made by several American manufacturers and fitted with a filament rated at 5V/0.25A – intended to operate from a 6-volt storage battery via a filament rheostat, as mentioned earlier.

The 201-A was a plug-in replacement for the earlier bright emitter type 201, but while it offered lower filament drain, it was still far from economical, with four valves adding up to a total of 1 amp.

As it happened, further research established that a dramatically greater emission efficiency of around 250mA per watt could be achieved by using a light gauge filament, coated with certain alkaline earth compounds. This kind of filament could operate, in practice, at a dull red heat, often being barely visible in dim light through the getter-coated envelope.

British and continental manufacturers grabbed a large slice of the Australian market during the 1920's with a steady stream of the new 'dull emitter' valves, notable for their low filament drain but more vulnerable than their earlier and more rugged American counterparts. The very frail filaments did not take kindly to vibration and jarring, or to inadvertent voltage overload.

Microphonic effects were also commonplace, with receivers emitting howling noises when vibration caused relative movement between the filament and the grid. This, in turn, gave rise to anti-noise sockets, using rubber suspension or springs to cushion the valve concerned – most frequently the detector.

Even so, I still look back with considerable respect on valves like the Philips A409 general purpose triode, A415 high-gain detector and contemporary types from Mullard, on which many Australian enthusiasts came to rely.

Advertising hype

Throughout the 1920's, radio magazines carried valve advertisements exploiting every conceivable marketing 'angle'.

'Sweet', 'quiet', 'noise-free', 'non-microphonic', 'long-distance' reception were par for the course. Cossor got it all together in a 1923 *Wireless World*, describing its new red-top P-2 triode as "Like a magic carpet – transports you everywhere". "It will enable you to pick up stations", they said, "which were previously out of your reach. Your set will be more stable and less liable to self-oscillation, and you will notice a marked absence of distortion and microphonic noises".

GWI, 'the valve with a silver lining', featured a 'non-vibrating anode and grid'. Lustrolux boasted their non-dependence on filament rheostats, emphasising 'simplicity of control'. Clearatron offered the presumed attraction of American design coupled with fabrication in a British factory.

Louden boasted an economical filament which also 'enjoys long life because the harmful charges which would otherwise continually bombard it are forced through the spiral anode out of harm's way'. That sounds like a most desirable attribute, except that, even now, I haven't the faintest idea of what they were talking about!

Back in the country, my father and others of his generation would study such advertisements and wonder how much better their wireless sets might be, if they could be re-equipped with valves like that. Just occasionally, someone would save up enough to indulge their fancy, triggering a round of 'horse-trading' for the ones that were no longer required.

Swapping valves around in those days was easy enough, provided one didn't overlook the filament voltage. Most sets used tubular bakelite bayonet sockets, with standard filament, grid and plate connections and one could plug in almost any 4-pin valve with a UV or UX base. By the time you'd done that a few times you were accepted as an experimenter!

Dynamos and Alternators -

There are many names that will live forever: Faraday, Ampere, Volta and Ohm, to name but a few. But how about Pixii, developer of the DC generator, and Jablochkoff, inventor of 'The Elliptic'? The source of this information is a marvellous old book, published in 1884 – one that we couldn't pass up sharing with our readers.

It is not often that a really old book on electricity is made available to us. The owner, Bill Sounness came into possession of the book, titled *Magneto and Dynamo Electric Machines*, following the recent death of his grandfather. It's a fascinating book, as I hope this article will show.

The book was published by Symons & Co, 27 Bouverie Street, London in 1884, as part of their 'Specialist Series'. Others in the series include Vol.II, titled *Gas Engines* (ready November 1884), Vol.III on *Ballooning* (ready December 1884) and two others on electricity (in the press) on *Primary Batteries* (Vol.IV) and *Arc and Incandescent Electric Lamps* (Vol.V).

The book I'm describing is Vol.I, suggesting it was released early in 1884. The publisher's precis describes the book thus: 'Vol.I: *Dynamo and Magneto-Electric Machines*. By Paget Higgs, LL.D., D.Sc., &c., &c. With the use of the German Original by Glaser de Cew, translated by F. Krohn. Crown 8vo. pp. xiii.-301, with 61 Illustrations, cloth, 6s.'

'This volume contains the theory, brief description of, and results obtained, with the best construction of Dynamo-Electric and Magneto-Electric Machines, and with electrical 'storage', so far as this latter may be considered as an auxiliary in the regulation of the current of such machines.'

On closer examination, it seems Dr Paget Higgs, in collaboration with a Professor Charles Forbes, edited – rather than wrote – the book, although Dr Higgs is attributed with 'many additions.' Here are some of the highlights of this fascinating book.

Preface

The short preface, signed 'the Editor' starts by quoting the original German author, who says: 'Few years only have elapsed since magneto- and dynamo-electric generators began to be employed in practice, and the experience gained with regard to them is, therefore, comparatively limited. But we are beginning to see that the machines as yet constructed are still capable of considerable improvement, and that by a rational construction we shall be able to increase their value.'

The Editor then adds his bit, stating (in effect) that the aim of constructors of dynamos has been primarily to 'arrive at some novelty, or to attain some hitherto unapproached dimension, in order to secure a valid patent or to impress the public.' He laments the long suffering public, declaring 'that now the public has become educated (and very dearly they have paid for this education)...'

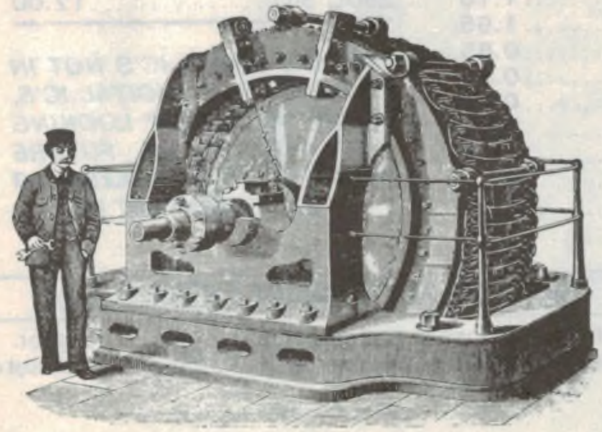
The conclusion to the preface, however, puts it all into context: '... for a time it was a machine regarded as likely to revolutionise all the mechanical world; now it is coming to be considered in its true light as a very valuable aid and auxiliary to steam and other prime movers, extending their sphere, and making more easy their application.' Oh, Ye of little faith!

Measurements used

The standards employed in the book for electrical measurement are based on the old CGS (centimetre-gram-second) system. They lack a certain amount of precision by today's standards, and include some of the following:

'The Ohm, unit of resistance, 10^5 CGS units. 1 ohm is about equal to the resistance of 48.5m of pure copper wire, 1mm in diameter at $0^{\circ}C$.'

The volt is described as: 'a unit of electromotive force = 10^8 CGS units. 1



This colossus is Gordon's alternator, not unlike a modern unit. The mechanic with moustache gives an idea of its size, although he would only earn $2.64 per week if he worked for Mr Gordon.

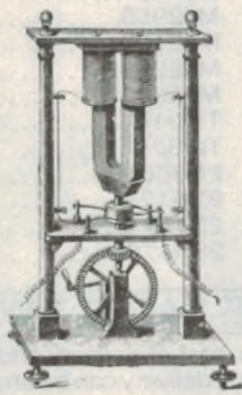


Fig.1: Pixii's DC generator is described as being the first practical application of Faraday's discovery of electromagnetic induction.

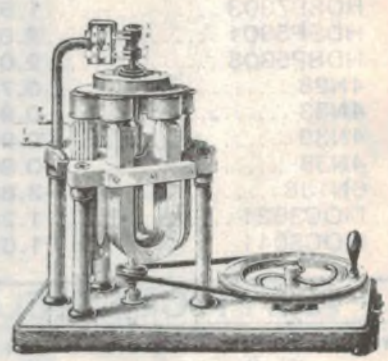


Fig.2: 'Stohrer considerably increased the efficiency of magneto-electric machines by increasing the number of the magnets as well as the number of armature bobbins.' It's also belt driven.

1884 style!

by PETER PHILLIPS

volt is about 5 to 10 percent less than the electromotive force of a Daniell cell.'

Current, measured in Amperes is defined as the unit of 'strength of current = 10^{-1} CGS units' In practical terms, 1 ampere is 'the current which, driven by the unit electromotive force, is able to traverse the unit of resistance in one second.' The Coulomb, 'unit of electrical quantity' is also equal to '10^{-1} CGS units.'

The horsepower (HP) is listed as watts/746, but the 'cheval de vapeur' is given as watts/735. I know 'cheval' is French for horse, but I am not sure about the 'de vapeur'. Anyway, one of these is not as powerful as a conventional horse, evidently.

The introduction

The book starts with a discussion on the development of the dynamo. Faraday, who is now generally attributed as being the inventor of the dynamo, is given very scant referral. 'Faraday's researches on the phenomena of induction, formed the theoretical basis for the construction of electric machines.'

According to *Collier's Encyclopedia*, Faraday built the first crude electric motor in 1821, and developed a disc dynamo in 1831. But Higgs states: 'It is to Pixii that the honour is due of having made the first practical application of the discovery (of electromagnetic induction). He constructed the first magneto-electric machine in 1832.' This contrivance is shown in Fig.1. As the picture shows, the rotor is a permanent magnet, sharing the shaft with the commutator that switches the induced currents from the fixed coils.

Others, so Higgs goes on, took the basic Pixii invention and rearranged it. The drawing of Fig.2 shows the Stohrer adaptation, with its fixed magnets, and rotating coil assembly. This machine was 'so satisfactory that subsequent inventors, adopting his idea, continued to increase the number of the armature-bobbins and magnet-poles, and in this way succeeded in obtaining currents of remarkable strength...'

Higgs also records 'A notable modification in the construction of magneto-electric generators was made by Dr. Werner Siemens, of Berlin, in 1857, who greatly improved the shape of the armature-bobbins.' This device is shown in Fig.3.

Alternators

The machines discussed so far are for 'generating continuous currents', and

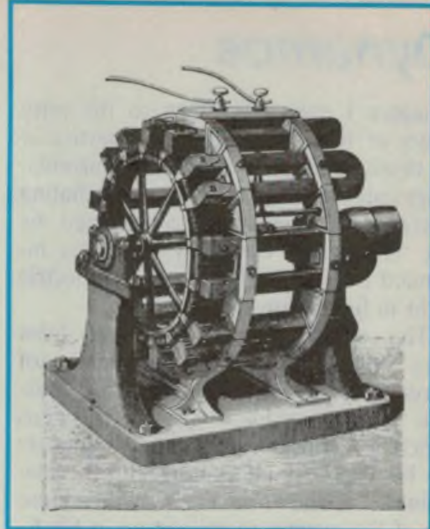
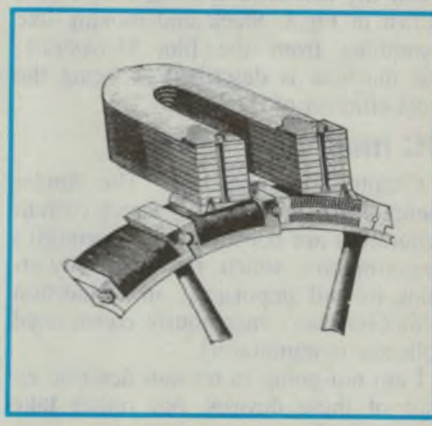


Fig.5: The De Meritens machine 'is considered by many to be the best alternating current machine available.' It looks similar to that shown in Fig.4, but apparrently uses a 'peculiar' construction of the armature – details of which are shown in Fig.6 below.



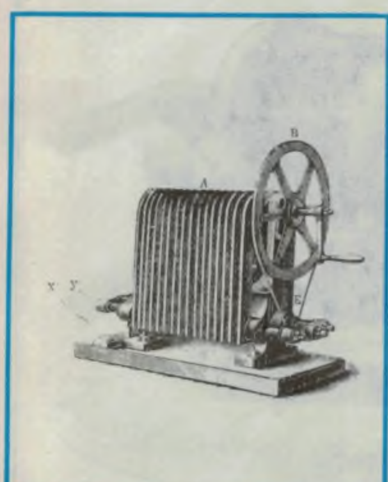


Fig.3: The Siemens machine is not unlike a modern magneto, despite being developed in 1857.

Fig.4: The construction details of the Alliance alternator shows the copious use of permanent magnets. This machine was intended to power the arc light in a lighthouse.

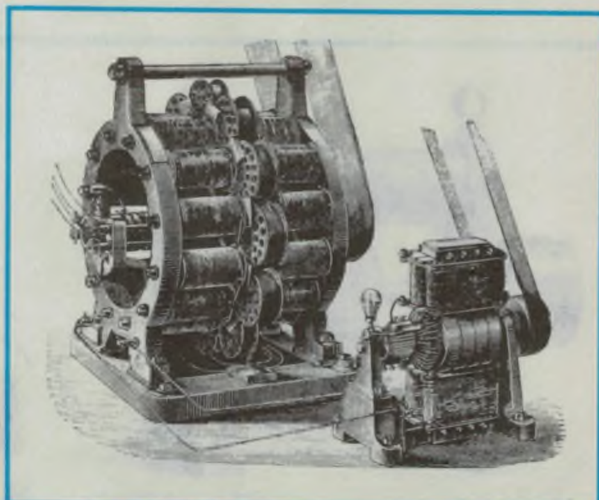


Fig.7: The Siemens-Halske alternator has an armature comprising coils wound on perforated wooden bobbins, attached to the rim of a wheel. It also does away with a permanent magnet field, using a dynamo to supply field current to the field coils.

Dynamos

Chapter I now gets down to the nitty gritty of 'today's' machines, in particular to those generating alternating currents. Higgs states: 'The first large alternating current machines were constructed by the 'L'Alliance' Company, and were intended for the production of the electric light in lighthouses.'

The 'current model' developed from that invented by Nollet, Professor of Physics at the Military College of Brussels is shown in Fig.4. The De Meritens machine, 'considered by many engineers to be the best alternating current machine...' is shown in Fig.5, with a close up of the magnet to coil set up in Fig.6.

The Siemens-Halske machine, shown in Fig.7 does away with the permanent magnet concept, and has its own exciter. The rotor has bobbins wound on wooden cores 'which are perforated for the sake of ventilation.'

But my favourite is Brush's machine, shown in Fig.8. Sleek and looking like something from the film *Metropolis*, this machine is described as being the most efficient of the lot.

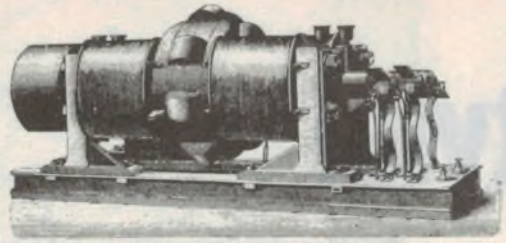


Fig.8: For stylish appearance, the Brush machine of 1881 surely takes first prize. Higgs describes it as being '..the most efficient of the machines that primarily generate alternating currents.'

Fig.9: Breguet of Paris is attributed with having developed this laboratory-use-only DC generator. It uses a laminated permanent horseshoe field magnet.

DC machines

Chapter II commences 'The fundament on which nearly all direct current generators are constructed is Pacinotti's ring-armature, which, however, only attains its full importance in connection with Gramme's ingeniously constructed collector (commutator).'

I am not going to try and describe either of these devices, but rather take the available space to reproduce some of the remarkable looking DC generators of the time. By now, Higgs is referring to machines existing around 1870 or so. The first, shown in Fig.9 is the Breguet device, a unit suitable for laboratory use, featuring a laminated field magnet.

A natural development of this is the Gramme machine, shown in Fig.10. Gulcher's dynamo, a machine 'intended for currents of large quantity but low intensity'(?) is shown in Fig.11. This machine 'will supply six Gulcher lamps of 1,300 candle power when working at the rate of 940rpm and using 10 horsepower.'

Siemens' plating generator is depicted in Fig.12, in which 'three are employed in the Royal Foundries, at Oker. With each of these, five to six hundredweight of copper is precipitated daily, eight to ten horse-power being required.'

Maxim's generator, shown in Fig.13 has a regulator, the operation of which, though 'described in Chapter IV' is not immediately obvious.

And finally, Edison's DC machine is shown in Fig.14. Higgs describes this machine as being 'remarkable for its dimensions, and well deserves the attention of the technologist on account of its practical construction, which follows certain theoretical laws.'

Higgs continues: 'Fig.14 represents one of the 12 large generators that are at present set up in New York, in a large central station whence a portion of the city receives the current for lighting with incandescent lamps.'

Some heavy theory

What follows in chapters III to XII can only be described as 'engineering mathematics.' And some of it is very complex. The aim is to describe the

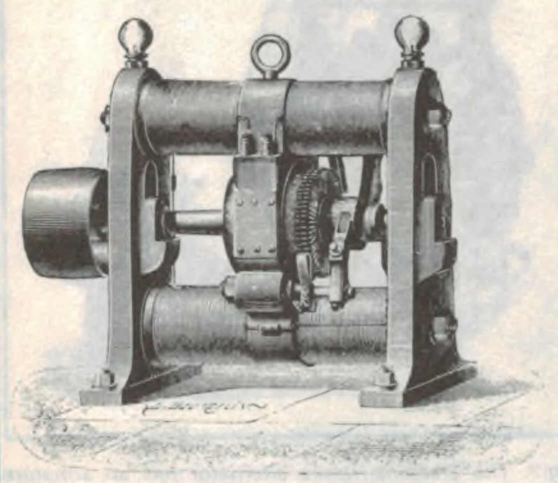


Fig.10: The Gramme DC generator of 1873 weighs 177.3kg, of which 47kg are due to the weight of the copper.

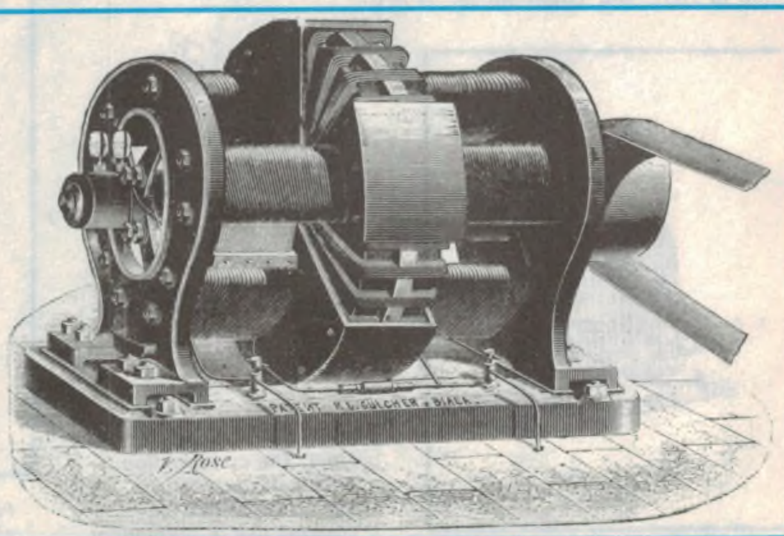


Fig.11: Gulcher's generator can supply six Gulcher arc lamps of 1,300 candlepower, requiring 10HP to do so.

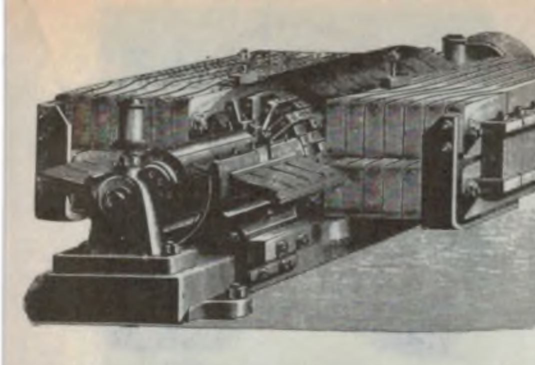


Fig.12: The Siemens plating machine certainly looks the part. The electro-magnets of this machine are encircled by thick, square sectioned copper bars, making seven turns around each limb of the magnets.

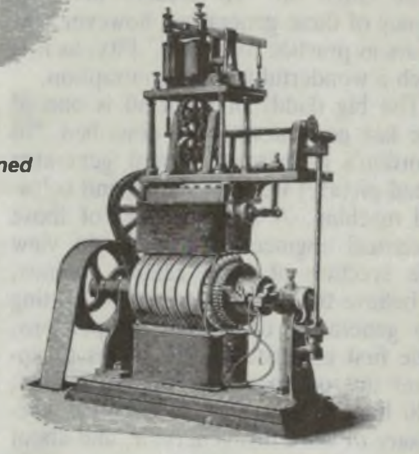


Fig.13: Maxim's dynamo-electric generator features a regulating device that 'excited great interest at the electric exhibition in Paris.'

technology, and to support the statement that 'Numerous experiments have also proved that the machines for continuous currents are always to be preferred when it is desired to obtain the largest possible yield of work. For the conditions of resistance and rate of rotation being the same, these machines give about 35% more effect in the luminous arc than the alternating current machines.'

Readers may recall the Tesla/Edison argument of AC versus DC, and no doubt Edison would have brandished his copy of Higgs while he electrocuted a few cats to prove his point.

It seems also that Paget Higgs himself was no mere theoretician. He describes his own work concerning exciting the field of a dynamo, and the problems associated with getting the initial burst of magnetising current at start up. The mathematical proofs of all sorts of experiments are full of terminology long since discarded, and some of it looks rather suspect.

For example, concerning Photometric Determination: 'Now, from Table II (*not labelled in the book, unfortunately*), we see, that as the whole of the electrical work done by the battery was equal to 3,809,000 kgrs.-mm., each Carcel power per hour cost 3809000/163.9 (= 23,229)kgrs-mm. per hour, or 6.4 kgrs.-mm. per second.' Make what you can of all that!

A lot of detail is included concerning the specifications of generators used to provide power for lighting. In general, arc lamps are the light source, requiring 'a powerful current at considerable tension, which must be maintained within certain limits to prevent the arc from becoming unsteady. This requires that the internal resistance of the generator be judiciously arranged.'

The use of generators in telegraphy is described, in which 'The first experiments were carried out in India, in the autumn of 1879, by L. Schwendler, who conducted a portion of the powerful current of a dynamo used in the telegraph workshops of the Alipore government for lighting, through the 850 miles of telegraphic wire between Agra and Calcutta, and with it he was able to transmit a number of telegrams without change being noticed in the brightness of the electric light, for the portion of the current conducted away was only about .004 of the total current.' This is also remarkable in that it has to be the longest sentence in the book...

Fig.14: Edison's DC generator of 1884 is no baby. It has water cooled journals, weighs in at 44,820lbs (20 tonnes) and uses a Siemens cylinder armature.

Predictably, the names of Weston, Siemens and Edison crop up regularly, although the book pre-dates Tesla by a few years. Tesla didn't arrive in New York until 1882, and it wasn't until 1887 that he started to make an impact with his revolutionary ideas of the rotating magnetic field.

Measuring instruments

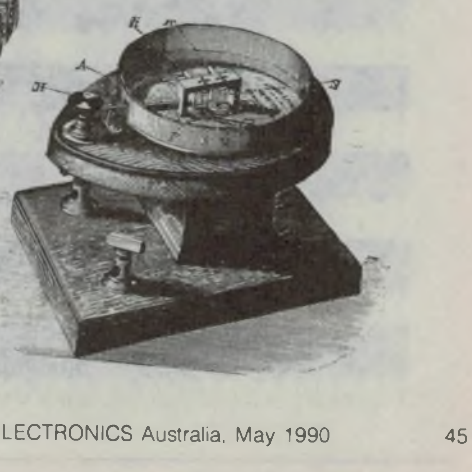
The names Ayrton and Perry are still known today, and Higgs includes a supplement on the 'dynamo-meter', the 'volt-meter' and the 'am-meter' developed by these erstwhile professors.

The dynamo-meter is totally mechanical, and was used to measure the 'amount of work transmitted'. Although several meters are described, the voltmeter of Fig.15 is certainly the most complex. The description is not entirely clear however.

This instrument incorporates 'a very fine cog-wheel (W) in the axis of the magnetic needle, and the teeth of this engage in the gearing (P) on the axis of the pointer. By this arrangement the deflection of the pointer is made ten times that of the magnetic needle, and if the construction of the instrument is such that up to 36° the deflections of the needle are proportional to the strength of current, 360° of the pointer's deflection will have this proportionality. Besides this, the axis of the needle, as well as that of the pointer, is connected with a very sensitive spiral spring S and S' respectively.'

The description then bogs down in a most complex dialogue that somehow fails to portray the basic principle of operation. Higgs is more interested in the gearing and spiral spring concept than the means of actually deflecting the pointer. I think the unit is a moving iron device, although it is difficult to tell

Fig.15: This Ayrton-Perry voltmeter uses gearing and has return springs. Perhaps you can figure out how it works!



from either the diagram or the text. Anyway, it's certainly an interesting device, regardless of how it works!

The latest

The final chapter is titled 'Latest Constructions of Generators.' It was this chapter that first attracted me to the book, particularly the following description of 'The Elliptic.' I'll let Higgs tell the story:

'Jablochkoff's new generator, termed 'The Elliptic' is an attempt to advance in the construction of electric generators by reducing the mass of the magnetic parts liable to a change in polarity. As shown in Fig.16, the generator consists of two coils, one of which is immovable and is placed in a vertical plane. The other moves on a horizontal spindle to which it is inclined.

At the same time, the plane of the vertical immovable coil is not placed perpendicularly to the axis of rotation of the movable coil, but makes an angle with it, which is determined by experiment and is dependent on the conditions under which the machine is to work.'

The description continues, making the point that this machine can also be an 'electro-motor' and in a rather arguable statement, asserts that: 'These generators are remarkable for their simplicity of construction, and in this probably no machine surpasses it.'

But the concluding sentence seems to suggest the Jablochkoff Elliptic may not quite catch on: 'At present the efficiency of these generators, however, appears in practice to be low.' Pity, as it is such a wonderful looking contraption.

The big daddy of them all is one of the last generators to be described. 'In Gordon's alternating current generator (lead picture) we have the second colossal machine. A large number of those electrical engineers who have in view the erection of large central stations, ...believe this is best attained by putting up generators of gigantic proportions. The first generator which seems to answer this purpose was built by Edison; 120 horsepower (around 90kW) is necessary to work this generator, and about 1,000 incandescent Edison lamps, of 16 candle power each, can be supplied by it.'

The Gordon generator has a length of four metres, and weighs 18,000kg. When running at 140 rpm, the total output current is around 5,000 amperes. With 1,300 Swan lamps of 20 candle power distributed over a circuit of 21km

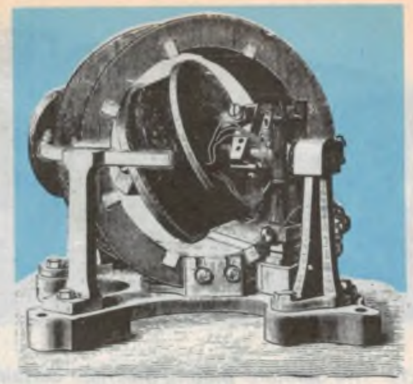


Fig.16: The Jablochkoff Elliptic. This machine unfortunately has a low efficiency in practice, but can also operate as a motor. Don't you just love it?

connected to this generator, only half the current capability was required, according to tests conducted at Greenwich in 1883.

Gordon also offers a costing for electric lighting in London, concluding that a total capital expenditure of 200,000 pounds would be required to establish a station capable of powering 60,000 lamps of 20 candle power each. He budgets for an annual wage and 'superintendence' bill of 5,390 pounds for 63 persons, which equates to a weekly wage each of $2.64. But then water is only 6d per 1000 gallons, so one can't complain.

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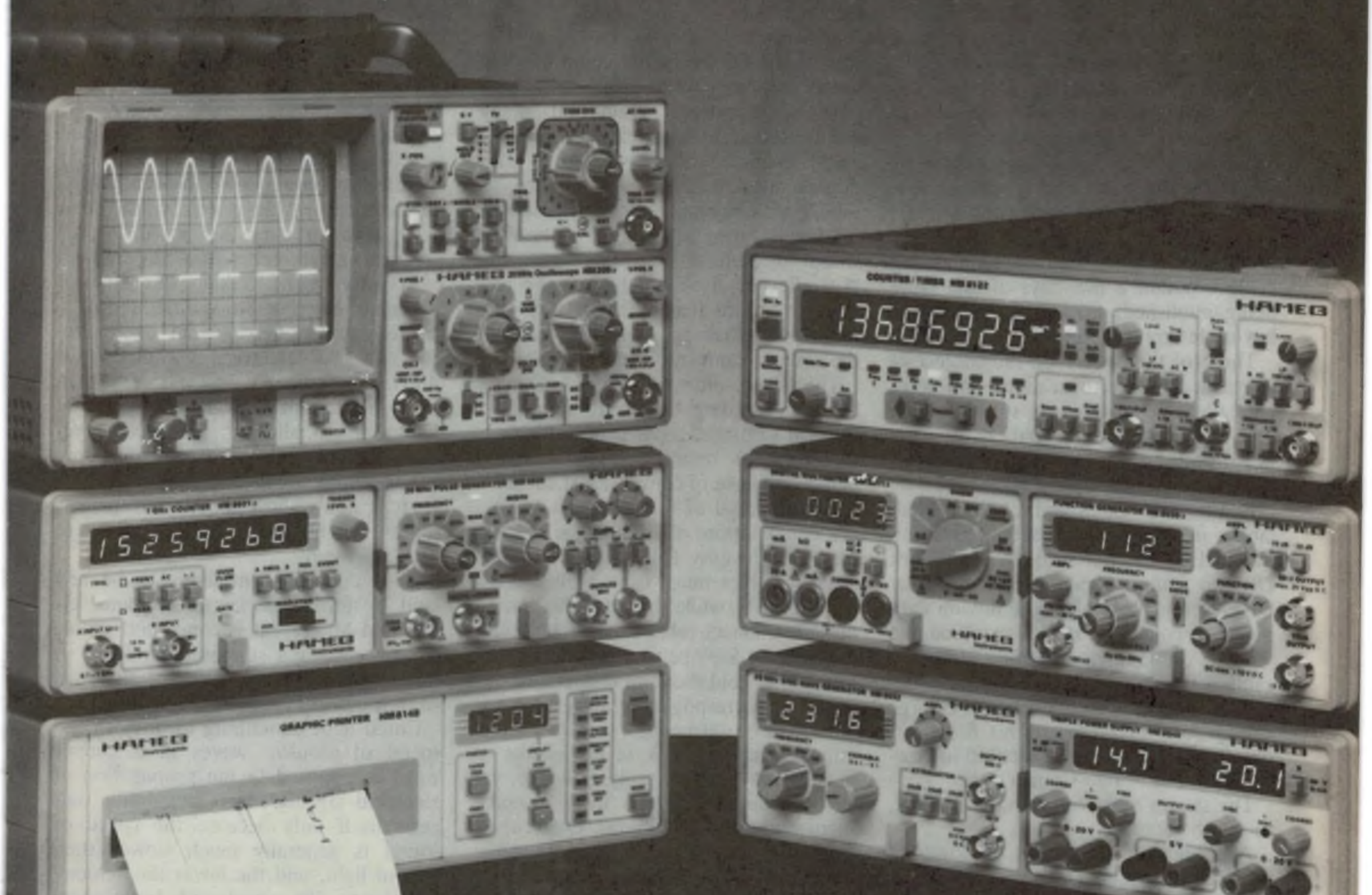


FORUM

Conducted by Jim Rowe

Oh, dem golden cables!

Yes folks, this month's topic is again audio cables – the kind which are claimed to be much more than *mere cables* connecting CD player A to amplifier B, or whatever. Following our last discussion in the February issue, I've had a number of letters reporting further interesting claims by marketing people. There was also a challenge to do some actual *listening*, which we accepted.

There's no doubt about the topic of fancy audio cables – it certainly keeps on coming back regularly, like Halley's comet. Just when I think we've surely heard the last of the esoteric claims, and sorted out whether or not they make any sense, another one pops up.

Back in the February column, you may recall, we discussed a variety of related topics including an interesting claim about the frequency characteristics of fat wires and thin wires; the subject of copper 'blackening' and various kinds of PVC covering; and the claims of 'directionality' in interconnecting cables. Within a few days of that issue being published, no less than five follow-up letters came in.

Three of them were on the subject of physical cable configuration, and were basically in response to stories which had appeared in a number of daily newspapers, regarding a new range of cables designed in California.

Readers C. Coulthard of Port Hedland in WA, Michael Macintosh (VK5KLG) of Loxton in SA, and Mark Dignam from a company called Doctor Disk, also in WA, all wrote in with clippings or copies of stories extolling the virtues of Golden Section Stranding cables. These have apparently been designed by US sound engineer George Cardas, and marketed by his firm Cardas Audio, which is represented in Australia by The Audio Connection.

The stories make 'interesting' reading, to say the least.

According to Mr Cardas, all kinds of wire tend to *resonate* when carrying an alternating current. And wires of the same mass and section, when stranded together in a cable, tend to resonate in unison – which he says is very undesirable, for hifi audio reproduction.

The solution, it appears, is to have a cable made up of strands of many different wire diameters, to break up this common resonance effect by making each of the strands resonate at a different frequency.

Actually Mr Cardas seems to go further than this, drawing upon the old Greek idea of 'golden ratios' – the proportions supposedly found in many natural things such as leaves, sea shells and galaxies. This is also tied in with mathematical number series (such as Fibonacci numbers), to determine the 'optimum' ratios between all of the wire strand diameters. Our old friend the skin effect is also brought into the picture, to ensure that both low and high frequency signals get their 'fair share' of the overall conducting path.

The nett result is that Cardas 'Golden Section Stranding' cables are apparently claimed to provide 'full bandwidth' performance, as opposed to the claimed peaky response of conventional cables.

Of course all of this attention to special combinations of stranding size doesn't come cheaply. The prices for Cardas speaker cables range from $450 to $750 per METRE, while those for the matching interconnect cable start at $290 and range up to $890 per metre. All are terminated in gold/rhodium connectors.

As our correspondents suggest, this is all rather intriguing. There's just enough technical talk in the claims to make them sound vaguely plausible, yet at the same time enough 'hype' to make them sound rather dubious. Quite apart from the prices, which probably make the performance of the cables a matter of academic interest only, at least as far as most of us are concerned!

But let's consider some of Mr Cardas's claims, for a moment. Exactly what kind of 'resonance' effect he's referring to is not clear. It's true, of course, that cables tend to have frequency dependant behaviour at radio frequencies and higher; but this is essentially only a factor of electrical *length* – and the kind of electrical termination present at each end.

For example the behaviour of a coaxial cable connected to a transmitter will depend to a significant extent both upon the impedance of the antenna connected at the far end, and the electrical length of the cable itself, at each frequency.

But we're talking here of much higher frequencies than audio, where the length of cables tends to be significant as a proportion of signal wavelength. By the time you come down to even 1MHz, an electrical wavelength in typical cable has grown to over 200 metres – so practical cables represent a tiny fraction of a wavelength, making this kind of 'resonant' effect of little consequence.

This is even more so at audio frequencies. An electrical wavelength at 20kHz in free space is no less than 15km, while that at 1kHz is a whopping 300km. Even allowing for a cable velocity factor of 0.7, these figures only fall to about 10km and 200km respectively. I don't know about *your* speaker cables, but mine are certainly nowhere near this long!

So it doesn't seem likely to be any kind of normal *electrical* resonance effect that Mr Cardas is concerned about. In any case, it's supposedly related in some way to the *diameter* of the wire strands in the cables, not their length.

Could it be something to do with the speed of *acoustic* waves in a copper wire, as opposed to the propagation of electrical signals? That possibility suggests itself only because the speed of sound is generally much slower than that of light, and the lower the velocity the shorter the wavelength for a given frequency. Perhaps this would give wavelength figures nearer the dimensions we're talking about...

According to the 59th edition of the authoritative *Handbook of Chemistry*

and Physics (CRC Press), kindly brought in by our News Editor Winifred Vincent, the velocity of sound in copper is around 5000 metres/second for longitudinal-mode waves, and 2300 metres/second for transverse-mode waves. This gives wavelengths of around 250mm and 115mm respectively for the two modes, at a frequency of 20kHz, rising to 5 metres and 2.3 metres respectively for a frequency of 1kHz.

While these figures are much shorter than the electrical signal wavelength, they still seem far too large for the *diameter* of cable strands to be relevant.

Perhaps I'm a bit dense, but with a minimum 'in copper' wavelength of 115mm for audio frequencies, I can't see how any kind of transverse radial acoustic resonance could occur in cable strands only a millimetre or so in diameter. This is less than 1% of the minimum wavelength – far too small to support any normal mode of vibration, I'd have thought.

In fact, I'd be very surprised if this kind of resonance could occur even at 20kHz unless the wire were at least 36.6mm in diameter – giving a circumference of 115mm, for fundamental-mode vibration. The corresponding minimum wire diameter for 1kHz would be a mere 732mm. Fairly hefty cable, by anyone's standards!

Judging from the pictures of Cardas cables shown in the newspaper articles, they're nowhere near this diameter. In fact it would be rather interesting if they were; fitting them to conventional connectors would be well-nigh impossible, and they'd certainly cause bumps in the carpet...

Of course even the above reasoning assumes that the acoustic resonance we're talking about could somehow be excited and maintained, by the audio signal currents flowing through the cable. And presumably it also assumes that having been excited, this acoustic resonance would in turn produce changes in the *electrical* behaviour of the cable, to have an adverse effect on the signals.

Trying to be charitable, I can think of only two possible ways in which an acoustic resonance could be excited by currents flowing in a single conductor. One is the *piezo-electric* effect, and the other the *magneto-strictive* effect.

But in order for there to be any significant piezo-electric effect, there would have to be a considerable electric field intensity produced in the copper cable conductors, in the *transverse* direction. In other words, in the plane of a cross-section of the wires. And to produce an electric field, you need to have a voltage difference – in the same direction.

Exactly where this voltage difference would come from isn't clear, at least to me. Perhaps this is where Mr Cardas would bring in the skin effect; yet as we've seen previously in this column, skin effect really only becomes significant at radio frequencies.

To recap, the term *skin effect* describes the tendency for current to concentrate near the surface of a conductor, as the frequency is increased. It is caused by the interior of the conductor having a higher effective inductance than the region nearer the surface, as a result of being enclosed by additional magnetic flux.

It is fairly easy to calculate the 'skin depth' of a conductor at any frequency, knowing its resistivity and magnetic permeability. The figure obtained shows how far you need to go, inwards from the surface, before the current density drops to 36.8% of its surface value.

For a copper conductor at 1MHz, the skin depth is 0.066mm. However it varies inversely according to the square root of frequency, so that by the time you come down to 20kHz it has grown to 0.47mm, and at 1kHz it has become 2mm.

As these figures are roughly of the same order as the full diameter of many audio cable conductors, it suggests that any current differential produced across the conductor cross-section due to the skin effect – at audio frequencies – would be quite minor. So it's hard to see how any significant voltage differential could be produced as a result, especially when you consider the very high conductivity of copper.

If the piezo-electric effect doesn't look too promising, how about the magneto-strictive effect? This is virtually the magnetic equivalent: the tendency of some materials to expand or contract, under the influence of a magnetic field. However it really only applies to ferromagnetic materials like iron, nickel and cobalt – or at least, to any significant extent. So we seem to draw a blank there as well.

The QED Incon P 100S stereo directional interconnecting cable, as it arrived. Each of the two leads consists of a twisted pair of signal conductors, enclosed with a 'drain' wire in a graphite screen and an outer plastic sleeve.

About the only possible effect I can think of, in terms of possible acoustic excitation, is the tendency for parallel conductors carrying currents to experience mutually attractive or repulsive forces, due to the interaction of their magnetic fields. This kind of force could perhaps occur in a multi-stranded cable, although I'm not sure if it can occur unless the strands are insulated from each other. I suspect the only possibility of this occurring in practice is with a cable having both 'forward' and 'return' conductors in close proximity.

In any case, the magnetic field intensity generated even around the conductors of a speaker cable carrying high power would be quite small, due to the low permeability of copper, air and virtually all plastics. So the forces produced would be extremely small – although they *would* vary at twice the signal frequency, due to the way they're proportional to absolute current amplitude rather than polarity.

Mind you, even with this doubling in frequency, from what we saw before about minimum cable size for transverse acoustic resonance we'd still be looking at a cable conductor diameter of at least 18mm before resonance would be possible even at 20kHz.

So I'm sorry folks, I really can't see any objective justification for Mr Cardas's claims regarding 'undesirable resonances' in normal audio cables. Nor can I see any justification for his use of many different wire strand diameters, carefully chosen to have 'golden ratio' relationships, as a way of getting around this supposed problem.

To me it all seems like an even more fanciful version of the 'fat wires for bass notes, and thin wires for treble notes' furphy, which we discussed back in February. But what do you think? Perhaps I'm missing something.

Other reactions

Passing now to the two other letters which came in from readers in response to the same topic, the first was from Athol Manning VK7LR, of Devonport in Tasmania. Mr Manning has been active in TV and public address servicing for some considerable time, and with his letter sent in a clipping of an advertisement from the Japanese electronics industry magazine *JEI*.

The advert is from a 1985 issue of *JEI*, and is for the LC-OFC (long crystal oxygen-free copper) cables marketed by phono cartridge maker Audio-Technica. It makes various claims, including one that the cables have 'zero audible distortion', and another that a 10-metre length of LC-OFC cable 'matches the performance of just 10 microns of standard tough pitch copper'. There's also a rather glib and oversimplified explanation of how the large number of crystals in ordinary copper, with the gaps between them 'filled' with 'semiconductive copper bioxide', causes distortion and 'bad sound'.

Mr Manning expresses surprise that Audio-Technica would want itself associated with such dubious statements, and says that if they were true, surely the differences between LC-OFC cable and 'ordinary' cable would be much more obvious. For example if 10 metres of LC-OFC really were capable of the same performance as a mere 10-micron length of ordinary copper, we wouldn't need to use 600-ohm lines and matching transformers to reduce losses in PA systems, would we?

Both of which seem to me very valid comments. It does seem strange that if there really is *that* significant a difference in performance between LC-OFC copper and ordinary ETP, the difference is not more obvious. Whereas in practice the difference in 'quality of sound' seems to be so subtle that many of us can't hear it – hardly the kind of situation you'd expect with a supposed 'million-to-one' improvement!

Like Mr Manning I find it a bit surprising that Audio-Technica would allow this kind of 'hype' to appear in its ads. However the ad in question does date back to 1985; perhaps we shouldn't hold them too responsible for something they said five years ago.

The remaining letter came from Canberra reader Mr Rod Baxter, who confesses to being a computer engineer with some 25 years experience. In his spare time he has built various hifi amplifiers, and 'dabbled' with other areas of electronics.

Because Mr Baxter's comments regarding fancy cables is basically a report of his personal experiences, I think it's best to quote him directly:

I have viewed the comments about 'special' coax cables, particularly directional ones, with some skepticism, for to me a cable is a cable. But a friend of *mine finally persuaded me to try a couple of his $100 coax cables between my preamp and amplifier. I did this to humour him, expecting little or no change.*

I connected the cables, observing the direction, and played a favourite CD. Well – in the words of the golden ear brigade, it wasn't a veil that was lifted from the music, it was more like an overcoat!

To put it into a better perspective, the improvement was very noticeable the next morning; an A-B comparison was not needed to detect the difference.

As it was a Saturday morning, I went out and bought metre lengths of as many types of coax as I could, so I could perform some listening tests. To cut a long story short, none of the cables I made up came near the expensive cables in performance, and the majority of them performed identically.

I am now in the position of being a non believer who prefers the sound of expensive cables!

One test I did make however, was to try them backwards. The result: no difference, that I could tell! The only conclusion I could come to is that yes, they do make a difference – reason unknown. But I think the directional idea is a sales pitch.

Incidentally I purchased a second pair for my CD player and the difference, although not as great, is still obvious.

I tried a similar experiment with speaker cables, to compare them with my heavy figure of eight type. I finally decided that the more copper the better in the speaker cables – single or multi strand made no difference, to my ears.

Thanks for those comments, Rod. I find your experience with the interconnecting cables very interesting, especially in the light of our own listening tests, to be described shortly.

What's also interesting is your results with the speaker cables. In many ways I'd have expected that if there *are* differences, they'd be more obvious with speaker cables than with interconnecting cables – because they're carrying rather higher currents, and working in a much lower impedance circuit.

By the way I'm not doubting your results, or necessarily your conclusions. Just expressing surprise, and a certain amount of bemusement!

Actually your conclusions about speaker cables are virtually the same as my own. My ears also tell me that it's basically just a matter of how much copper is used – and the more the better, irrespective of the number of strands involved.

Our own tests

Which leads me logically to the *sixth* response to the February column. This came not so much as a letter, but as a 'phone call from Andrew Goldfinch, of Leisure Imports. As you might recall, Leisure Imports is the firm which distributes the 'QED' range of high-quality interconnecting and speaker cables – including the 'Incon' directional cables.

You might also recall that I quoted from a letter received from Andrew Goldfinch in the August 1989 column, and referred back to one aspect of his letter in the February column.

It became quite clear that Mr Goldfinch was anything but happy with the suggestion I made in February column, that the fact that there was a lack of complaints and requests for refunds didn't necessarily mean that all buyers of the cables could hear a dramatic improvement in sound quality, and were blissfully happy. He wasn't impressed with my alternative explanation, that they might perhaps have been unable to hear any improvement, but have been unwilling to admit it.

Fair enough; he's entitled to his views, just as I'm entitled to mine. Neither of us is in a position to canvass all of the buyers individually, and using a technique designed to ensure that there would be no embarrassment in them admitting their honest reactions, either way. So we had to agree to differ...

Mr Goldfinch was also unhappy about Ian McQueen's comments, regarding the possibility that some kinds of black PVC used in cable sheathing could actually *accelerate* the 'black wire' oxidation effect. He interpreted this as suggesting that QED's cables, which apparently use black PVC, were in some way of poor quality.

Of course this wasn't what what was being suggested at all, by either Ian McQueen or myself, and I'm happy to clarify this. There's been no attempt to suggest that QED use anything other than the highest quality materials, or that their cables have ever been subject to the 'black wire' effect.

All that I was trying to suggest was that opaque black insulation was not *in itself* a guarantee that the wires inside would not go black – only that you wouldn't see this happen, if it should do so! And Ian McQueen's message was that *some* kinds of black PVC have apparently been found to cause a higher incidence of wire blackening, than others such as clear PVC.

In other words, we were both merely suggesting that black ain't *necessarily* beautiful, or intrinsically better. But of course QED's cables with their high grade black PVC insulation may *very well* be entirely free of any wire blackening effects, as Andrew Goldfinch insists.

To continue with the story, though, Andrew Goldfinch's main complaint was that to date, all of my discussion of the claimed merits of 'special' audio cables had been *theoretical*. This was a complete waste of time, he suggested; everyone knew it was extremely difficult to come up with either measurements which explained why these cables were better, or convincing theoretical explanations. But, he insisted, there *are* clearly audible differences between these cables and ordinary types – which become evident to the human ear with only a few minutes of unbiased listening.

It would take only 10 minutes of my time to verify this for myself, he stressed. Why hadn't I taken this simple practical step? Was I scared of discovering that I was wrong, in pooh-poohing these cables?

I replied that in order to carry out such tests with real objectivity, and avoid bias, one would have to make up special switching boxes and carry out true 'double blind' comparisons. It would take a good deal more time than 10 minutes to make up such switching boxes, and use them to perform objective listening tests.

It wasn't that I was scared of what I might find – rather that unless I went to a considerable amount of trouble, the results would be pretty meaningless because of the risk of unwitting bias.

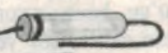
"Nonsense!", he replied. "I think you're simply not game to discover you've been wrong. I've been selling these cables for years now, and I *know* that when they're used as directed, they give an obvious improvement in sound clarity. If you were prepared to listen to them for 10 minutes, with an unbiased mind, you'd hear the difference yourself."

Well, the outcome of our discussion was that we agreed on one thing: if he sent over a sample of his QED 'Incon' directional interconnecting cables, I would carry out listening tests as objectively as I could, with a simple setup, and publish the findings – whatever they turned out to be.

Andrew was as good as his word. A couple of days later, the sample 1-metre long Incon P100S stereo interconnecting cable arrived. And as soon as I could





Forum

after that, I set up the gear at home to carry out the promised comparison listening tests.

I decided to compare the Incon cable with two other types. One was a very low cost 'standard' 1m stereo interconnecting cable, as sold by various audio suppliers and found in umpteen electronics stores. The other was a sample pair of Hitachi LC-OFC interconnecting cables, type SAX-102, which by sheer coincidence had been sent to me a couple of weeks previously by Kevin Mayne, of Alcatel/STC Cannon – the Australian distributor for Hitachi cables.

As part of the tests I also decided to try listening to not just the Incon cables with both possible connections – 'forward' and 'backward' – but the Hitachi cables as well. The reason for this is that although Hitachi don't make any claims that their cables are directional, I'd noted that they had little 'one way' arrows printed on the outer sleeves, like the Incon cable.

I'll tell you the results of my own listening tests in a moment. But before I do, I'll stress that without giving any indication of what I had found, I asked my long-suffering wife Laraine to listen to the various cables and write down *her* impressions. And I played a little trick on her, not explaining that sometimes she was listening to some of the cables in the 'forward' direction, and at other times in the 'backward' direction...

I'll tell you what *she* wrote down in a moment, too. But there's one further step to relate, first. Without giving any indication of what either Laraine or I had found, I brought in all three sample cables the next day, and asked fellow *EA* staffer Rob Evans if he would take them home and carry out similar tests. He was able to do so the following weekend, also managing to rope in his own 'better half' for a further opinion.

So all in all, we ended up with four different people who listened to various kinds of music (familiar to them, in each case), and on two different systems – both of which would best be described as 'good average quality'. And we were all doing our best to be as objective as possible.

Now for the results. Frankly I myself couldn't hear any significant differences between any of the cables, or between either 'direction' for either the QED Incon or Hitachi cables. I listened to various test tracks repeatedly, with each combination, striving to note any clear and repeatable difference; but without any positive result.

Laraine did find that one type of cable produced sound that was slightly 'cleaner' and less harsh than the others: the Hitachi SAX-102. And this seemed to her to be the case regardless of which way around any of the cables were used (and don't forget, I tricked her here – she wasn't aware of the swapping around). But she did stress that the difference was *very* subtle. She didn't detect any differences between the QED Incon and 'el cheapo' cables, though, or between either direction for the QED.

Rob Evans and his lady had very similar results. In a nutshell, they couldn't detect any clear differences between any of the cables, connected either way around.

But what can we conclude from all this? Not a great deal, I suspect – except perhaps that with two particular hifi systems, the effects of the 'special' cables were so subtle that three people out of four couldn't detect them and even the fourth felt that any difference was on the borderline of significance.

Perhaps Jim Rowe's 50-year-old ears have now turned entirely to cloth, and wouldn't recognise really clear sound (or the supposedly horrible distortion of a 'reversed' Incon cable) if it fell on them from a great height. But if so, why weren't the differences picked up by the younger and more acute ears of Laraine, Rob Evans and his wife?

On the other hand, what about Rod Baxter's discovery that such cables produced an effect like 'an overcoat being lifted from the music'? Andrew Goldfinch can provide quite a few testimonial letters from delighted customers, in similar vein – suggesting that for *some people* at least, the differences are far from subtle.

All I can suggest is that the effect of these cables may vary quite significantly from system to system, for reasons which are still not clear. Perhaps it's something to do with the output impedance of the preamp, CD player, cassette deck or other signal source; perhaps the input impedance of the amplifier also plays a role. Perhaps it's more complicated than that; I really don't know, and I haven't had a chance yet to investigate it further.

One thing *is* clear, though. A 10-minute listening test didn't answer all the questions; if anything, it raised a whole lot more. Sorry, Andrew!

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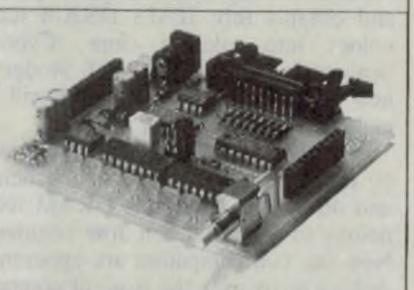

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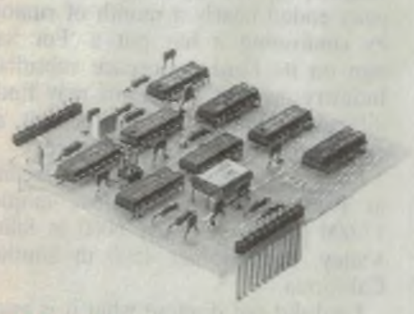

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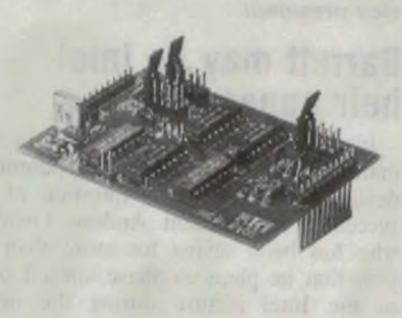

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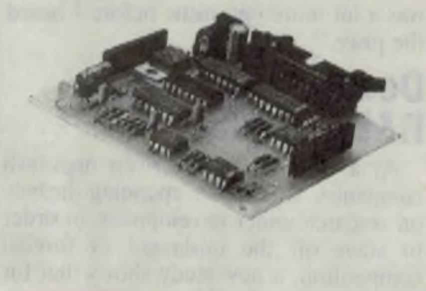

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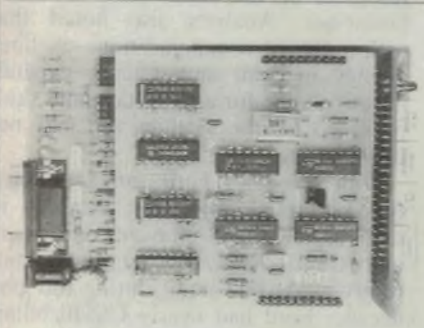

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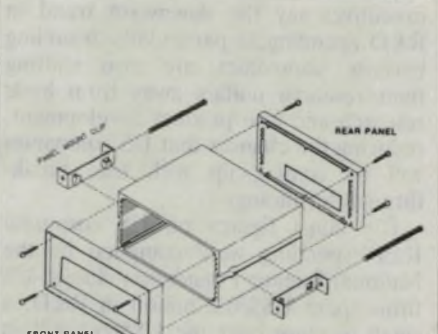

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Silicon Valley NEWSLETTER

Rodgers gloomy on DRAM prospects

After making headlines late last year about his company's ability to quickly and cheaply turn IBM's DRAM technology into saleable chips, Cypress Semiconductor president, T.J. Rodgers, now says he is not optimistic he will be making a deal with IBM after all.

In September, IBM surprised many by taking Rodgers up on his challenge and offered its 4-megabit DRAM technology to the small San Jose company. Now the two companies are apparently drifting apart over the issue of compensation.

Initially, IBM reportedly asked Cypress for US$50 million in up-front cash. Cypress, in late December, countered with a proposal that included some cash and a 'bag full of Cypress products and technology.'

Rodgers said he has not heard from IBM since then. "It is looking grim. I was a lot more optimistic before I heard the price."

Downward trend in R&D spending

At a time when American high-tech companies should be spending heavily on research under development in order to stave off the onslaught of foreign competition, a new study shows that for the first time in 14 years, corporate R&D spending had fallen below the US inflation rate.

Economists and corporate research executives say the downward trend in R&D spending is particularly troubling because companies are also shifting their research dollars away from basic research and into product development, reducing the chances that US companies will be coming up with true breakthrough technology.

The latest figures on US corporate R&D spending were compiled by the National Science Foundation. In all, US firms spent US$68.8 billion in R&D, a small increase over the US$66.5 billion in 1988, but after the adjustment for 1989's 4.6% inflation, spending actually declined nearly 1%.

Craig Barrett, Intel's new executive vice president.

Barrett may be Intel heir apparent

Intel has made several changes in its management structure, apparently designed to answer the question of a successor to president Andrew Grove, who has been saying for more than a year that he plans to phase himself out of the Intel picture during the next couple of years.

It appears that the new heir-apprent will be Craig Barrett, who has been credited for streamlining Intel's world wide manufacturing operations. As part of the shuffle, Barrett was put in charge of Intel's entire internal operation.

With the appointment, Barrett will assume the highest management position ever held by a non-founder of the company.

In his new position, to be effective May 2, Barrett will carry the title of executive vice president of Intel. Currently, Barrett is senior vice president and general manager of Microcomputer Operations.

With Robert Noyce, now director of Sematech, out of the picture, Barrett will be the third in line after Grove and chairman Gordon Moore. Apparently, Barrett was chosen over several other contenders, including the heads of three of Intel's operating units – Laurence Hootnick, microprocessor chief David House, and Leslie Valdez.

Barrett is a 15-year Intel veteran and is said to be responsible for turning Intel from a company most noted for its excellence in research and development, to one that can manufacture its products efficiently as well.

Under the new structure, Grove will devote most of his energies to strategic issues and customer relations, while Barrett will be in charge of the company's day-to-day operations.

For sale: Ford Aerospace

Silicon Valley's largest defence contractor is up for sale. Ford Motor Company ended nearly a month of rumours by confirming it has put a 'For Sale' sign on its Ford Aerospace subsidiary. Industry analysts said Ford may find it difficult to find a buyer for the unit, and even harder to get a decent price.

Ford Aerospace, with major facilities in Palo Alto and San Jose employs 17,000 people – nearly 6000 in Silicon Valley, and another 4500 in Southern California.

Ford did not disclose what it is asking for the aerospace unit, which makes both military and commercial communications and other satellites. However, the company did say that the decision to sell was prompted by a desire to focus resources on the automobile and other businesses. Analysts also noted that with a glut of communications satellites already in orbit and defence expenditures heading for a steep downhill skid, prospects for the satellite unit may not be very rosy.

With the sale, Ford can accomplish two key fiscal objectives: prop up its cash reserves and prevent one of its units from possibly draining those same reserves. At one point during this past decade, Ford had nearly US$10 billion in cash reserves. Following the completion of the purchase of Jaguar, those reserves will be down to only US$2 billion.

Wiltron sold to Japan

Following a buying spree of US equipment firms that started about a year ago, Wiltron, a vendor of electronic test equipment has agreed to be bought out by Anritsu for US$180 million.

Ironically, this acquisition may affect European and other international markets more than the US equipment market, as two-thirds of Wiltron's US$85 million in 1989 business was derived from sales outside the United States.

"This is not a typical financial merger. This is a merger driven by the meshing of the production lines and sales organisations," commented Wiltron spokesman Peter Chalfont.

Wiltron was formed back in 1960 by a group of former Hewlett-Packard engineers. It currently has some 800 employees and operates out of Morgan Hill, south of San Jose.

Anritsu said it will leave Wiltron's management intact and has no immediate plans to make changes in the company's operations. The firm is privately held, with three founders owning the majority of stock. The remainder is held by several hundred current and former employees.

NBS Philips & Thomson form HDTV consortium

The National Broadcasting Company, better known as the NBC television network (and owned by General Electric), is joining with Holland's Philips Consumer Electronics and France's Thomson Consumer Electronics to form a consortium that will develop the next generation of high-definition televisions.

Although Philips has been aggressively pursuing HDTV technology research, company officials said they felt the firm's efforts of designing a successful HDTV product for the lucrative US market would stand a much better chance of succeeding in conjunction with NBC and Thomson. The arrangement has united three of the world's most powerful non-Japanese consumer electronics firms.

Besides the HDTV research performed at Philips, the consortium will also benefit from HDTV work underway at the David Sarnoff Research Center in New Jersey. NBC and GE have been the prime sponsors of the high-level HDTV research at the non-profit Sarnoff centre.

Analysts said the union of the three firms poses the first serious challenge to the Japanese, which so far, have built up a substantial technological lead in the development of HDTV component, display and related technologies.

"We believe it is time for consolidation rather than fragmentation," said Michael Sherlock, president operations and technical services at NBC. "By bringing the best and the brightest from around the world together, we intend to make sure that American viewers are way out front, gaining from the next generation of television."

US Memories goes under

In the end, only US$150 million stood between Sanford Kane and his goal of starting up a company that would be able to supply the most critical of all computer components in large volume, to a US market which has become as dangerously dependent on Japan for memory chips as the West was dependent on OPEC in the 1970s for its crude oil.

But with all of his natural charisma and forceful arguments, Kane was unable to convince the dozen or so interested companies to give the go ahead to his start-up proposal. At a press conference in Santa Clara, a visibly frustrated Kane officially gave up on his effort to start US Memories.

For the first time, Kane and US Memories chairman Wilf Corrigan publicly conceded that some of the reluctance among the potential investors in US Memories was due to certain Japanese DRAM producers, which put pressure on their US customers to stay away from the DRAM venture.

Just one week earlier, four additional companies – Compaq, Tandem Computers, AT&T, and NCR – had pledged their support for US Memories. But during a seven-hour marathon meeting in Dallas, Kane was unable to convince these and the original seven companies to come up with the minimum requirements for his already scaled-down start-up proposal.

Kane bitterly explained how the failure of US Memories was due in large part to the inability of different corporations to work together on a common problem.

"The difficulties we encountered were symptomatic of another major weakness in the US industry: our inability to work together in cooperative ventures. We are less and less the master of our destiny. This is why our major competitors are unable to undermine our industries," Kane said.

Corrigan added that the failure of US Memories also casts a dark cloud over the prospects of other cooperative ventures planned or already under way.

Varian president resigns

Only two months after long-time chairman and chief executive officer Thomas Sege announced his intended retirement in June, Varian Associates in Palo Alto said its president Norman Pond has also resigned to 'pursue personal interests.'

With two of its top managers gone, Varian may be facing a management crisis at a time the firm has embarked on an ambitious reorganisation and shake-up in its market focus.

Pond had been president since 1987 after joining Varian in 1984. At the time of his appointment, many expected Pond to be the heir-apparent to Sege.

Pond's resignation did not come as a total surprise. Industry analysts said that Pond's star appeared to have faded considerably in September when Sege announced his retirement and appointment of a five-person 'office of the chairman' that included Pond and was charged with finding his replacement. If Pond had been Sege's successor, that step would not have been necessary.

Analysts said the possible loss of faith in Pond may have been caused in part by the problems Varian is experiencing in its critical electron tube division, which Pond headed between 1984 and 1987.

Bush drops HDTV from budget

As expected, President Bush's 1991 budget did not include funds for the first phase of a Pentagon project aimed at developing high-definition television technology.

Besides scrapping the HDTV project from the 1991 budget, the Bush Administration also said it will withold the US$20 million which the Pentagon's DARPA arm still has left over from the US$30 million allocation it received in the 1990 budget. The government said the release of those funds will depend on a progress report on the research projects undertaken with the US$10 million that has already been spent.

Jack Clifford, who directs the micro electronics and instrumentation division of the Commerce Department, said he does not expect any additional funds to be released for HDTV research. "From what I have seen, there is not going to be any government-led HDTV effort."

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The Serviceman

Dry joints, unlucky numbers and a real curly problem with a VCR!

Another interesting 'mixed bag' for you this month, with two of my own stories – one of which seems to defy a satisfying explanation – and a third from a colleague in semi-rural Victoria. His story is quite intriguing; and while my own second item concerns a most unusual piece of equipment, the fault in it turned out to be fairly familiar.

When I write up these Serviceman stories, I try very hard to give you all the details. Not only those associated with the symptoms and how I found and fixed the fault, but if at all possible, an explanation of why the set behaved as it did. Sometimes my knowledge of theory is insufficient to fully explain the symptoms, but I can usually say enough to satisfy the average reader.

There are occasions, however, when logic flies out the window and I cannot see any connection between the fault and the symptoms. The tale that follows is one of these mysteries.

It was actually written in two parts. Fortunately, I had not sent the first chapter in to the *EA's* editor when the callback arrived. This gave rise to the second episode, and compounded the confusion that already existed.

The set was a Kriesler 59-03 – a big, double ended 22" console model colour TV with pushbutton channel selection.

The owner complained that the set persisted in shifting off channel, at indeterminate times. It might be every five minutes, or only once a night. But it could always be relied on to play up at the most interesting part of a murder mystery!

All channels would shift up the scale, and after they had been re-tuned at the new location, they would all go downscale to their original positions.

Quite obviously, I was looking for a shift in the tuning voltage; and I felt certain that this would eventually turn out to be a dry joint somewhere in the channel selector or tuner. I was right, but I was also very wrong.

I wasn't able to spend much time in the owner's home, as he was in a hurry to go out. So I packed the set into the van and took it back to the workshop.

Back home, I went over the front control panel with a metaphorical fine toothed comb. All I could find there to explain the fault was that one of the plug and socket assemblies was a little loose. The socket contacts could be disassembled and tightened, so a few minutes' work there eliminated one possible source of trouble.

I let the set run, to see if it would play up again; but the results with the tuner were inconclusive. Instead, I found three new faults!

I accidentally bumped the 'large signals' board, whereupon the set gave out a small squeak and the picture disappeared. When I bumped the board again the picture promptly came back.

Over several such cycles I learned that the fault was in some way shutting down the line oscillator, while voltage remained on the line output. The picture collapsed to a vertical line, then faded to nothing.

It was obviously a dry joint around the line module – a problem not all that rare in early Krieslers. So I went over the module very carefully, looking for breaks. I also checked that area on the main board, just in case.

I found nothing. But at next switch-on, the symptoms had changed. Now the colour was intermittent! One thump and there was no colour; another thump and the colour was back.

Whatever it was, the fault was still on the large signals board, so I started again to look for a dry joint. Although I found a number of doubtful joints, none were so far gone as to be the certain cause of the troubles.

After all this attention, the next switch-on produced yet another fault – random dark lines across the screen. There was just one good thing about all this: the cutting-off and the no colour reappeared at odd, erratic intervals.

Through all this, the original fault never once showed up. The set stayed on channel as though glued there. Either the loose plug and socket had cured it, or the new symptoms were merely different manifestations of the same fault.

I couldn't see any sign of a dry joint, even though I knew there had to be one. So I set about resoldering every joint on the board. I divided the board into 16 small, manageable areas, and worked over each in turn.

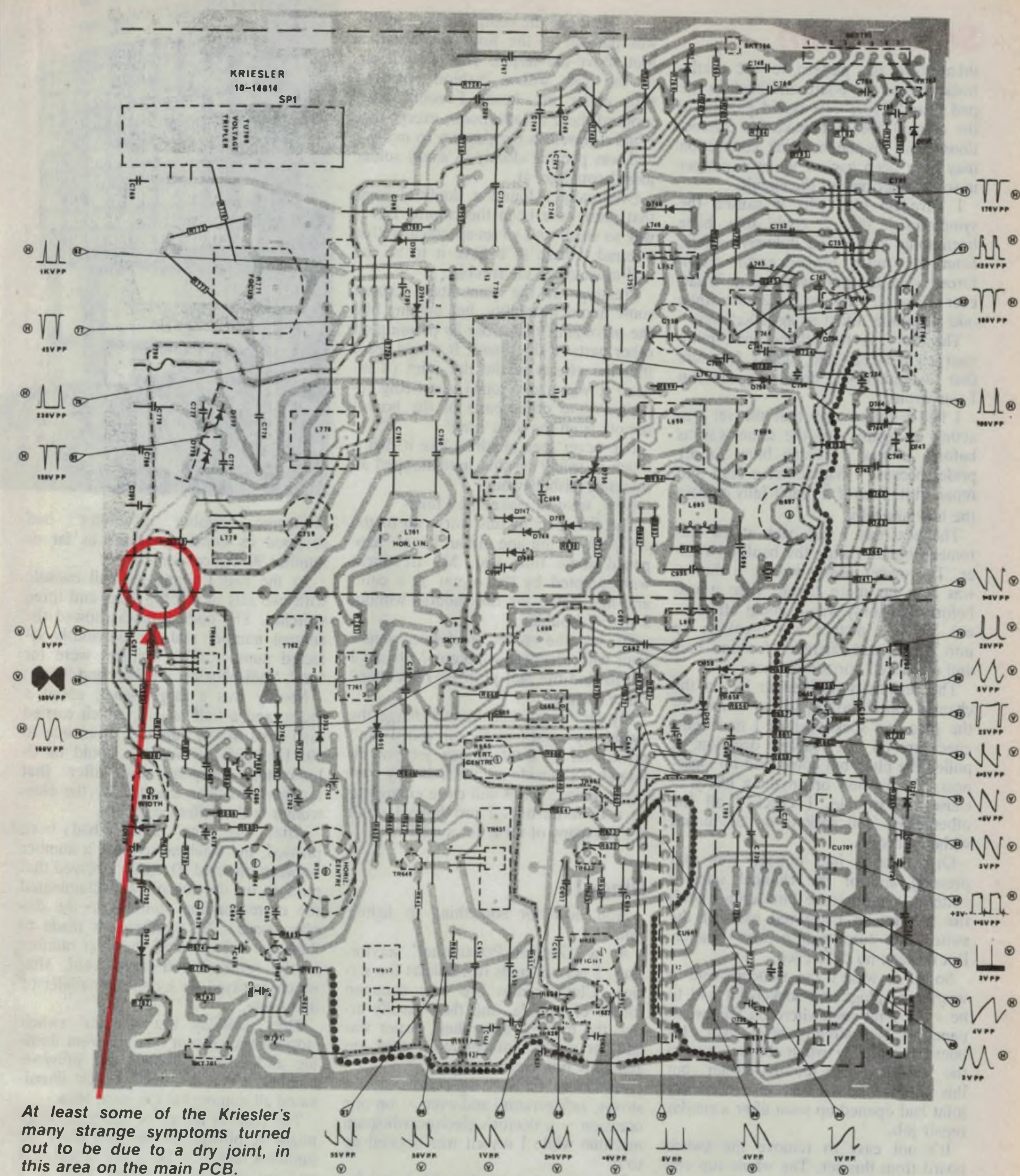
I was on the eleventh of these areas when I found it!

The early Krieslers (and the Philips chassis on which they were based) have a large heatsink, mounted across the middle of the circuit board. This is secured with tabs bent over on the back of the board, then soldered to earthy tracks of the printed pattern.

The soldering is quite important, because some of the earthy tracks of the PCB actually rely on the heatsink for connection to chassis ground. In other words, the heatsink forms a jumper link for some parts of the pattern.

Right over on the left hand side of the board, adjacent to socket SK102, I found a tab from the heatsink sitting in a ring of eroded solder. There seemed to be no contact whatsoever between the solder and heatsink, so any fault caused by that dry joint should have been permanent. But it wasn't.

Resoldering the joint cured all of the troubles, and the set hasn't moved off channel since. (I've left that sentence in



At least some of the Kriesler's many strange symptoms turned out to be due to a dry joint, in this area on the main PCB.

the present tense, as written, but you'll soon see that my confidence was badly misplaced!)

The only trouble is, I can't explain why the dry joint did what it did. The heatsink is firmly soldered to the board in 13 places. The two outer edges are solidly bonded to the earthy print pattern that surrounds the board. Three of the 13 connections form vital earth connections for part of the circuitry.

It was one of these joints that had come apart. It seemed to have a solid DC connection through the heatsink, probably to the centre of the board, then down the pattern to the earthy track around the board and back to the pad near SK102. The board pattern in the manual does not make the connections clear, so the heatsink connection may have been backed up by a jumper in some other part of the circuit.

I have no idea why it caused the symptoms it did. It could only have been some kind of an inductive effect, from the much longer earth return forced when the joint went open. Whatever it was, it's one to remember when odd symptoms afflict an aged Kriesler.

The story so far related took place over eight weeks ago, and I felt sure that I wouldn't hear about it again. But I was wrong.

I had a call to say that the set was acting up again, just the same way as before. It was a savage blow to my pride, because I had found a fault and repaired it, even if it didn't fully explain the how and why.

The next day I was back at the customer's home, facing the baulky Kriesler. The owner wasn't wrong – the set was now far more touchy than it was before. Not only was it going off-channel, but the picture was breaking up into a confused mixture of sound bars and un-locked horizontal lines.

The sensitivity seemed to be on the channel switch board, in the vicinity of the plug and socket which I had tightened up on the earlier occasion. I pulled the plug, but could find no looseness or corrosion or anything likely to cause the trouble. I checked all the other plugs and sockets on the board without success.

One thing I had noticed was that pressing any of the channel selector switches caused some interference with the picture; so I sprayed each of the switches in turn with contact cleaner. But it made no difference.

So, if it wasn't the switches and it wasn't the plugs and sockets, it had to be a dry joint somewhere on the switch panel. I had already been over this board thoroughly when the set was in the workshop two months earlier, but this wouldn't be the first time that a dry joint had opened up soon after a similar repair job.

It's not easy to remove the switch board from this set. The whole top end of the control panel has to come out to release the board. I decided against that lengthy procedure on this occasion, and instead adopted a pose that would have looked quite amusing had there been anyone around to see me.

I hinged out the control panel, until it was parallel to the floor and about a foot above the carpet. Then I lay down on the floor with a cushion from the sofa under my head. I could have snoozed there all afternoon, except that I had a jewellers eyeglass up to my eye and was peering closely at every solder joint I could get at.

Eventually I found a doubtful joint that must have been the culprit. But it was so small and so un-spectacular that I found it hard to believe it to be the real cause of all the trouble.

Pressing on the joint itself caused some minor instability, but nothing like the paroxysms that arose by pressing on other parts of the board. It would seem that the effects of the dry joint (if indeed it was a dry joint) was being reflected onto other parts of the board, remote from the joint itself!

I've never seen anything like it, but a touch of solder on that joint stopped all traces of misbehaviour.

Now, what to make of all this?

The first part of this story, up to the dry joint on the line output board, happened some time ago. My treatment was accepted by the owner as a cure, and had lasted for two months without a sign of trouble.

So, was the recent breakdown a new fault with identical symptoms? Or did I fail to find the real problem back then? I don't know.

My problem is that I can't charge the owner my usual fees for this job. I can't prove that it's a totally new job and although it's outside my usual 30-day warranty period, it was still close enough to be a doubtful one. I just hope I don't get too many of these for a while!

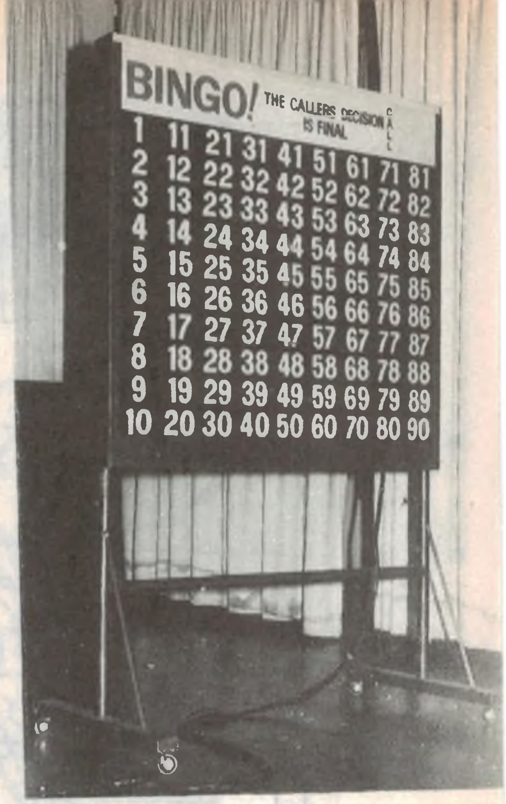
Bingo!

And now for something in lighter vein.

As a 'General Practitioner' serviceman, I get all kinds of requests for service. Clock radios are one common source of trouble, and they usually arrive the evening after their owner was late for work. Unfortunately, they are generally not worth fixing.

At other times, I get calls to fix stoves, refrigerators and even – on one occasion – a doctor's electrocardiogram machine while I myself was hooked up to it!

But what must be the oddest call for help came recently when an acquaintance rang in to say "Me number's stuck! I got no 90!" It turned out that he was a caller in a local Bingo Hall, and the display board attached to his



electronic number generator had dropped its bundle, at least as far as number 90 was concerned.

At the hall I found a small console with two sets of display tubes and three switches. The display tubes showed the current number and the previously selected number. The switches were for 'run', 'redisplay last number' and 'test'.

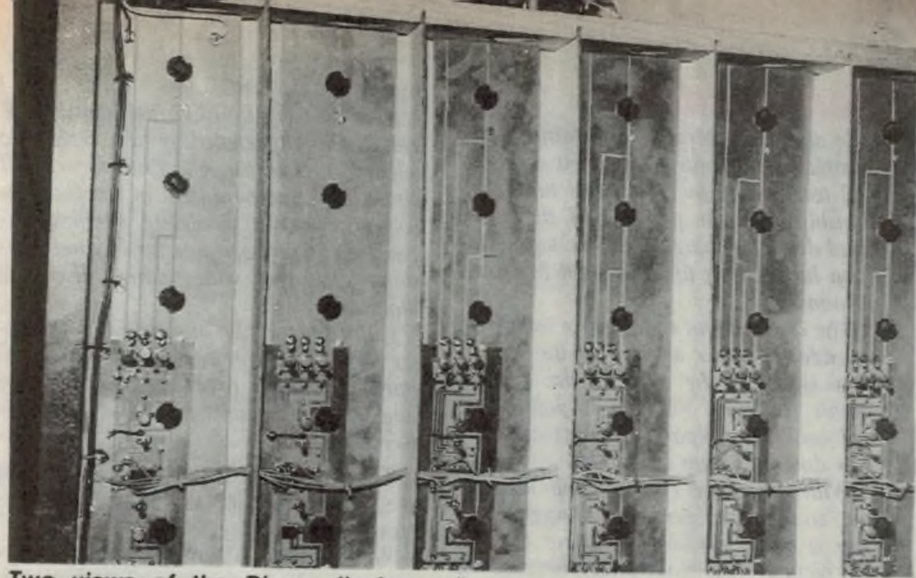
Nearby was a large panel, about a metre and a half square, which carried nine rows of ten numbers: from one to 90. Each of the numbers could be illuminated independently, after that number had been selected by the electronics in the caller's console.

After the 'run' switch had been pressed, the machine selected a number between one and 90, then displayed that number on the console and illuminated the corresponding number on the display board. The number was made to flash on and off until the next number in the series had been selected, after which it stayed on for the remainder of that game.

The 'redisplay last number' switch stopped the current number from flashing and instead, flashed the previous number. And the 'test' switch illuminated all numbers at the same time.

The reasons for all of this technology might be obvious to one who plays the numbers regularly, but I just accepted it and got on with the repair. That is, I had to get number 90 to light up.

The display board uses small 12V lamps, similar to those used in car dashboards. The sockets that hold the lamps were also automotive types. This part of



Two views of the Bingo display unit, which our Serviceman also found himself repairing this month...

the display was decidedly low-tech, and most unlikely to give any real problems. On the other hand, the electronics, though primitive, offered plenty of scope for difficulties.

Incoming signals from the caller's console are first decoded by a small circuit board at the bottom of the cabinet, then distributed to 15 double-sided boards – each controlling six of the 90 numbers.

Each side of the switching boards carries an IC, three driver transistors and three switching transistors. There are nine wires running to each of the 15 boards, comprising logic input, 12V input, ground and six output lines to the relevant lamps. Although there's plenty of room behind the front panel, it's still a very busy place.

It took little time to find that the number 90 lamp was OK and that the trouble was 'no 12V' at the lamp socket. It took considerably more time to trace the lead from the 90 socket up the side of the panel, where it joined with the leads from all the other lamps, and then across the top of the panel to one of the switching boards mounted almost diagonally across from the numbers it controlled. (Whoever designed this panel must have got his cable at a discount!)

Once I had found which transistor switched number 90, it was a quick job to determine that it was open circuit. I established that the driver transistor was OK, as was the IC decoder. This may not have been the case if the switching transistor had gone shorted instead of open, but Murphy was on holidays (or maybe he was anxious for the Bingo to start!)

Unfortunately, the switching transistor was a type 2N3053 which I didn't have in my kit. As far as I could tell, it was a simple NPN type, probably a 40V/1 amp unit, and a suitable BD type should do the job just as well.

But it wasn't to be. The BD transistor which I selected simply would not switch on. It's probable that the available base drive current was insufficient, or something like that.

I might have gone through my collection of transistors until I found one that would work, but I'd already spent as much time on the job as I felt was justified. Better to come back next day with the correct transistor, which I did.

After that there was no more trouble. Number 90 came on bright and clear every time the 'test' switch was pressed. It took a lot longer to get the number up in the random select mode. It could have been the first number to be displayed, but not for me. I had to wait through more than 60 calls before 90 started to flash and proved that the repair was indeed finished.

The Bingo game is run by a charity and although they insisted on paying me for my work, I felt constrained to make only a nominal charge. They're happy, I'm happy and now I know a bit more about Bingo display boards than I did at the start of the exercise.

Curly VCR problem

And now to round off this month's collection of servicing stories, we have one from a contributor, Mr C.B. of Dromana, Victoria. C.B. has turned up a most unusual video recorder fault, which I'm sure would have trapped the most experienced serviceman. The story is told here in his own words:

One of the difficulties of operating a general service workshop in a country area is the vast range of equipment you have to repair.

If you were to count the number of makes and multiply that by the number of models, then multiply that by the different product groups (TV, VCR, hifi etc.), you start to see the scale of the problem. This makes it difficult to get to know well the products you work on.

Back in the black and white TV days it was possible to know most of the standard faults for any model. This made home service practical and kept most repairs economical. These days the variety of gear that passes over the bench makes repairs in the home nearly impossible; you simply can't carry enough service manuals, nor afford to stock the huge range of necessary parts.

In years gone by I have successfully repaired TVs well over 10 years old. These days the response to a parts or service manual inquiry on a 10-year-old model is usually "sorry, can't help".

Just to complicate things further, you can be caught with faults in equipment that you thought you knew well. Which leads me to the tale of the wobbling VCR.

It was a Sharp VC-481, a very popular machine with few surprises for an experienced technician. Or so I thought...

The machine presented with a reasonable picture on play, but a regular flutter in the sound. The flutter was quite distinct and seemed to occur at a rate of 4 to 5 hertz.

Checking the tape path drew a blank, so I lifted the tape from the audio/control head with a plastic alignment tool. The flutter was obviously a variation in tape tension, enough to be heard but not to cause any visible tracking error in the picture.

I stripped the machine down and removed the cassette loading mechanism, to gain access to the reel bases that drive the supply and takeup tape spools. On a few occasions I've encountered serious wear or foreign matter, causing the tape back tension control brake to cause short term tape speed variation.

Not a sausage. The brake band was clean and the hub the brake runs on was in perfect condition. The fault was obviously in the servomechanism. The procedure with this sort of problem is as follows: reach for the service manual, warm up the oscilloscope and engage the thinking apparatus.

The first place to look was the capstan motor drive voltage. The scope showed a DC component of about 5 volts, with a lovely 2 volt peak to peak sine wave of 5Hz superimposed. "That confirms it," I thought, "a servo fault".

In playback mode the capstan servo has two loops. The speed loop sets the average speed of the tape and uses a fairly slow time constant, so that overall *tape speed is correctly maintained. The second phase control loop sets the control track pulse to the correct time relationship with the position of the video head drum spinning within the tape. This loop has a short time constant for rapid response.*

The error output signal from each loop is added together and forms the correction signal to be sent to the capstan motor. In most VCRs it is possible to kill each loop separately. This can narrow down the hunt quite a lot.

With the phase control loop disabled the sound was perfect, although there was a noise bar slowly rolling through the picture. This made sense, because the heads were no longer obliged to start reading the video tracks at their start point, and were simply drifting through at random.

The scenes that followed weren't pretty, so I won't elaborate; suffice to say that an entire working day disappeared, along with my patience. I couldn't find the slightest reason for the oscillation in the phase loop.

At this stage in the proceedings, discretion being the better part of valour, I kicked the machine under the bench and filed the problem in my subconcious.

Every couple of days I pulled the rotten thing out and had a short fiddle, just to clarify any questions that had formed.

After a week the answer came to me. There wasn't anything wrong with the electronics of the VCR at all! The fault condition was mechanical in nature, although no individual component of the servo system was in itself faulty.

This machine had come from the workshop of a colleague, who, having done his best, had passed it over to me to see if I could do anything with it.

The original fault was dirty heads, and a desperate need for some general servicing. These things had been attended to, and to complete the job a new kit of drive belts had been fitted.

The recorder had been back with the customer for three weeks before the sound problem had shown up. It turned out that the new capstan drive belt, a fairly short flat item, was too compliant. There was too much elasticity between the motor pulley and the flywheel formed on the base of the capstan shaft, producing 'backlash' and hence making the servo become unstable.

The belt kit used was made by a reputable Japanese manufacturer, and I have never seen or heard of any quality problems with them. But an 'original parts' drive belt cured the problem completely, and gave me a new slant on servicing modern equipment.

John Logie Baird's mechanical TV system was superseded by fully electronic television. Now the wheel has turned full circle, with the new field of 'mechatronics' turning out devilishly cunning apparatus, with properties far beyond anything possible with either discipline alone.

Unfortunately the marriage of mechanics and electronics can also turn an apparently simple problem into a costly and wasteful headache for the local serviceman.

Thanks, C.B., for that new slant on mechanical problems in nominally electronic equipment.

We servicemen tend to think of ourselves as electronics specialists but really, there is little that is totally electronic among the work that we do. So much of our work is mechanical in one way or another, even to the problems of mounting a transistor that is a different type to the original.

Audio tape and cassette recorders were bad enough when they developed mechanical problems, but we now have even more scope for trouble with video recorders. And let's not mention CD players or computer disc drives!

Once upon a time we were all 'radio mechanics'. Then came television and we upgraded our skills to become 'electronic technicians'. Yet it could be argued that we are still mechanics of one kind or another, albeit more skilled than the 'dial-stringers' and 'valve jockeys' of yesteryear.

As C.B. points out, it doesn't pay to ignore the possibility of a mechanical fault in electronic equipment.

Fault of the Month

Sanyo CTP5601

SYMPTOM: Low height. Vertical linearity and height controls have no effect and most voltages around the vertical stage appear to be correct. All of the electrolytic caps that might cause this fault check OK.

CURE: Vertical output transistor Q904 (2SC1025) had an open circuit base/emitter junction. An important clue to this fault is the lack of any voltage on the emitter of Q904. It should be around 62V.

This information is supplied by courtesy of the Tasmanian Branch of The Electronic Technicians' Institute of Australia (TETIA). Contributions should be sent to J. Lawler, 16 Adina Street, Geilston Bay, Tasmania 7015.

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According to our author, he's found

The painless way to home construction

Here's a very positive and constructive (pun intended) article on building hobby electronics projects. It's especially intended for newcomers to electronics, who may not know how to get going – or simply aren't aware of things like Vero-board.

by TOM MOFFAT

Home brewing – it ain't dead yet! Despite the wails of deadbeats who say "it just isn't worth building stuff any more", the gentle art of home brewing is still alive and kicking.

Think of it this way: every electronic gadget you see for sale nowadays started off as somebody's home brew project. The professionals call them 'prototypes'. But you and I know the truth – a 'prototype' is just somebody's lashed-together thingamabob that finally managed to work!

Throughout my own electronics career, I have built up many circuits just to see what would happen; to see if some idea or technique were possible. Many of these constructions were absolute duds, tossed into the junk box for possible salvage or stripping for parts. Other devices that showed promise were hacked about, re-built, refined, and eventually turned into magazine projects or full-blown commercial products.

Photo 1 shows four examples, clockwise from upper left: a computer speech synthesizer, a prototype weather fax receiver that eventually went into full commercial production, a single-wire multi-channel remote control system, and a fax decoder that became a magazine project.

All of these circuits were built using a construction method known as 'Vero-board'. This is a phenolic insulating material similar to cheap-quality printed circuit board, drilled all over with holes on a 1/10" grid. This is convenient, because integrated circuits also have their pins set up on a 1/10" grid. In this instance, inches rule!

On the back of the board, the holes are connected together, in one direction only, with strips of copper. You turn the copper strips into useful conductors by removing selected sections of the copper with a drill bit. Simple, and effective!

But let's go to the beginning. The construction methods we will look at are for YOU to use to try out YOUR OWN designs. This isn't kit building, this is original design.

We will use as an example in this article a little circuit you won't be the least bit tempted to copy. It's quite useless, as you can see (Fig.1). The circuit consists of a NOR gate, a transistor driver, a LED, a few resistors, and a bit of wire to tickle the inputs of the NOR gate so you can see what happens to the output. Wow!

Circuits of this type usually begin life on a chunk of plastic called 'proto-board', shown in Photo 2. Like Vero-board, proto-board is laid out on a 1/10" grid. But where connections to Vero-board are soldered, every little hole on proto-board contains a springy socket that grips a wire or pin that is pushed into it. If you want to change something, you just pull the wire or component out of one hole and try something else. The parts can be re-used many times over. EVERY true experimenter should have at least one piece of proto-board, to mock things up quickly.

Photo 3 is a close-up of our experi-

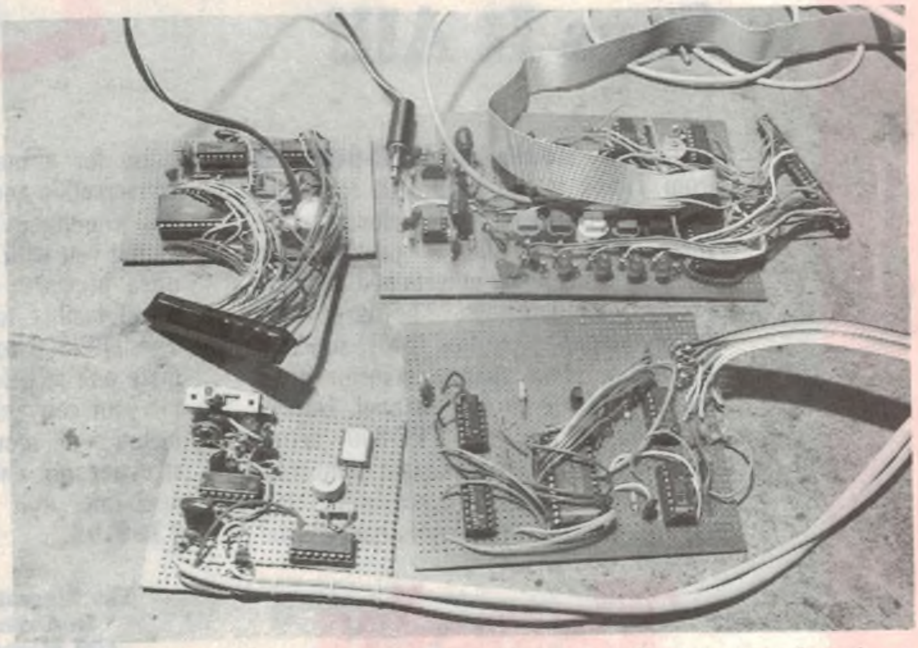


Photo 1: Four examples of projects the author has built up on Vero-board – a speech synthesiser, a weather fax receiver, a multi-channel remote control system and a fax decoder.

ental circuit lashed up on proto-board. 's based on a 74C02 quad NOR gate. nly one of the four gates is used; the st are wasted (at least for now).

The output of the gate is connected to a transistor driver, and thence to a LED. The LED lights up when the gate's output goes high. The gate's two inputs are both pulled low via 1k resistors; in this condition the LED will light up. Placing positive voltage on either or both inputs will send the output low, turning the LED off. And that's all the circuit does. So you won't want to pinch this design; go and design something yourself, if you want anything useful!

As your proto-board project evolves, you should try to keep a more-or-less up to date schematic circuit diagram of it. It's a good record of the work you're doing, and a circuit diagram makes it easier to visualise exactly what's going on. You should also be making notes of any funny results (smoke from IC1, etc!).

As noted earlier, Fig.1 is the circuit diagram of our demonstration project. It is very important to give your project a working name and make sure all your notes and diagrams are labelled with it. That way you won't pick up a scribbled circuit later on and ask yourself, "now which one was that for?". Our useless demonstration circuit has been named 'EA-THING'.

Fiddling about with proto-board will probably teach you the most about electronics in the shortest possible time. All you need is a handful of assorted resistors, capacitors, diodes, etc., some small NPN and PNP transistors, and a collection of CMOS IC gates.

The CMOS family is preferred for several reasons: it's tame (not prone to breaking into unwanted oscillations), it's not particularly choosy about what voltage it runs from, it draws minuscule currents from inputs and the power sup-

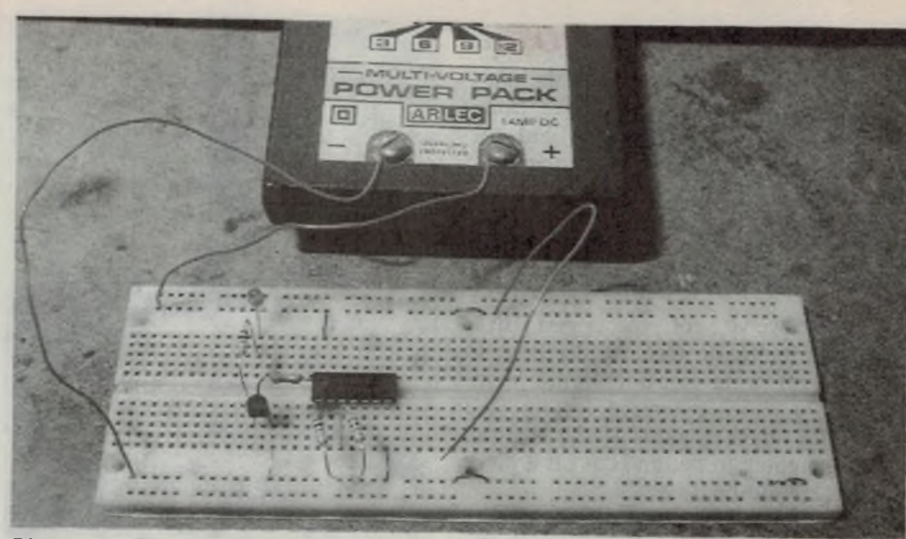


Photo 2: The easiest way to get your circuit going initially is using a 'proto-board', as shown here.

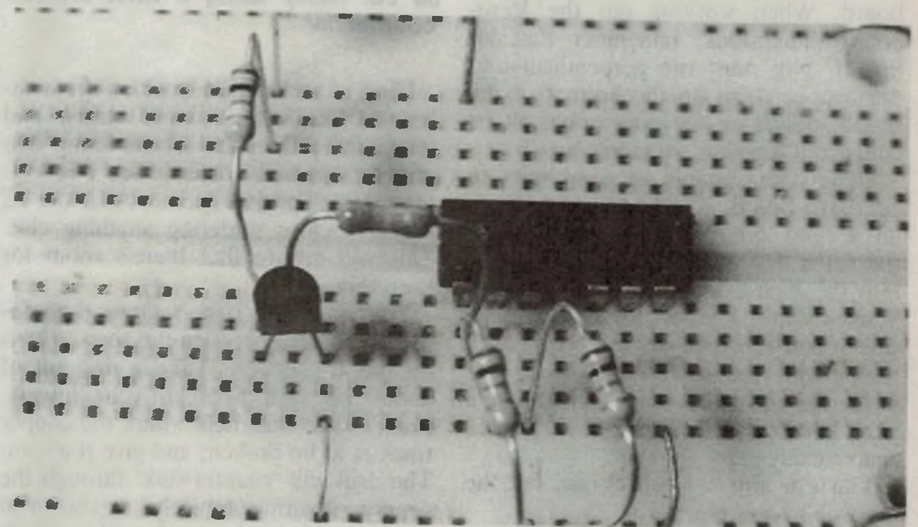


Photo 3: A close-up of proto-board wiring, showing how the component leads are poked into the socket holes.

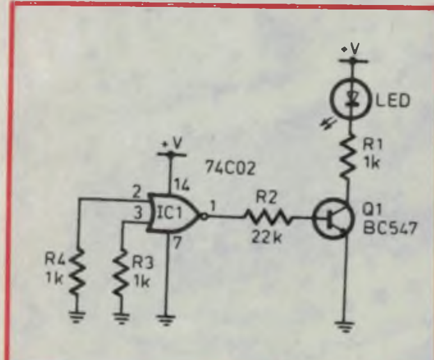


Fig.1: The circuit of our little demo project – a useless little gadget called the 'EA-Thing'.

PRECAUTIONS

There are a few things to look out for while zipping around your Vero-board, drill bit in hand. Do NOT cut any copper track unless you have to. Many times you will discover you have to add to the circuit, and the track you cut would have gone just where you wanted it too. Also do NOT get too heavy-handed with the soldering iron; the tracks will get hot and lift from the board's surface. Little accidents like this can be repaired with bits of wire, but it's messy and inconvenient.

Another source of trouble is where screws go through the Vero-board, as in the keyer in Photo 9. If you just drill the holes and bung the screws in, they may short out to the copper tracks. The solution is to counter-sink the screw holes with a larger drill bit, so there's no way the copper can touch the screws.

Vero-board, by its very nature, dictates circuits with long leads and square corners – not conducive to good RF design. So don't get any ideas of building a two-metre transmitter on Vero-board; it's very unlikely to work at all. I've built a couple of 160-metre and 80-metre amateur transmitters on Vero-board, but they've been pretty touchy. Not really recommended, but if you want to have a go, feel free.

All in all, this type of construction is really best for audio and digital circuits, but if you're a radio amateur with an experimental streak, there's plenty there to do. Perhaps you can be the one to come up with the next world-wide standard of high-speed picture transmission by narrow-band radio!

ply, and it's rugged. Despite the dire warnings from the experts, I've done horrible things to CMOS IC's and got away with it. I've even hooked them up backwards so they got too hot to touch, and they still worked once connected the right way around.

Going to Vero-board

Right, we've got the EA-THING working, more or less, so it's time to move it off proto-board and onto Vero-board for more extensive testing. We must first make a guess at the size the circuit is going to be, and cut off a piece of blank Vero-board stock.

You can make a pretty good estimate of the 'real estate' required from the amount of space used on the proto-board. When working out the Vero-board dimensions, remember that in-line IC pins must run perpendicular to the copper strips on the bottom of the board; otherwise the pins would all be connected together, wouldn't they?

There are a couple of good ways to cut Vero-Board. The best method is to lay a ruler along a line of holes where the cut is desired and then score deeply into the board, along the holes, with a Stanley knife. It's best to do it on both sides. You can then lay the board on a table, with the scored line along the edge, and give the overhanging part a good whack with your fingers. It should snap cleanly.

You can also use a hacksaw, but the cut won't be as clean.

When the board is cut to size it's a nice idea to smooth off the edges with a file. Then you must carefully clean the copper side of the blank Vero-board, otherwise it will be very difficult to solder to. Some versions come with a lacquer on the copper, but even this may be nicked and corroded.

The best way to clean the copper is to scrub it with good old-fashioned 'Ajax'. If it's really daggy, you can tackle it with some 'Twinkle Copper Cleaner' first; *then* hit it with Ajax. When you're done, the board should be as clean and bright as that in Photos 4 and 5.

Rinse the board, dry it with a clean towel, and then try not to touch the copper at all as you build your circuit on it. The same cleaning technique, by the way, works great on grotty PCB's.

Now you can begin installing your IC sockets on the non-copper side of the board. ALWAYS use sockets; never solder the IC's straight in. You'll be removing IC's later when you're trying to figure out why the circuit won't work.

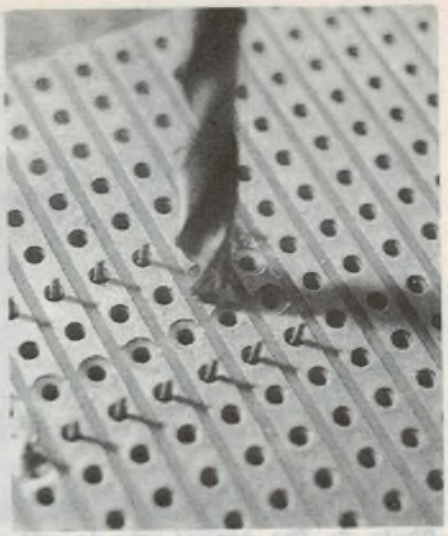


Photo 4: How Vero-board tracks can be cut easily using a twist drill as 'countersink'.

Place a socket into position (remember ACROSS the copper strips) and then tack it in place by soldering two pins on opposite corners. See Photo 4. On a larger project tack in ALL the IC sockets before soldering anything else. This will ensure that there's room for everything.

Your next job is to remove the copper strips from between the rows of pins on the IC sockets. Take a drill bit of about 1/8 inch between your fingers. Press it into each hole where the copper track is to be broken, and give it a spin. The drill will 'counter-sink' through the copper, severing it nicely, as shown in Photo 4. It's harder to clear the copper when there is solder from an adjacent hole, so don't solder the rest of the pins until the 'drilling' is finished.

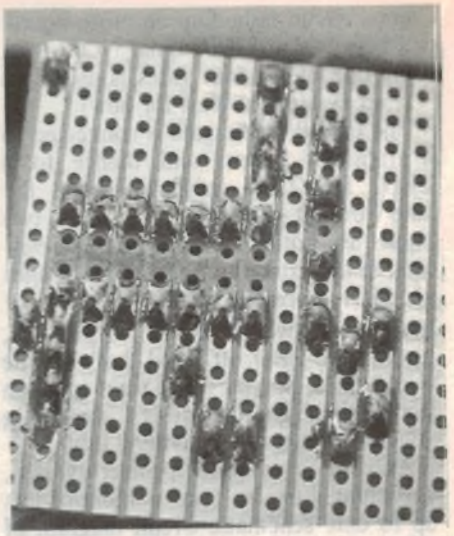


Photo 5: The copper side of a piece of Vero-board with our EA-Thing project wired up.

Photo 5 shows the copper side of the Vero-board with the circuit completed. Note that ALL copper has been removed from between the IC pins; this was done by heating the remaining shreds with a soldering iron until they just fell off. It makes a much neater job.

Flipping the Vero-board over, we get Photo 6. One jumper wire was required to provide a ground connection between pin 7 of the IC and the emitter of the driver transistor. This was made with a bare wire, to provide a convenient place to pick up ground for an oscilloscope or multimeter.

On larger projects, once the IC sockets are in place, I normally run all power and ground jumpers before I do anything else. These will generally lay flat on top of the board, aligned per-

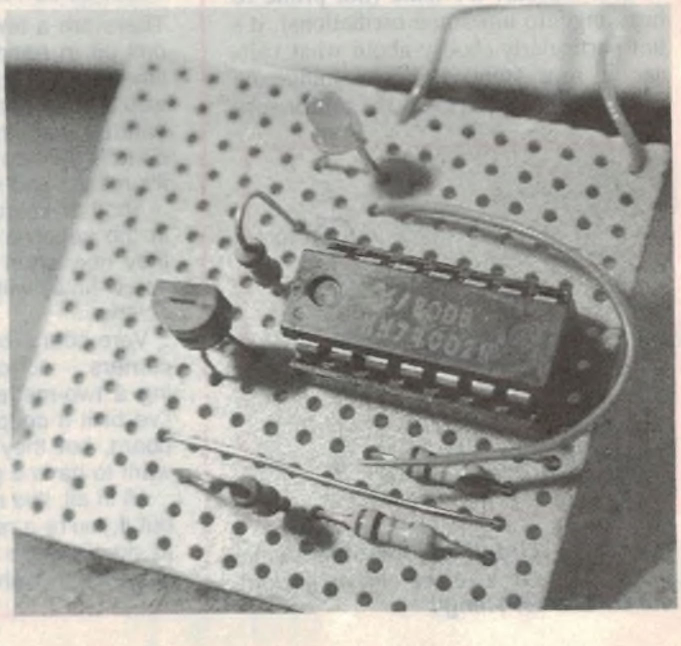


Photo 6: The top side of the board shown in Photo 5 above. Note the bare tinned copper wire link.

pendicular to the copper strips below. I usually use bare wire unless there is a danger of shorts. I then temporarily connect the volts and confirm that power and ground appear on the correct pins of each IC. Once the power wiring has tested OK I then install the transistors, resistors, capacitors, diodes, and other components.

Finally come signal and logic lines. It isn't very often that the copper strips run where you want them to, so you'll need to install lots of bits of coloured wire from pin 6 of this to pin 3 of that and so on.

The best source of wire is multi-coloured ribbon cable. You can pull each wire away and use it individually. If you're building some kind of computer gadget that uses an eight-bit data bus, you should try to use coloured wires to indicate which is bit 0, which is bit 1, etc. The wires should follow the resistor colour code, so black=0, brown=1, red=2, and so on. When it comes time to trouble-shoot your creation, you'll be thanking yourself for being so thoughtful!

Remember that when you connect a wire to a copper strip running to an IC pin or other component lead, you must take note of where else the copper strip goes. If it makes a connection you don't want, you must cut it with the drill bit. But if it just runs off to the edge of the board, leave it alone – it might come in useful later.

Photo 7 is an overview of our Vero-board 'development lab'. There's not a lot there; you can set yourself up for just a few dollars. You'll need the usual hand tools; perhaps you already have them.

Below the board is our 1/8" drill bit, and an Exacto knife for precision trimming of copper cuts. If you can get a surgeon's scalpel, so much the better. The spectacles are only for old goats like me who have passed 40. They magnify two times, you can peer over the top of them, and you can buy them off the shelf in chemist shops.

Photo 7: An overview of the author's Vero-board 'development lab', complete with tools, power supply and close-up specs.

Photo 8: And here's Tom Moffat himself, designing the final PCB using Protel Easytrax running on his Toshiba laptop PC.

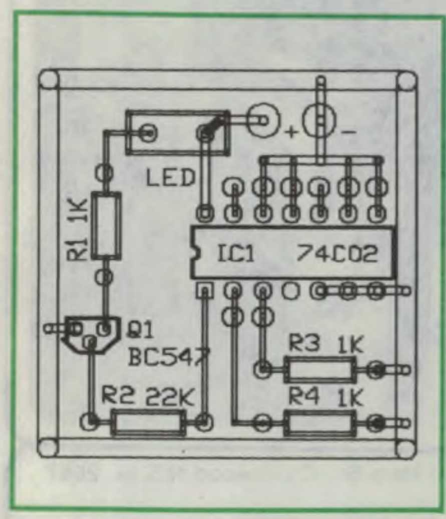


Fig.2: The PCB pattern he produced using Easytrax, printed out on a dot-matrix printer (75% of full size).

As for the Arlec Multi-voltage Power Pack, it's something I've had lying around for years to provide power for experimental projects. It's a bit rough and ready, and it's not regulated. A power supply that would be just perfect for this kind of experimental work appeared in the July 1989 issue of *EA*. I want one!

If your new design is a smashing success, you may decide to produce it as a manufactured product, or as a magazine project. Either way, the next logical step is to reproduce the Vero-board design as a proper PCB.

Fig.2 is a PCB layout for our demonstration circuit, produced on a Toshiba laptop computer with the new Protel Easytrax design program. This makes a nice, small 'CAD workstation' that fits on the dining room table (see Photo 8). It can all be folded up and put away when not being used.

As you can see, the PCB layout is very similar to our Vero-board layout. It could have been tightened up a bit, but I thought it better for this article to leave it looking as much like the Vero-board version as possible.

There are a couple of enhancements, though. There is now a big fat ground bus running around the whole perimeter of the board. As well, the power supply tracks have been thickened. This is good practice, to make their impedance as low as possible.

It is also good practice to tie all unused inputs to either the power rail or ground. Pins 5 and 6 on IC1, which are extra gate inputs, have been permanently tied to pin 7, the chip's ground, and then onto the big ground bus. The gate output is left open.

On the other side of the IC, spare gate inputs have again been grounded, but this time they've been arranged with some extra pads so they can be cut loose from ground with a knife or scalpel and used for something else. The gate outputs are also brought out to pads.

Again a warning: don't go off and build this 'EA-THING', because it's really quite useless for anything other than demonstrating design techniques!

Most of your projects will never make it to the PCB stage, but they'll still be good one-off gadgets nevertheless. It is possible to make a quite professional quality project on Vero-board, for permanent use. If you tizz it up a bit and put it in a case, no one will ever know it's a nasty old Vero-board prototype.

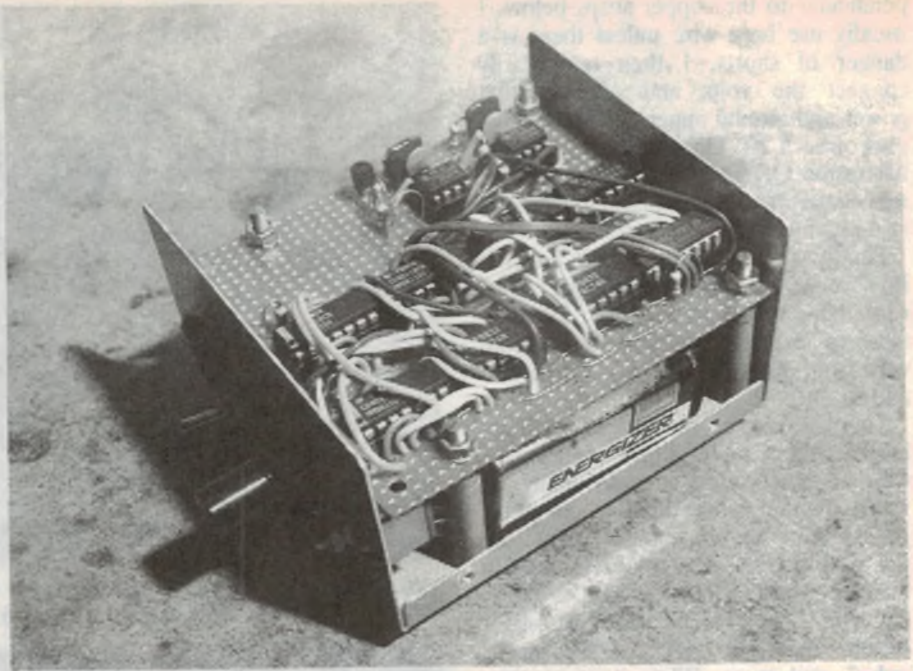
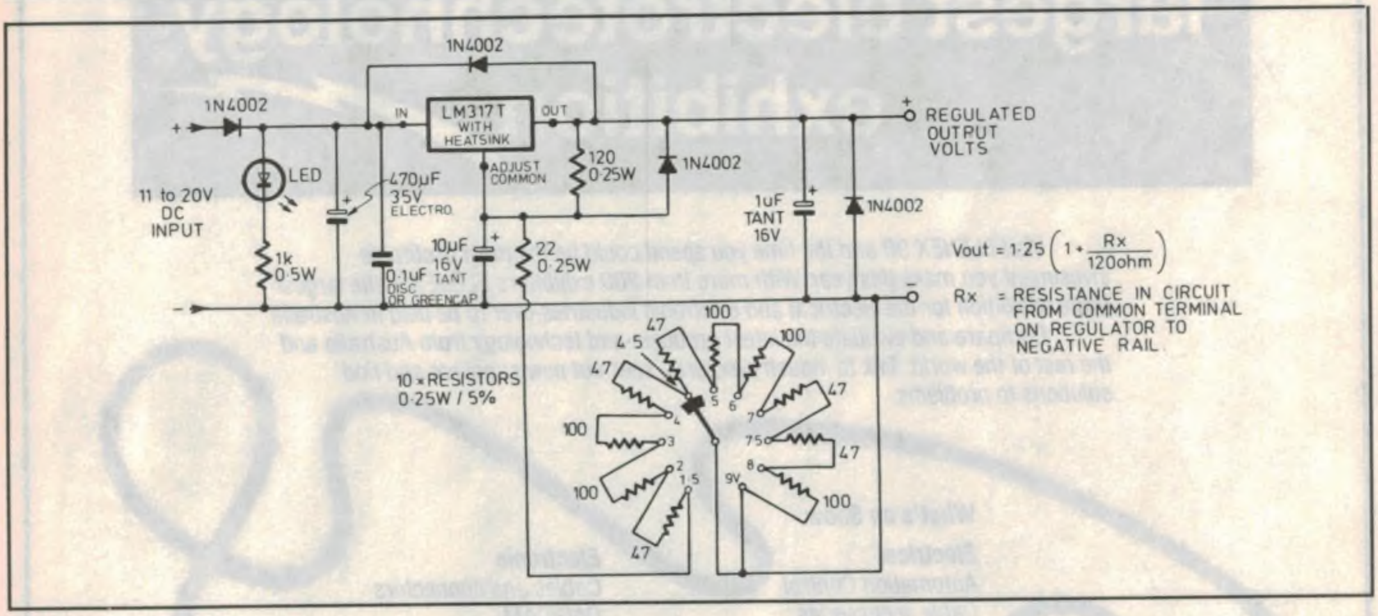


Photo 9: An example of what can be done using Vero-board. This is an electronic Morse keyer built by the author several years ago.

Photo 9 is an example of what can be done. This is a Morse Code electronic keyer, loosely based on a design in the *ARRL Radio Amateur's Handbook*. I built it several years ago, using CMOS IC's for the reasons set out above, instead of the original TTL IC's. The keyer now runs quite happily from a 9 volt transistor radio battery, instead of requiring a mains power supply. You'll notice I left a nice patch of blank real estate in one corner for 'future expansion'. But I haven't figured out a use for it yet.

Circuit & Design Ideas

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



Flexible low-cost variable supply

Variable regulated power supplies employing three terminal regulators usually use a potentiometer to provide a varying resistor in the adjust or 'common' terminal of the regulator, to provide variable output voltages. The disadvantages of this arrangement is that one can never be sure of the output voltage, which requires checking with a multimeter each time a specific voltage is required, or incorporating a costly meter into the supply to indicate output voltage. These arrangements introduce cost or complexity or inconvenience of one sort or another when using a regulated variable power supply.

The use of a potentiometer also introduces a hazard which can occur with breakdown of its carbon track causing loss of rotor contact, then break-through of input voltage to the output. This can easily destroy equipment connected to the regulator.

The circuit shown overcomes these difficulties and makes for a very convenient regulated variable supply. It uses a conventional LM317 supply circuit but substitutes a switched voltage selector for the potentiometer.

Thus, once set up with the appropriate resistors, output voltage remains calibrated to the selected switch position, assuming of course the LM317 is working within its various ratings.

The choice of the switch is very important; it must be a make-before-break action and MSP provide such a range covering 4 to 12 positions. I chose to use an 11 position switch from their range, its number being MSP-AK52251. The use of a make-before-break switch guarantees against an input voltage break-through situation occurring, and allows the user to change voltages (up to the maximum of the connected equipment) without having to disconnect the supply or the supplied item of equipment.

I have two units constructed in plastic boxes (the small types originally used by A&R) and these units are used from time to time to power 4.5, 6 and 9V radios, etc. from a 12V (11-14 actually) car battery source. I have also found it very useful on occasions for testing the filaments of old 1.4 volt battery valves.

A IN4002 diode is used at the input to protect against a reverse polarity supply connection, and at the output to protect against a reverse polarity voltage connection. A LED is connected at the input as a power-on indicator. The LM317 is fitted with a small aluminium heat sink of approximately two square cm, which allows the unit to pass approximately 400mA before thermal shut-down. This caters for all my needs, but a larger heat-sink would obviously allow the LM317 to work nearer to its maximum 1.5 amp capacity. The resistor values wired to the switch are 1/4 watt/5% tolerance types and provide an accuracy to better than 0.1 volt on all positions.

Bruce Hunt,
Heathmont, Vic.

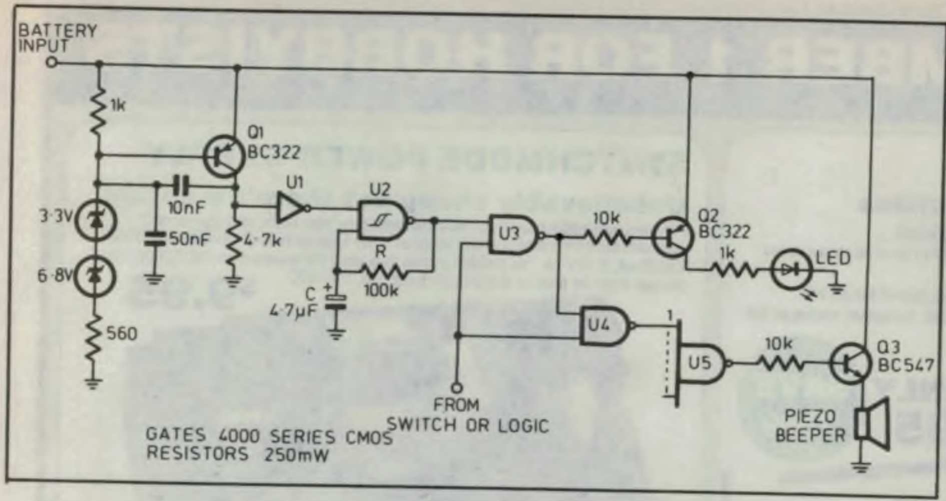
$40

Sound editor for video dubbing

My brother-in-law takes a camcorder on his holidays, and transcribes its small tape onto VHS using a VCR. But he needs something to edit the sound during that process, either to add afterthoughts to the recorded sound or to replace unwanted sound, traffic or wind noise, with speech.

I have made a device to perform both tasks. It is built around a type 324 quad op-amp, as shown.

The microphone signal goes to IC1a which has a volume control. The tape sound goes to IC1b, which has unity gain and an input that can be grounded with the mic on/off switch, without



Low battery voltage alarm

This circuit is part of a power distribution/switching/charging system for a mobile home, where power is supplied by one of a number of batteries. Most of the gates are spares in packages used for the rest of the control logic. They are all 4000-series CMOS, selected for their wide supply voltage range and noise immunity. The low voltage warning level can be readily altered by changing the values of the zener diodes; thus the circuit can be adapted for a number of applications where a visible and audible warning of low battery voltage is required.

Q1, the zener diodes, the three resistors and two capacitors form the voltage level sensing circuit. As long as the battery voltage is OK, i.e., above the zener voltage, Q1 outputs a 1; if the battery voltage falls below the zener voltage, Q1 outputs an 0.

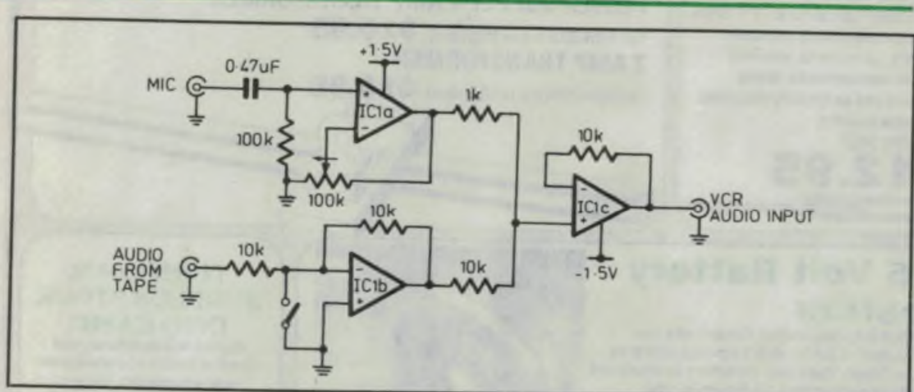
U1 inverts and buffers the output to provide a suitable input to U2. When the battery is OK, U2 outputs a 1; if the battery is down, U2 acts as an astable with the period governed by C and R.

The output from U2 is gated with the input from a selection switch or logic by U3, whose output drives the LED via Q2. If the battery is selected, i.e., the external input is 1, and the battery voltage is OK, i.e., U2 output is 1, then the LED is one. If the battery is selected and the voltage is down, U2 output alternates between 1 and 0 and the LED blinks on and off.

U4, U5 and Q3 drive a piezo beeper in conjunction with the flashing LED, if the battery is selected but the voltage is down. U5 is a NAND gate used as a NOR gate, with as many inputs as there are batteries in the system. Each input is driven by a copy of the circuit, up to U4, and if any of the battery voltages are down, the relevant LED will flash and the beeper will sound.

Jens Schumacher,
Boronia, Vic.

$40



short circuiting the camcorder output.

IC1c is a mixer that provides a gain of 10 to the mic signal from IC1a, and unity to the tape sound from IC1b.

Power comes from two AA cells in a battery snap, to which has been added an earth connection to split the supply into +1.5 and –1.5 volts.

J. Morphet,
Rosebud, Vic.

$35

UHF Wireless Security System

FULL DETAILS SEE PAGE 61 - 1990 JAYCAR CATALOGUE

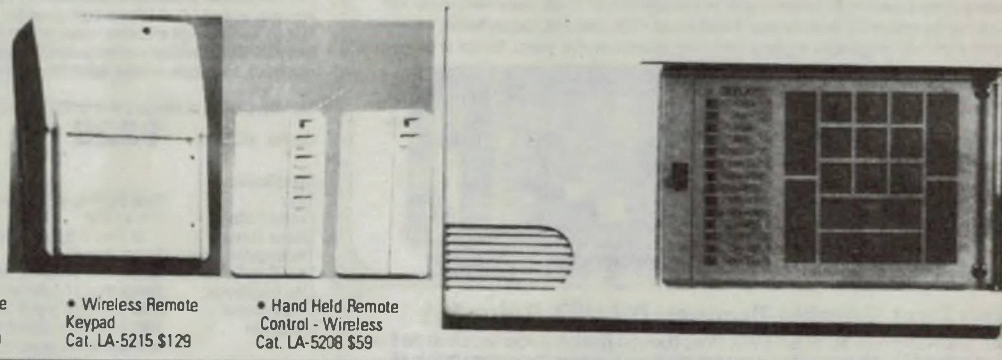
Just imagine a security/alarm system that does not need wires to connect the PIRs, window/door reed switches, personal remote control and optional remote keypad. The only wiring required is to connect to a horn speaker.

NEW UHF 303MHz Microprocessor Control Wireless Security Alarm System

COMPLETE SYSTEM includes
- 1 x Control Panel
- 1 x Passive Infra Red Detector/Transmitter
- 1 x Door/Window Reed Switch/Transmitter
- 1 x Hand Held Remote Control/Transmitter
- 1 x Horn Speaker - 10 watt/wired
- 1 x 240V AC adaptor
- 1 x 1.2Ah Back-up Battery
- 1 x Set of batteries for all transmitters

Cat. LA-5200

ONLY $599



OPTIONAL EXTRAS
- Door/Window Reed Switch - Wireless Cat. LA-5210 $69
- Wireless Passive Infra Red Detector Cat. LA-5205 $149
- Wireless Remote Keypad Cat. LA-5215 $129
- Hand Held Remote Control - Wireless Cat. LA-5208 $59

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Ideal as a first meter. Compact enough to fit into the glove box in your car.
- 2,000 ohms/volt
- Mirror scale to prevent parallax error
- Complete with test leads and instructions
- DC & AC volts 0-10, 50, 250 & 1000V
- -10 to +22dB
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- 0-1M ohm (2 ranges)
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- Battery included

Cat. QM-1001

$18.50 NORMALLY

MAY ONLY $15.50

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FREE POWER WITH SOLAR CELLS
0.45 VOLT MODULES

Ideal for experimenters. Connect in series or parallel if you wish. Terminal strap enables easy connection to other cells.

TWO HANDY SIZES

0.45V 400mA
Size 96 x 65 x 6mm
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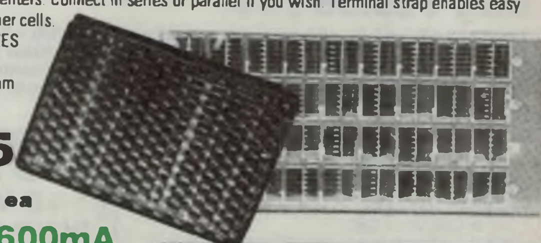
10+ $3.50 ea



0.45V 600mA

Size 96 x 65 x 6mm
Cat. ZM-9007

$5.50

10+ $5.00 ea

12 volt @ 120mA

Quality cell with aluminium picture framing around the edges. Resin covered. Size 327(L) x 165(W) x 18mm thick.
Cat. ZM-9009

$79

DIODE MADNESS

1N4007 1A 1000V
50 for $5
Cat. ZR-1009

1N4003 1A 300V
Cat. ZR-1003
50 for $2.50

6" TWINCONE WIDERANGE

Freq. Resp.	60-15kHz
Sensitivity	89dB/1mt
Impedance	8 ohms
Power	0 watts RMS
Magnet Weight	5.3oz

Cat. CE-2320

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HORN SPEAKER

Fully weatherproof. Suitable for PA, intercom, security systems, etc. 10 watt 8 ohm.
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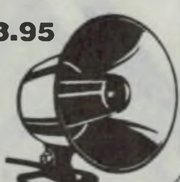

TV GAME COMPUTER SWITCH

Allows you to easily switch between 2 inputs to your TV.
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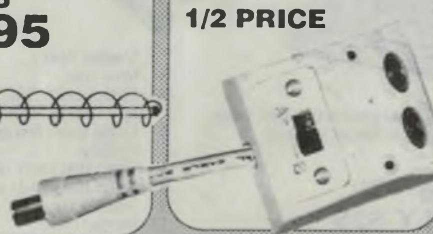
1/2 PRICE



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$6.50 for 10

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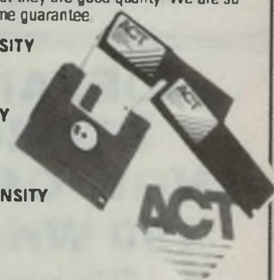

SPIROMATIC INDOOR ANTENNA

For prime reception areas, site on top of your TV. Popular spiral design. 300 ohm cable supplied.
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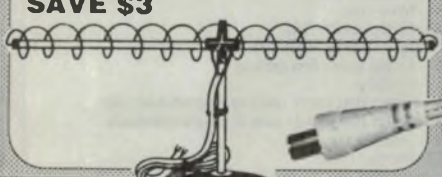

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10 x 3 1/2" MF2HD
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JAYCAR - NUMBER 1 FOR KITS

VOLTUP KIT
A 1.5 to 9V DC/DC convertor

Ref: EA May 1990

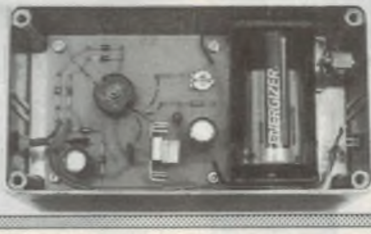
Replace those expensive 9V batteries with an economical 1.5V D cell. Lasts much longer and saves you the cost of the kit in no time. Shortform kit - PCB, potcores, battery holder, heatsink and all electronic components supplied (excluding optional receiver parts). No box or box hardware supplied.

Cat KA-1724

ONLY

$19.95

Box not supplied



±50V (0-100V) 1.5A Dual Tracking Power Supply Kit

Ref: Silicon Chip April '90

This magnificent switchmode type laboratory power supply has great professional features but costs around 1/2 of inferior built up units.

This kit features high efficiency toroid power transformer, professional high resolution 10-turn wire wound voltage control potentiometer, latest I.C. technology, excellent line load regulation, low ripple voltage, apart from a smart plastic case! (for more information see specs below).

The Jaycar kit is complete down to the last nut and screw as well as all hard-to-get I.C.'s.

Cat No. KC-5073 **$229**

Specifications

Type:	Dual tracking with switchmode pre-regulators for high efficiency
Output Voltage:	0 to +/-50V
Output Current:	1.7A from 0 to 87V; 1.5A at 91V; 1A at 100V
Tracking Accuracy:	Better than 30mV
Load Regulation:	Better than 500mV at +/-V and 1A
Line Regulation:	Better than +/-5mV for mains voltages from 220-260V AC
Ripple output:	Less than 3mV p-p at full load
Protection:	Fully protected against output short circuits and forward and reverse voltages connected to the output; fuse protection for the power transformer.

Non First Syllable Dropped Off VOX Relay Kit

Ref: Silicon Chip April '90. At last a VOX (Voice Operated Relay) that does not cut off the first bit of speech! This clever project uses an acoustic delay to prevent the common fault in all but the most expensive VOX circuits - the 10mS or so of that is lost by relay operating time. It may not sound much but it is very annoying and a long time in speech terms.

This kit is supplied by Jaycar in a short form, i.e. without case, front panel, plug adaptor etc. This saves you over $20 on the price otherwise, as we believe most of these projects will be built into other equipment anyway. All other parts (including all PCB parts) included.

Only $59.95 Cat KC-5074

Specifications Signal delay: 16.4 miliseconds • Clock frequency: 15.7kHz • Frequency response: 100Hz to 43kHz within (pm) 3dB • Maximum output signal: 800mV RMS • Maximum input sensitivity: 0.7mV RMS (to actuate relay) • Harmonic Distortion: <0.5% at 250mV and 1kHz <1.5% at 800mV and 1kHz • Signal to noise ratio: (ms) 66dB unweighted with respect to 500mV RMS at the output

LEAD ACID BATTERY CHARGER

Ref: Silicon Chip March 1990

Comprehensive battery charger for GEL batteries. Charges both 6 & 12 volt batteries. Charging rates: 1.2Ah (250mA); 2.5Ah (520mA); 4.5Ah (900mA); 6Ah (1.2A); 15Ah (3A). Charges our range of GEL batteries. Includes PCB and all board components. No box or front panel. Transformer not supplied: 1.2Ah-4.5Ah use MM-2008 $18.95 or 6Ah-15Ah use MM-2000 $37.95.

Cat. KC-5071

$69

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Ref: EA Dec 1989/Jan 1990

NEW - upgraded design - now gives 140W rms channel into 8 ohms.

Dual toroidal transformers supplied.

Cat KA-1725

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Plant Checker

Another surplus buy. If you are a gardener you have probably seen the moisture meters in nurseries that indicate the moisture level in soils for about $16.

This unit does that, plus more:

- Indicates moisture level in soil • Check proper PH value of the soil
- Check strength of light (LUX) • Also includes a thermometer in F/C

With all these features you would expect to see this in nurseries for $30 - $40.

We have a limited quantity available for only $14.95. That's right - about 1/2 price or less. Don't miss out.

Cat QM-6136

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Lesson One

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8. Guess That Word - auto or program manually
9. Letter Finder
10. Number Finder

Children are encouraged to learn to compose music, spell, learn maths and play strategic games all on their own without supervision!!

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NORMALLY $69

SAVE $30 ONLY $39

Construction Project:

Novel IR Night Viewer

Build this fascinating project and overcome a basic human shortcoming: our inability to see in the dark. Now you can unlock the mysteries of the night with our low cost night viewer. The project features good performance, low power consumption and will cost a small fraction of the real value of the infra-red imaging tube used.

by BRANCO JUSTIC and CONRAD MARDER

Since World War 2, the military have used Night Vision Binoculars and Night Scopes to probe the dark. One might well ask why isn't this type of equipment available for civilian use? The answer is very simple – cost!

If you were to buy a new infra-red imaging tube such as that used in this project you'd be paying over $3000. No! That's not a typographical error – a new XX1080 IR image tube costs over three thousand dollars! But don't get alarmed – we did say this was a relatively low cost project...

Oatley Electronics, the developer of this project, has sourced some IR image tubes at ridiculous prices, making the unit to be described in this article possible. The tubes are ex-military service disposal items and are currently selling at prices between $100 and $300. Some tubes are brand new, and others are used, but all are guaranteed to be in good working order.

Interested now? After all, that's a mere fraction of what they originally cost. So read on to find how this project works and how to build it. This is a fascinating project with lots of uses.

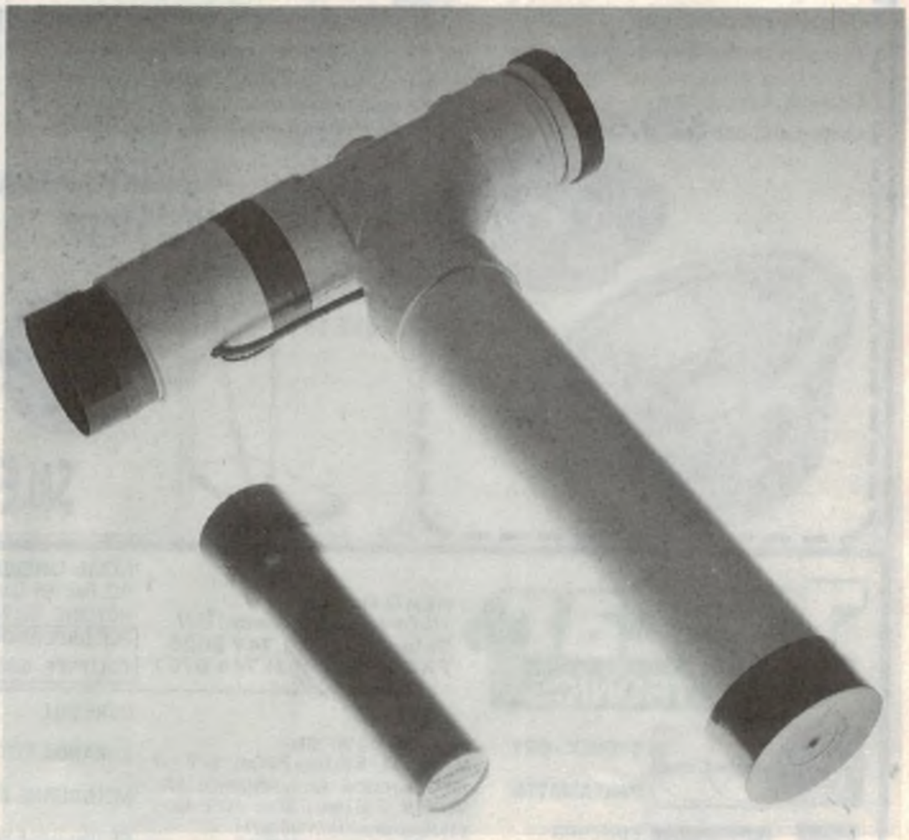
The night viewer

The Night Viewer described here is the result of considerable development. The high voltage power supply we have developed can be used with different types of IR image tubes, and its features include low power consumption with excellent voltage regulation. The circuit operates from a 9V battery, drawing around 15mA, and inexpensive lenses and a plastic housing make it a most economical project. If we sound proud – well, we are!

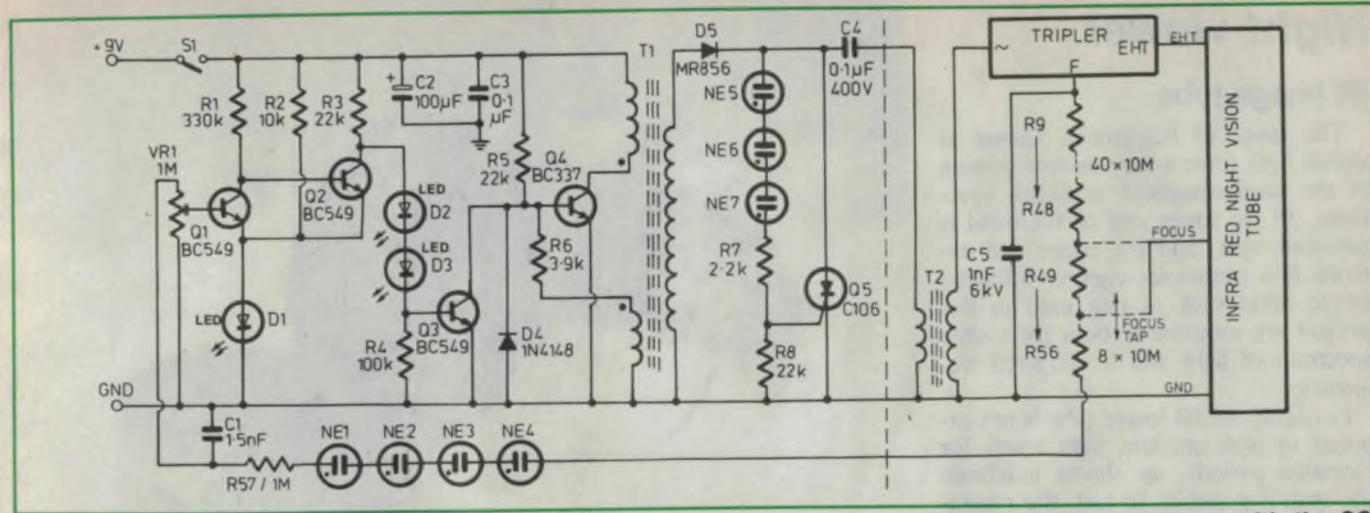
The prototype has proved very effective and operates very well in extremely low natural light levels. However we decided to develop an infra-red torch as well, which can be used to 'light' the viewing area to allow it to be seen – in what to the unaided eye appears to be total darkness. The torch is very simple, comprising nothing more than a conventional torch with an infra-red filter.

During our experimenting with the unit, we found some rather interesting things regarding the response of various objects to infra-red light. For example, both black and white people appear the same when observed through the night viewer, showing up with equal brightness on the viewer's screen. Also, healthy plants appear brighter than unhealthy plants, perhaps explaining why certain illegal plants are easily detected when grown in the bush!

A television IR remote control unit when looked at through the Night



Build our Infra-red night viewer and companion infra-red torch, and use them to see in the dark.



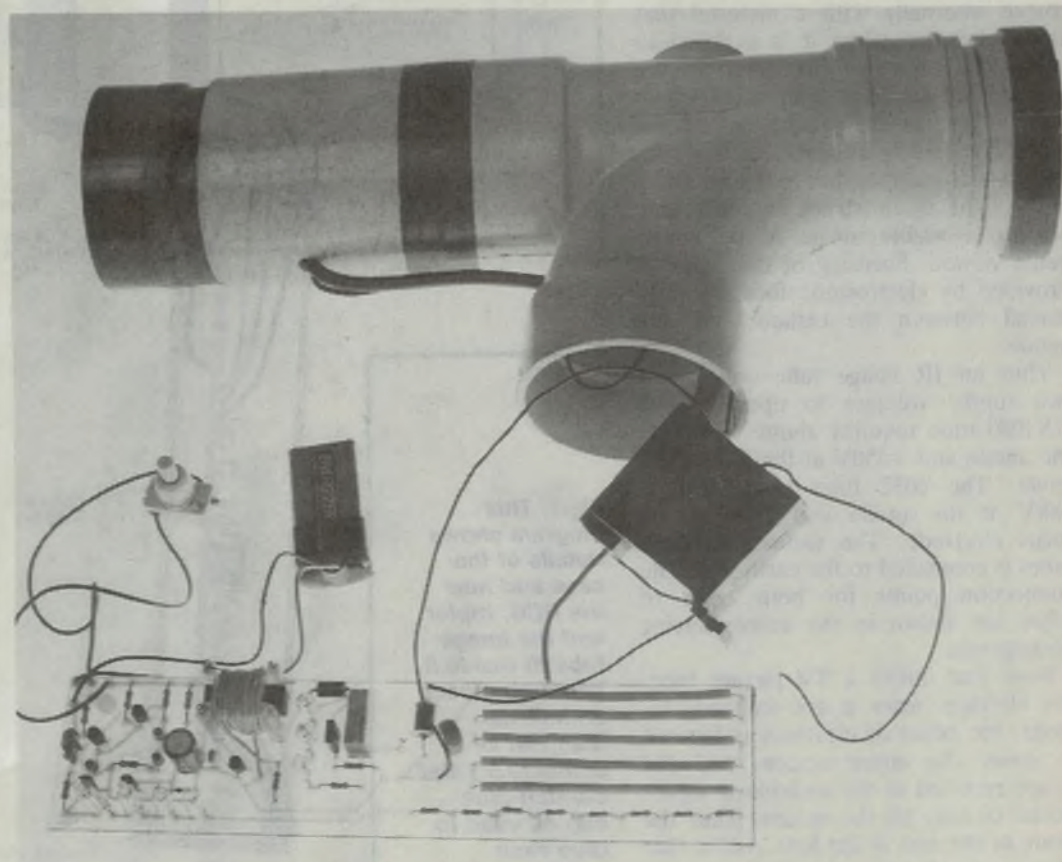
The circuit diagram. The circuit comprises a ringing choke oscillator around Q4, a relaxation oscillator with the SCR (Q5), a tripler driven by T2 and feedback via neons NE1 to NE4. VR1 sets the output voltage which, for an XX1080 IR image tube should be around 14kV.

Viewer appears as an array of very bright spots of light, with one spot for each IR LED used. This is dramatic evidence of just how invisible infra-red light is to humans, demonstrated further by the infra-red torch which seems to emit no light at all – yet appears to light up the surroundings almost like a conventional torch, but only when seen through the IR viewer.

The lens system used on the prototype viewer consists of two magnifying glasses purchased from local shops. While this arrangement could no doubt be improved, we found it produced very acceptable results for normal use. We also found that the focusing needed very little re-adjustment during use, particularly if the objects being looked at were of a reasonable size.

The case is made from 65mm plastic plumbing fittings, available from most hardware shops. If a smaller handle is required, the PCB can be cut into two sections, connected with three core flex. The remote section could then be worn in a belt pack.

Summing up, the Night Viewer comprises a PCB, tripler, the IR image tube, and two magnifying glasses as lenses, all fitted into a case made of plastic tube. It's simple to build, and amazingly cheap when compared to the cost of a comparable unit used by the military. Now for details of the project and the IR imaging tube used.



This photo shows the PCB, tripler and the case holding the IR image tube. The wire from the top of the tripler hanging free became detached during photographing, and should connect to the left of the top string of resistors. The wire running under the tripler is the focus lead, and terminates on a PCB pad as shown in the layout diagram. The EHT lead should be long enough so that the tripler can be removed from the case.

Night viewer

IR image tube

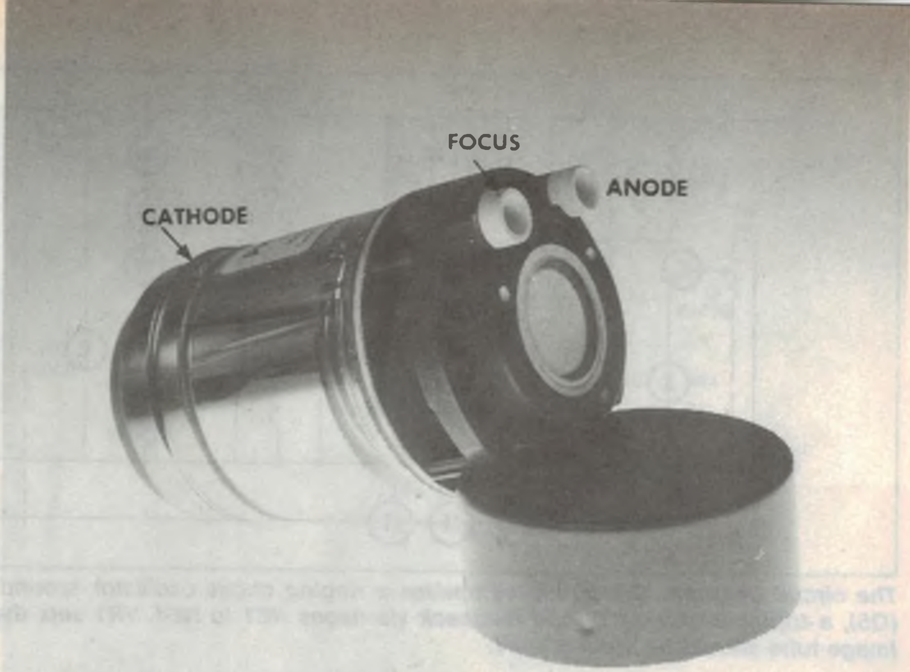
The range of frequencies known as visible light form a very narrow portion of the electromagnetic radiation spectrum. At the lower end of the band is infra-red light, and the upper end extends into ultraviolet energy. Infra-red image tubes such as that used in this project are sensitive to both the visible spectrum of light and to infra-red frequencies.

Providing the IR image tube is not exposed to high ambient light levels for extended periods, an almost indefinite life span is possible. In fact, the recommended *maximum* illumination of the tube is 1 lux, while the light level in a well lit room may be around 200 lux. If the tube is exposed to such light, it will saturate and take a few seconds to restore after its return to the dark. Such exposure doesn't seem to harm the tube, but should be avoided as continual high light levels could result in a permanent loss of sensitivity.

IR image tubes are simple in principle and have a construction similar to a cathode ray tube. At one end of the tube is the cathode, which is exposed via an external lens to the scene being viewed. The cathode end of the tube is coated internally with a material that emits electrons when it is exposed to light. The electrons produced by the cathode are accelerated by a high positive voltage at the anode end of the tube. The screen is located at this end, and it has a phosphor coating which emits light when struck by electrons, causing a visible image of the scene being viewed. Focusing of the image is provided by electrostatic focusing rings placed between the cathode and the anode.

Thus an IR image tube only needs two supply voltages to operate. The XX1080 tube requires about +14kV at the anode and +450V at the focus electrode. The 6032 tube needs around 18kV at the anode and 2KV at the focus electrode. The cathode in both tubes is connected to the earth line. The connection points for both types of tubes are shown in the accompanying photographs.

Note that unlike a TV picture tube, the electron beam is not scanned. Instead, the beam of electrons is focused to cover the entire screen, and the image received at the cathode is reproduced directly on the screen. Thus the heart of the unit is the lens system that focuses the scene optically onto the



This photo shows the XX1080 IR image tube, viewed from the cathode end. The focus terminal is the socket to the front of the picture and the anode is next to it. The cathode is the metal ring.

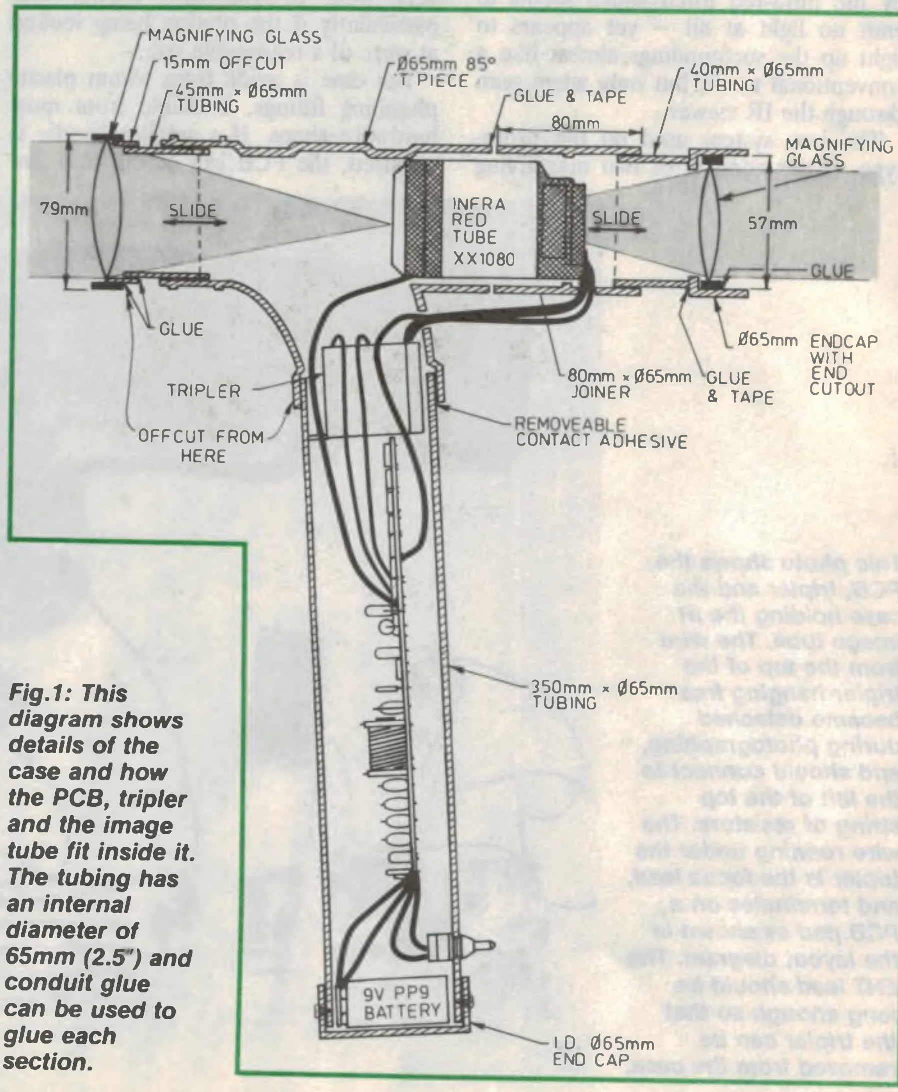
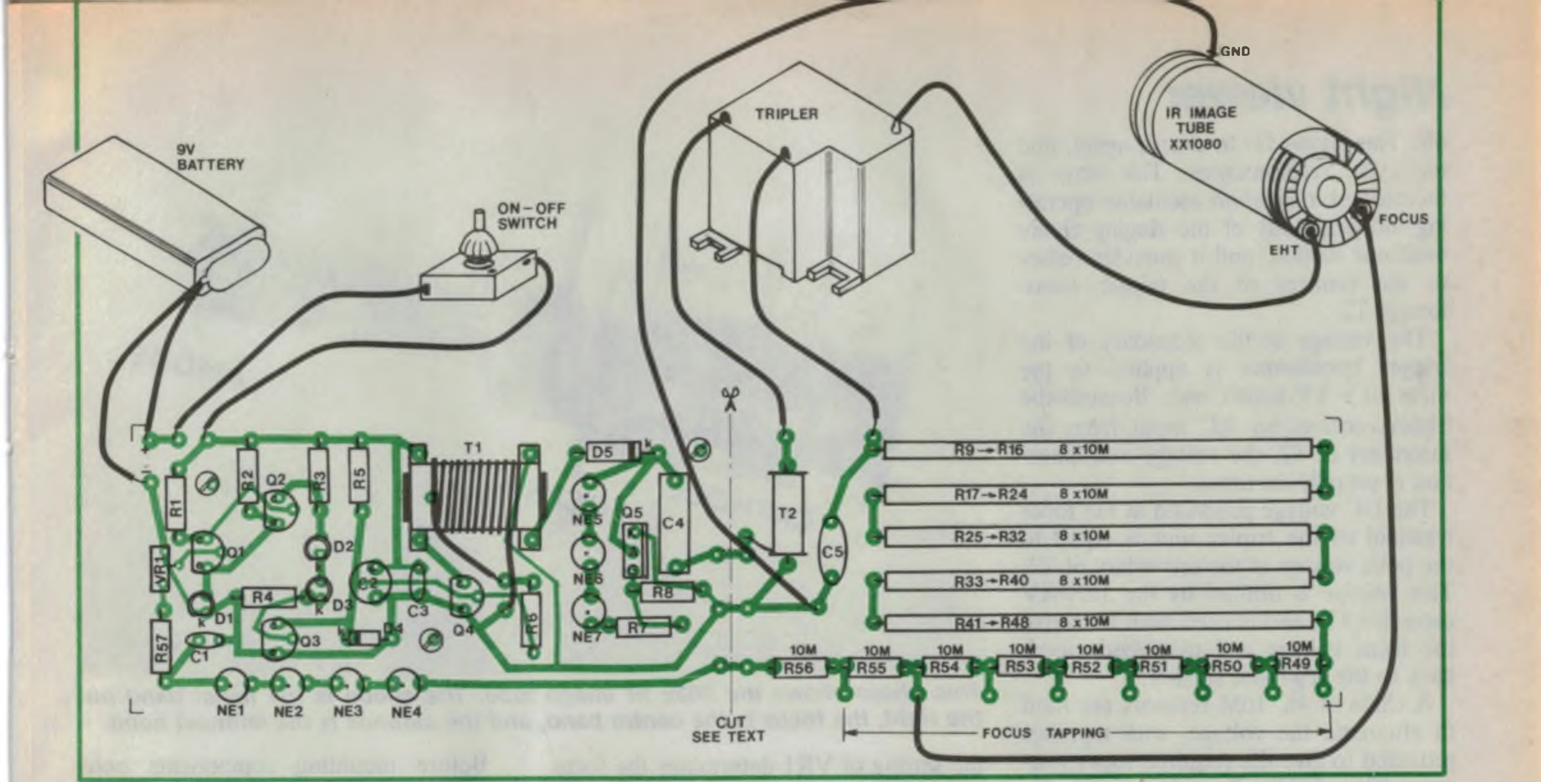


Fig.1: This diagram shows details of the case and how the PCB, tripler and the image tube fit inside it. The tubing has an internal diameter of 65mm (2.5") and conduit glue can be used to glue each section.



The layout diagram. Take special care with the phasing of the extra winding required on T1. The 48 by 10M resistors are arranged as five strings of eight resistors, soldered end to end. The remaining eight by 10M resistors provide tapping points for the focus voltage. The PCB can be cut to give two sections joined by three core flex if required.

cathode, which in turn emits electrons with varying intensity from different sections of the cathode.

The infra-red torch

As already mentioned, the viewer operates well in very low light level conditions such as that from moonlight or even starlight. However its most spectacular application is using it in total darkness. Under these conditions it is necessary to light the area with a source of infra-red energy. We initially tried infra-red LEDs, which proved relatively useless. We then experimented with a conventional torch globe, and ended up with an infra-red torch.

Incandescent torch bulbs are a good source of both visible light and infra-red light. However, the visible light needs to be completely filtered out, otherwise the purpose of this project is defeated. Infra-red filters are available from most photographic equipment suppliers, but are probably rather expensive. We first tried a number of layers of dark coloured cellophane, but best results were obtained with conventional 35mm film, such as that used in a camera.

Most colour negative films after use have some section of the film that is completely exposed, usually at the start of the film. When developed, this section appears almost black, and is normally discarded. However, it is an excellent infra-red filter, and we used four layers of this film in a hand held torch, giving a unit with high infra-red output, but with virtually no visible light output. In fact, the amount of infra-red light output was hardly reduced at all, even with more than four layers of film.

The filter is placed between the glass and the reflector of the torch, and the glass (or plastic) can be used as a template for cutting the film. Because 35mm film is not wide enough to cover the front of the torch completely, overlapping semi-circles of the film are required. The film will be held in place between the glass and the reflector once the torch is reassembled, so there is no need to glue the film. A number of layers made up of semi-circles of the film are required, arranged so that the overlaps for each layer cross the adjacent layer.

The infra-red torch we used was fitted with a pre-focused globe, which gave a rather intense and relatively small spot of infra-red light with minimal light away from the spot. For general use it may be preferable to use a non-focused torch globe if a wide area needs to be lit.

Circuit details

As already described, the IR image tube simply requires an EHT voltage and a focus voltage to operate. However, developing these voltages from a 9V battery is, predictably, rather difficult, particularly if they need to be regulated – as they do here.

Briefly, the power supply comprises four main sections: the inverter, the SCR converter, the voltage multiplier (TV tripler) and the feedback regulation section.

The inverter is a 'ringing choke' type and comprises transformer T1, transistor Q4, resistors R5 and R6 and diode D4. Resistors R5 and R6 provide voltage divider biasing, to Q4 to allow the oscillator section to start up. Positive feedback is via the feedback winding through R6. Diode D4 prevents reverse biasing of the base-emitter junction of Q4.

The oscillator stage around Q4 operates at approximately 100kHz and the resulting AC voltage at the primary of T1 is stepped up to a higher voltage by the secondary winding. Diode D5 rectifies this voltage and C5 is charged via the low resistance of the primary winding of the trigger transformer T2.

When the voltage across C5 exceeds the breakdown voltage of the three series connected neon globes NE5 to NE7 (approximately 220V), the resulting current through the neons will trigger the SCR (Q5) into conduction. And when the SCR is turned on, C5 is quickly discharged into the primary of the trigger transformer T2.

Once C5 is discharged, the neon globes extinguish, and the SCR will turn

Night viewer

off. This allows C5 to charge again, and the cycle recommences. This stage is therefore a relaxation oscillator operating independently of the ringing choke oscillator section, and it provides pulses to the primary of the trigger transformer T2.

The voltage at the secondary of the trigger transformer is applied to the input of a TV tripler unit. Because the tripler receives an AC input from the secondary of T2, the voltage multiplication is actually six times.

The DC voltage produced at the focus terminal of the tripler unit is equal to the peak voltage at the secondary of T2. This voltage is filtered by the 1nF/6kV capacitor C5, and is used both to derive the focus voltage and to provide feedback to the regulator section.

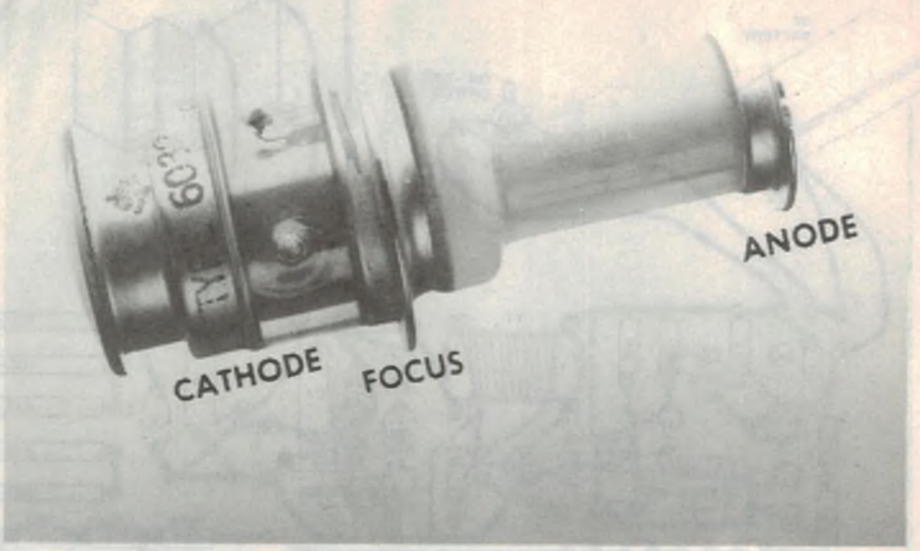
A chain of 48, 10M resistors are used to attenuate the voltage, with tappings provided to give the required focus voltage. The feedback voltage is also dropped across a further four neon globes, NE1 to NE4, producing a relatively small voltage across R57 and the potentiometer VR1. The four neon globes improve the stability of the focus voltage, and so reduce 'shimmer' on the screen of the IR image tube.

The chain of 48 by 10M resistors make up the high resistance required in the focus voltage divider network and share the applied high voltage. A string of high voltage rated, high value resistors could be used instead, but apart from being much more expensive, it would not give the range of focusing voltages needed.

The tripler also provides the required EHT anode voltage for the tube.

Looking now at the feedback regulation circuitry, a voltage reference is formed by LED D1 and the base-emitter voltage of Q1. Resistor R2 provides forward bias to the LED. When the voltage at the base of Q1 rises above the voltage reference (approximately 2.4V), Q1 turns on, robbing the base current from Q2. Transistor Q2 therefore turns off and its collector voltage rises. When the collector voltage of Q2 exceeds the barrier voltage of the series combination of the two LEDs (D2 and D3) and the base-emitter voltage of Q3 (around 4.2V), Q3 turns on.

When this happens, the base of the oscillator transistor Q4 is grounded, stopping the oscillator. The oscillator will start up again as soon as the voltage at the focus terminal of the tripler drops sufficiently to cause the voltage at the base of Q1 to drop below 2.4V. Thus, the setting of VR1 determines the focus and EHT voltages applied to the IR image tube.



This photo shows the 6032 IR image tube. The anode is the metal band on the right, the focus is the centre band, and the cathode is the leftmost band.

Construction

A kit of parts for this project is available from Oatley Electronics. Some IR image tubes are also available, but since they are a disposal item, it is best to check their availability and price before ordering.

Before attempting construction, first a few warnings:

1. **HIGH VOLTAGES! The power supply provides the 15kV anode voltage needed to operate the tube. Although the power supply is only capable of supplying a few microamps, the capacitors can supply a high current for a short period of time, even after the unit is switched off. Special care is therefore required.**
2. The IR tube used is extremely sensitive to light. Avoid exposing the cathode end of the tube to high ambient light levels and cover this end of the tube with an opaque material when not in use.
3. When testing the unit out of its insulated case, connect the earth of the circuit to a good electrical earth, such as the mains earth.
4. It is believed that some IR image tubes emit a small amount of X-radiation, and their manufacturers recommend wrapping the tubes in lead foil. In the project, this could be done by wrapping the foil around the outside section of the plastic case that contains the tube.

Before mounting components onto the PCB, there are two tasks to complete. The oscillator transformer T1 is supplied with the secondary and the primary windings already wound on it. However a feedback winding needs to be wound onto the transformer, by winding 10 turns of insulated hook-up wire over the top of the existing windings. Check carefully that the direction of the winding is the same as that shown on the component overlay diagram.

The 48 by 10M resistors are arranged as five strings of eight series connected resistors, fitted inside plastic tubing, with eight more resistors connected to PCB pads. The five strings of eight resistors should be prepared prior to mounting them onto the PCB, by soldering them end to end. The lead of each resistor (except for those at the two end leads of the string) should be cut to a length of 3mm, and then soldered to the next to give eight series-connected resistors. This can be achieved by laying the resistors in the valley formed by the pages of an opened magazine to align the resistors prior to soldering. Don't twist the resistor ends together, as this makes the string too long. The finished strings can then be covered with plastic tubing to minimise the shock hazard.

All of the components, including the prepared transformer T1 and the resistor strings can now be fitted and soldered onto the PCB. Carefully check the orientation of all the polarised components prior to soldering – including all transistors, diodes, the electrolytic capacitor and the SCR.

The switch, battery clip, and the tripler can now be connected to the PCB. The connector at the end of the EHT lead normally fits into the ultor of a television picture tube, but as it is not needed here, it should be cut off.

The focus and EHT leads need to be fitted with a 'bullet' connector so they can be plugged into the sockets of the XX1080 IR image tube. We used the socket pins from a 9-pin miniature valve base, although anything similar would be suitable.

Once completed and tested, the tube connections should be completely covered with a silicone sealant, otherwise a corona discharge may result, especially in humid weather. This could overload the power supply and produce shimmer on the viewing screen. The exposed focus terminal on the tripler unit should also be covered with silicone sealant. As well, the high voltage end of the completed PCB should be sprayed with several coats of PCB lacquer. The sealant and the lacquer should be allowed to dry thoroughly before applying power to the PCB.

The earth lead from the PCB can be soldered directly to the metal earth band of the tube. First clean the metal by lightly sandpapering the area, followed by tinning of the wire and the metal band, and finally soldering the two together. Do this quickly, but *don't solder near the glass to metal seal, as this could damage the tube.*

If you don't like the idea of soldering to the metal band, this connection can be achieved by wrapping the wire around the earth band of the tube. An elastic band or plastic tie could be used to maintain a good contact between the wire and the metal band.

As shown in the assembly diagram (Fig.1) and the photographs, the case for the unit was made from 65mm plastic tubing and an 85° T-piece. These are available from most hardware shops, although the end caps fitted to the handle and the viewing end may not be as readily available.

Fig.1 shows that the XX1080 tube fits snugly into position, although the smaller diameter 6032 tube will require packing with plastic foam to give a snug fit inside the case. Plastic foam can also be used as packing around the PCB, the tripler and the battery to prevent them moving inside the case.

The lenses used in the prototype were magnifying glasses purchased from local shops. The handles need to be cut off before fitting them to the case, leaving only the lens and its frame. The lens used at the front (scenery end) should have an outside diameter of 79mm, and a focal length of around 15cm. We obtained ours from a newsagent. The lens fitted to the viewing end was purchased from K-mart ($1.48), and has an outside diameter of 57mm with a focal length of approximately 10cm.

Testing

The following test procedure is only applicable to the XX1080 IR image tube. Oatley Electronics will supply instructions for any alternative tube types that may become available.

As already mentioned, when the unit is being tested out of its case, it should be earthed. If this is not done, you may receive small electric shocks, even when touching the low voltage sections of the PCB. This is because the whole circuit is floating, allowing high voltages to develop all over the board. Either earth the unit if it is being supplied by a 9V battery, or test it with an earthed power supply.

Also, when the unit is operating outside the case, lay it on an insulated base such as a plastic box or plastic sheeting. Otherwise corona will develop around the high voltage section, causing possible overload of the power supply and preventing normal operation.

While the following adjustments are being undertaken, cover the IR image tube so that it is not exposed to light. The focus lead should initially be connected as shown on the layout diagram, although this setting may need to be altered as described further on.

Adjust the trimpot to its maximum clockwise position as viewed from the front of the PCB: that is, move the wiper towards the 1M resistor, R57. This sets the EHT output voltage to its minimum value. Be careful here, as the power supply is capable of developing around 25kV if the trimpot is at its maximum anticlockwise position, which could damage the tube.

Before switching the unit on, remember there will be *high voltages* present around the tripler's focus and EHT terminals and that the capacitors in the tripler and capacitor C5 will retain their charge for some time after the unit has been switched off. These can be discharged through a 1W, 1M ohm resistor, by connecting this resistor between the relevant points and ground. Use a well insulated probe to connect the resistor, and after discharging, check that no voltage is left by shorting these points to ground.

It is not a good idea to short these points directly to discharge them, as this can damage the capacitors.

PARTS LIST

1 PCB coded OEIRNW
1 battery connector
1 SPST insulated switch
1 oscillator transformer
1 trigger transformer
1 TV EHT tripler
1 infra-red image tube (see text)
7 NE2 neon tubes
2 magnifying glasses (see text)
Wire, screws, 65mm plastic tube and fittings for case

Resistors

All 1/4W, 5%: 1 x 2.2k, 1 x 3.9k, 1 x 10k, 3 x 22k, 1 x 100k, 1 x 330k, 1 x 1M, 48 x 10M.
1 1M vertical mount miniature trimpot

Capacitors

1 1nF 6kV disc ceramic
1 1.5nF 100V polyester
1 0.1uF 100V mono
1 0.1uF 400V polyester
1 100uF, 16V electrolytic

Semiconductors

1 1N4148 diode
1 MR856 power diode
3 BC549 NPN transistors
1 BC337 NPN transistor
1 2SC106 SCR
3 3mm red LEDs

Kits of parts for this project are available from:

Oatley Electronics
5 Lansdowne Parade,
Oatley West, NSW 2223.
Phone (02) 579 4985

Postal address (mail orders):

PO Box 89, Oatley West NSW 2223.

PCB and components kit.........$59.95

Some IR image tubes are also available (see text)......................P.O.A.

Post, packing and insurance (no tube) $3.00

Post, packing and insurance (with tube) $10.00

The PCB artwork for the project is copyright to Oatley Electronics.

With the trimpot set as described, connect a digital multimeter with an input resistance of 10M (typical value for most DVMs), across the 1M resistor R57. Adjust the trimpot until the voltmeter reads 4V. This sets the EHT voltage to around 14kV, and on the prototype, the trimpot was moved approxi-

Night viewer

mately one third of its travel from the minimum position.

The focus setting can now be established by first taping a small piece of flyscreen mesh directly over the cathode end of the tube. If the focus is correct, the image of the mesh on the screen will be sharp. If not, switch off the power, allow time for the capacitors to discharge, then try another focus tapping. When correctly focused, the size of the image may be slightly smaller than the screen size.

The foregoing assumes that the circuit is working. As it turns out, the circuit has built in visual and audible indicators of its operation. If the three series neon globes (NE5-NE7) are lighting dimly, both oscillators are operational. If the four series neons (NE1-NE4) are glowing slightly, the pulse transformer section and part of the tripler must be working. Diode D1 (LED) should always be on when power is applied, giving an indication that power is available to the circuit.

If D2 and D3 (both LEDs), are alight (dimly), the oscillator is being controlled by the regulating section. While this is occurring, a 'chirping' sound should be just audible, due to T1 responding as the oscillator is turned on and off by the regulator. With a bit of experience, the state of the battery and the circuit loading can be estimated by this sound, which also serves to indicate that the power switch is on.

Finally, as already mentioned, the PCB has been designed so that the low voltage section can be separate from the high voltage section. This is achieved by cutting the board as shown on the layout diagram, and reconnecting the sections with a length of three core flex. This way, the low voltage section can be constructed in a box and carried separately, perhaps worn as a belt pack. The benefit is that a smaller handle could be fitted to the case.

Using the Night Viewer

Before using the unit, fit everything into the case. A hole for the on-off switch is needed; otherwise everything just packs inside the tube. The screen of the tube will glow a greenish colour while power is applied, and all that remains is to adjust the two lenses to give as sharp a picture as possible. The unit should not be used in the daytime, unless in a dark area, and covers should be fitted over the ends of the case to protect the tube against high ambient light.

Once night falls, you can try the unit by simply looking at the screen end and adjusting the focusing of the lenses to obtain a sharp image. Don't expect binocular clear results, as the lens system is fairly basic. However, it should be possible to view reasonable detail with careful adjustment.

The most spectacular results will occur with total darkness and the infrared torch. When seen through the viewer, an area will appear as though lit by a conventional light source, even to the extent of overload if the torch is too strong. But it's only when you look at the area just viewed through the Night Viewer that you realise how little you see otherwise, and how good the viewer is. By experimenting with the lens system and a focused source of infra-red light, it should be possible to see into the distance, at least to 20 or 30 metres. One trick might be to attach the torch to the case of the viewer, so that one hand is free to adjust the lenses for best focus.

Certainly you will find the Night Viewer a most intriguing device, and one with lots of uses. Night becomes day – almost!

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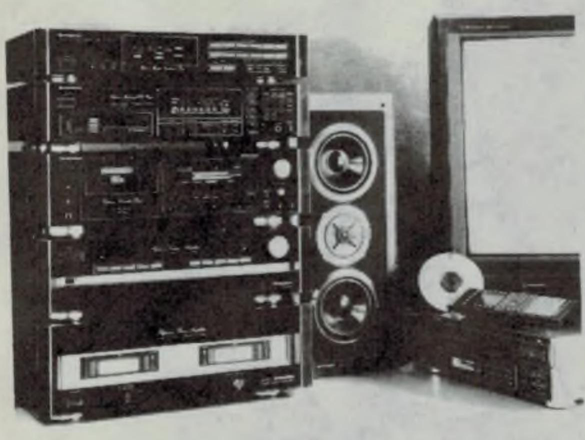

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Construction Project:

Converter for the 144 - 148MHz amateur band

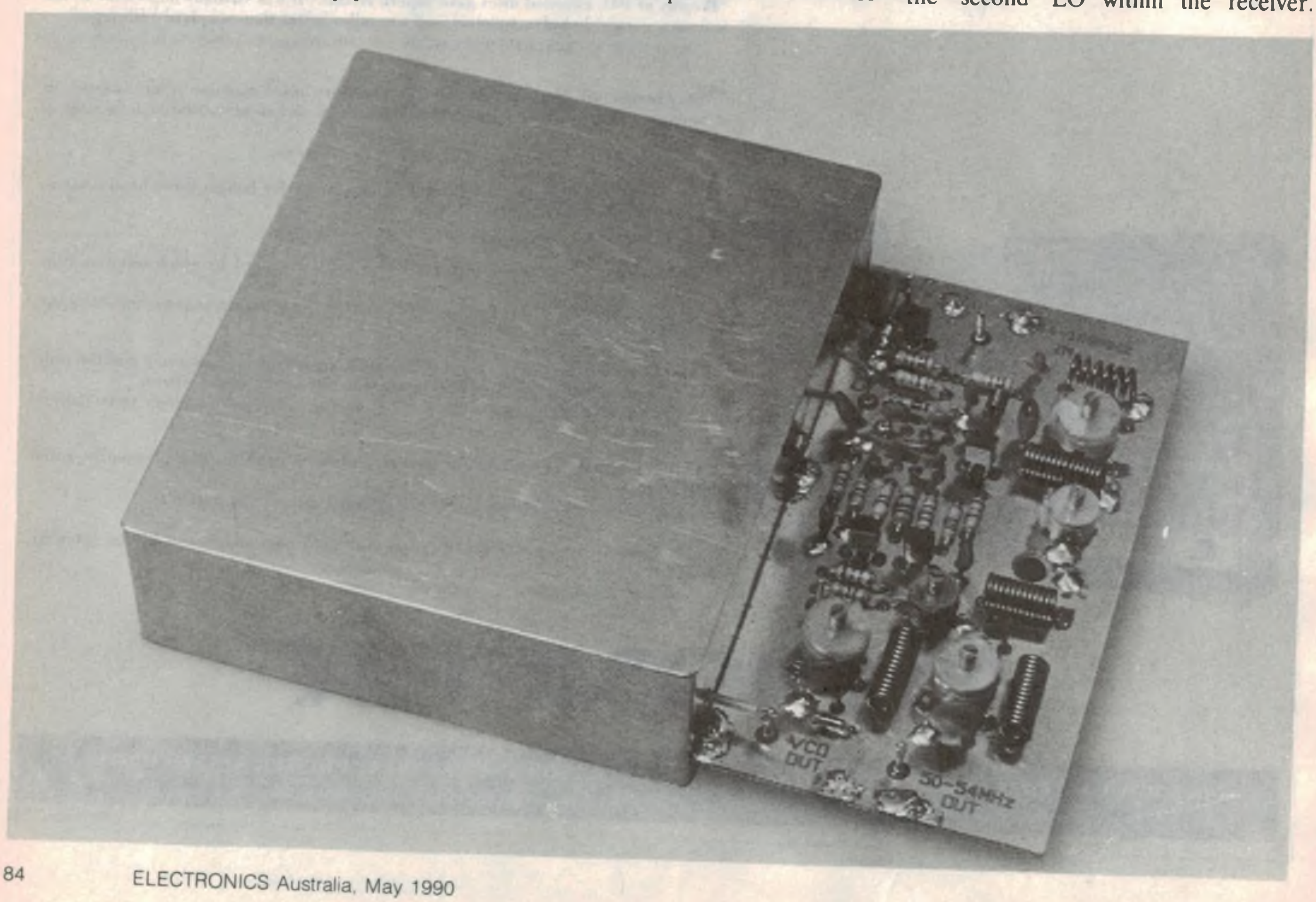
Here is the third design in our current series of amateur radio projects. This converter module will make it possible to receive the 2m amateur band on a 50-54MHz receiver. It is easily incorporated into our recently described 6m FM receiver with its multi-band capability.

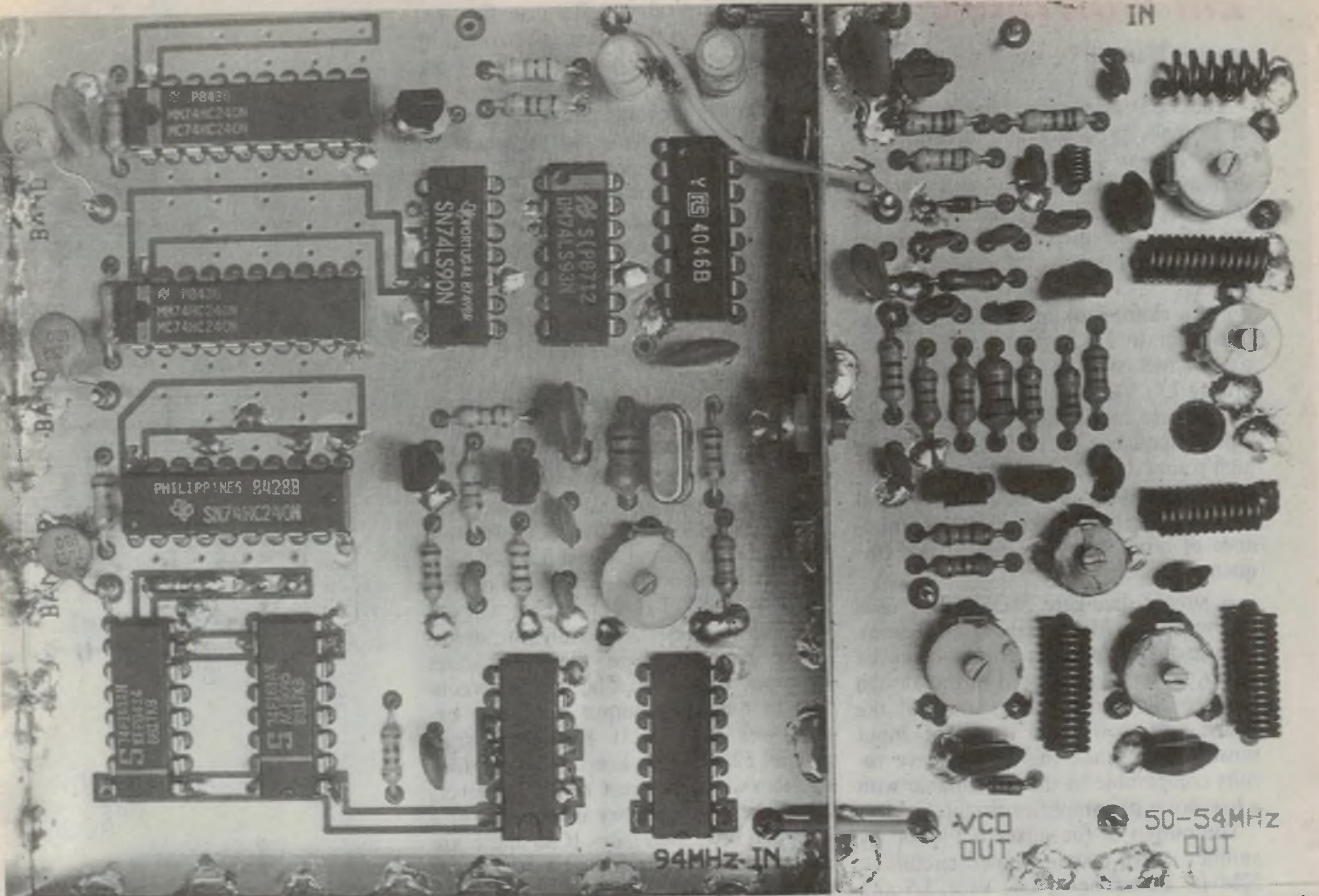
by DEWALD DE LANGE

When we published our 6m FM receiver design (January and March 1990), we envisaged upgrading it to cover a number of amateur bands. With a band selector switch already provided and with space for several frequency ranges on the tuning dial, all that has to be added are the appropriate frequency converting units.

This month we present the first of these converters, all suitable for building directly into the receiver. With this first converter fitted you will be able to receive the 144-148MHz band, in addition to 50-54MHz. Changing bands is simply a matter of flicking a switch.

These converters operate by mixing the whole of the required band down to the input range of the receiver. Tuning of a particular frequency is achieved, not by the usual adjustment of the first LO (local oscillator), but by adjusting the 'second' LO within the receiver.





A top view of the converter PCB, with the top of the shield box removed to reveal the circuitry inside. Note that the PCB is double-sided, with the copper on the top used mainly as a shielding ground plane. Use this picture and the PCB overlay as a guide to assembly.

The receiver is thereby used as a *tunable IF* (Intermediate Frequency) receiver.

An advantage of our modular approach is that the converter board can be built into the receiver case, saving you the cost of another box – a rather expensive item these days. The overall cost would also work out a great deal cheaper than having separate receivers for each band.

Besides providing the LO frequency required for this conversion, the present converter unit has been designed to generate two other selectable frequencies. These will be used for converters that are being planned for the future, to cover additional amateur radio bands.

Circuit description

At the heart of every frequency converter is a mixer – a non-linear device that produces the sum and difference of two input frequencies (and other higher order products). One input frequency in this case is of course the RF (Radio Frequency) signal in the 144 to 148MHz range which we wish to pick up.

To generate a 'difference' signal in the 50 to 54MHz band, the other mixer input, or local oscillator (LO) frequency, should be exactly 94MHz. As the name suggests, this signal is generated on the converter board itself. With a crystal oscillator used as a reference, the exact LO frequency can be obtained, either by frequency multiplication or with a phase-locked loop (PLL). It is the latter method we have used in this design.

The block diagram of Fig.1 illustrates the circuit operation. The RF input is firstly filtered to remove the image frequencies around 42MHz, which could also create 52MHz signals, should they mix with the LO. The filter also prevents radiation of the LO frequency via the RF input path and provides the optimum source impedance to the mixer for low noise figure.

After the mixer, the desired IF is filtered out from among the other output products. The filter also improves the image rejection of the subsequent mixer.

The VCO (Voltage Controlled Oscillator) forming the LO, is phase-locked to a 20MHz crystal oscillator. Both the VCO and the reference oscillator are divided down to the phase comparison frequency of 250kHz. This frequency has been chosen according to the band

TABLE 1
Coil winding details

All the coils from L1 to L6 are air cored. L1 to L5 are wound with 0.8mm enamelled wire on a 3mm (1/8") former.

- L1 6 turns distributed over a length of 10mm (about 38nH), tapped 2T from the grounded end.
- L2 14 close-wound turns (210nH), tapped 6T from the grounded end.
- L3 12 close-wound turns.
- L4, L5 15 close-wound turns (225nH). L5 is tapped 5T from the bypassed end.
- L6 6 close-wound turns, on a 2mm (5/64") former using 0.5mm enamelled wire.

spacing that will be used in future converters.

The VCO frequency is first divided by 2, to make programmable division possible. For an LO of 94MHz, the programmable division required is 188. As this VCO will also be used by future converters, the division has been made selectable by means of three tri-state buffers.

For a closer look at the circuit operation refer to Fig.2. The RF filter consists of two coupled tuned circuits comprising L1, VC1, L2 and VC2. Both inductors are tapped to step the 50 ohm input impedance up to 5000 ohms. The high source impedance (or voltage gain) gives the mixer a low noise figure, and is close to matching the 8k input resistance of mixer transistor Q1 at this frequency.

A simple dual-gate MOSFET is used as the mixer. More elaborate schemes, such as a pre-amplifier with a balanced mixer, weren't considered in this design to keep the component count and the board size down. In terms of input sensitivity at least, this design gave results comparable to that obtainable with a low-noise pre-amplifier circuit.

The output of the mixer is filtered by another set of coupled tuned circuits at 52MHz, consisting of L4, VC4, L5 and VC5. In this case the output filter presents a 900 ohm load to the mixer (50 ohm external load assumed). The load impedance is kept low to reduce intermodulation products. Because the supply voltage for the mixer is provided by the receiver, capacitors C2 and C4 are required for DC de-coupling.

Diode D1 prevents stray RF coupling via the band selector switch, when the frequency band is not selected.

The VCO is formed by the Colpitts circuit around Q2. Inductor L6, with bypass capacitor C6 on one side, forms a tuned circuit with C10, C11 and the capacitance of varactor diode D2. The strength of the oscillation (or loop gain) is determined by the ratio of C11 and C10.

Transistors Q3 and Q4 amplify the oscillator output and supply a TTL-level signal to the subsequent digital ICs. The DC output level is set to 1.5V by the bias network R6 to R11 and choke L7.

Next, to phase-lock the VCO we need to divide its output down to the comparison frequency of 250kHz. For this purpose FAST TTL ICs, which will operate up to 100MHz typically, are used.

The high speed of these ICs does have one drawback. The harmonic content of the sharp output transitions extend well past the IF frequency range around 52MHz. To keep these spurious signals out of the rest of the receiver, all of the PLL circuitry is enclosed in a screened box. Two gates IC3a and b are added to further isolate the VCO output from the PLL.

Although FAST TTL counters can operate with such high input clock rates, using them as a programmable divider at 100MHz turns out to be close

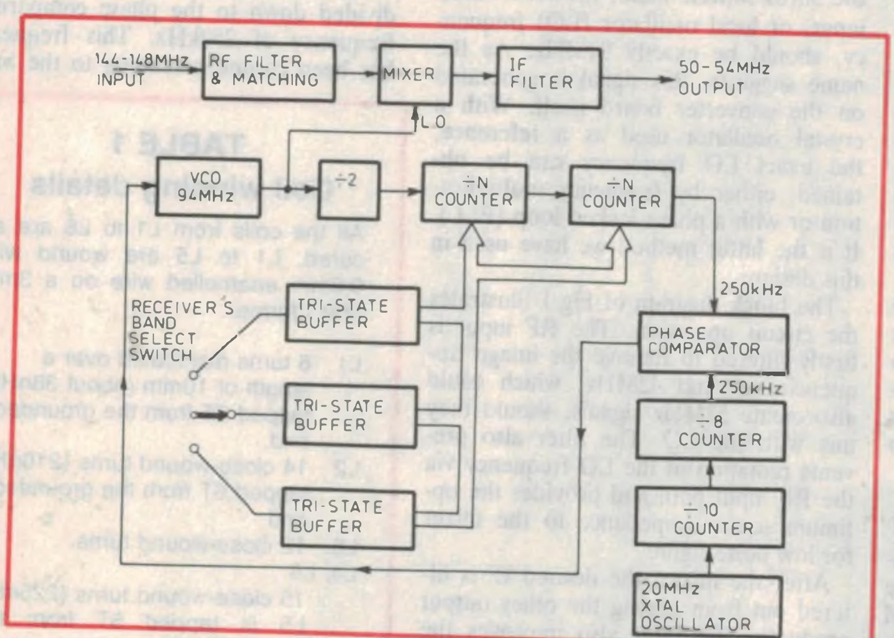
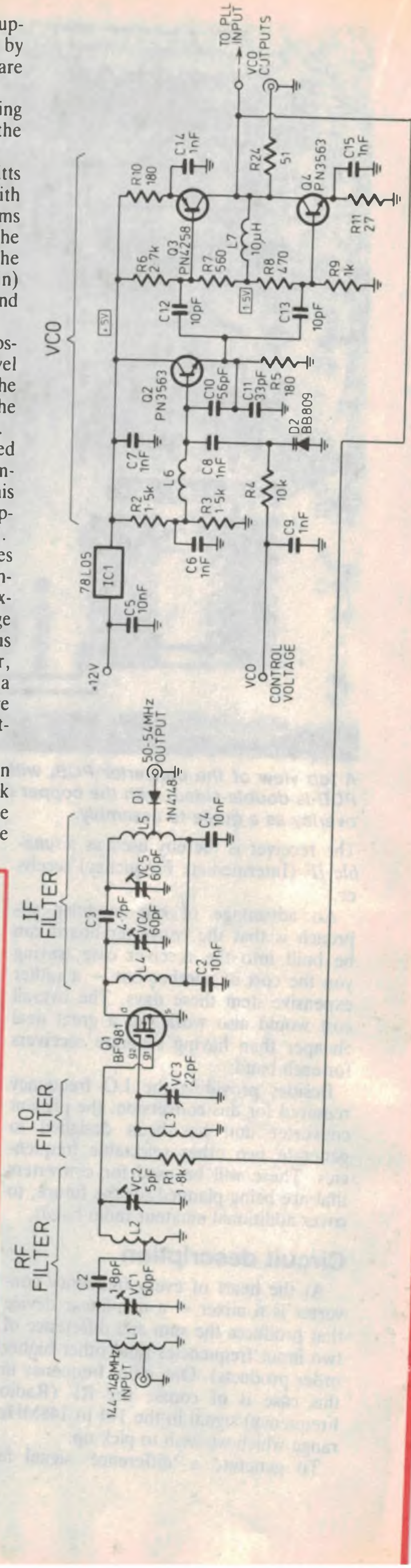


Fig.1: A block diagram of the converter, which uses a PLL system to lock the local oscillator to 94MHz. The additional buffers allow the VCO to be used for later converters as well.



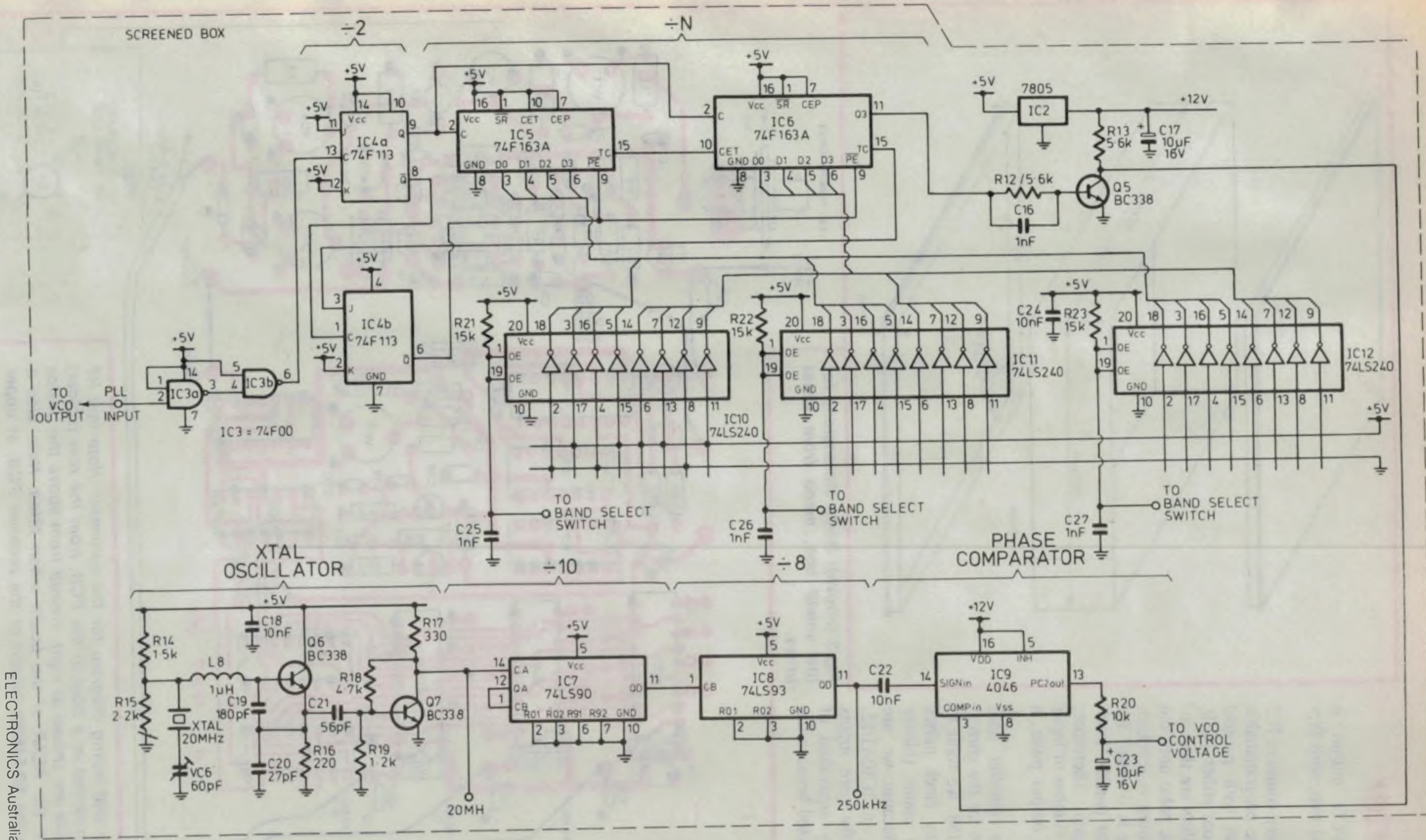


Fig.2: Shown on this page and that opposite is the complete circuit schematic for the converter, with each section identified in terms of its function. The PLL system provides effective crystal control for the local oscillator – not just for this converter, but for later converters as well. ICs 11 and 12 are optional at this stage.

2m Converter

to impossible. The VCO output is therefore first divided by two, with flip-flop IC4a.

Two synchronous binary counters IC5 and IC6 are used for the programmable division. A cycle starts with parallel data being loaded in from either IC10, IC11 or IC12. The counters are then incremented on each clock pulse until the maximum or terminal count is reached. At that point, counting is disabled for two clock pulses, so that parallel loading can take place again. Therefore, every time the required number of input pulses have passed, an output pulse is produced.

What should be the parallel data loaded into IC5 and IC6 for the correct division? To divide by 188, we want to start counting that many clock pulses ahead of the terminal count (binary number 1111 1111). Because we are using inverting buffers in IC10/11/12, the code required at the gate inputs simplifies to the binary equivalent of 188 – 2. The 2 is subtracted because the

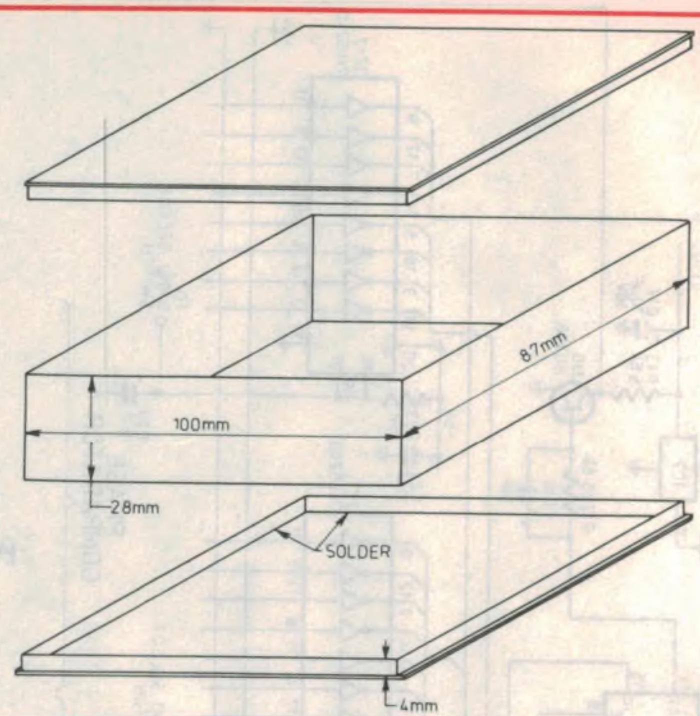
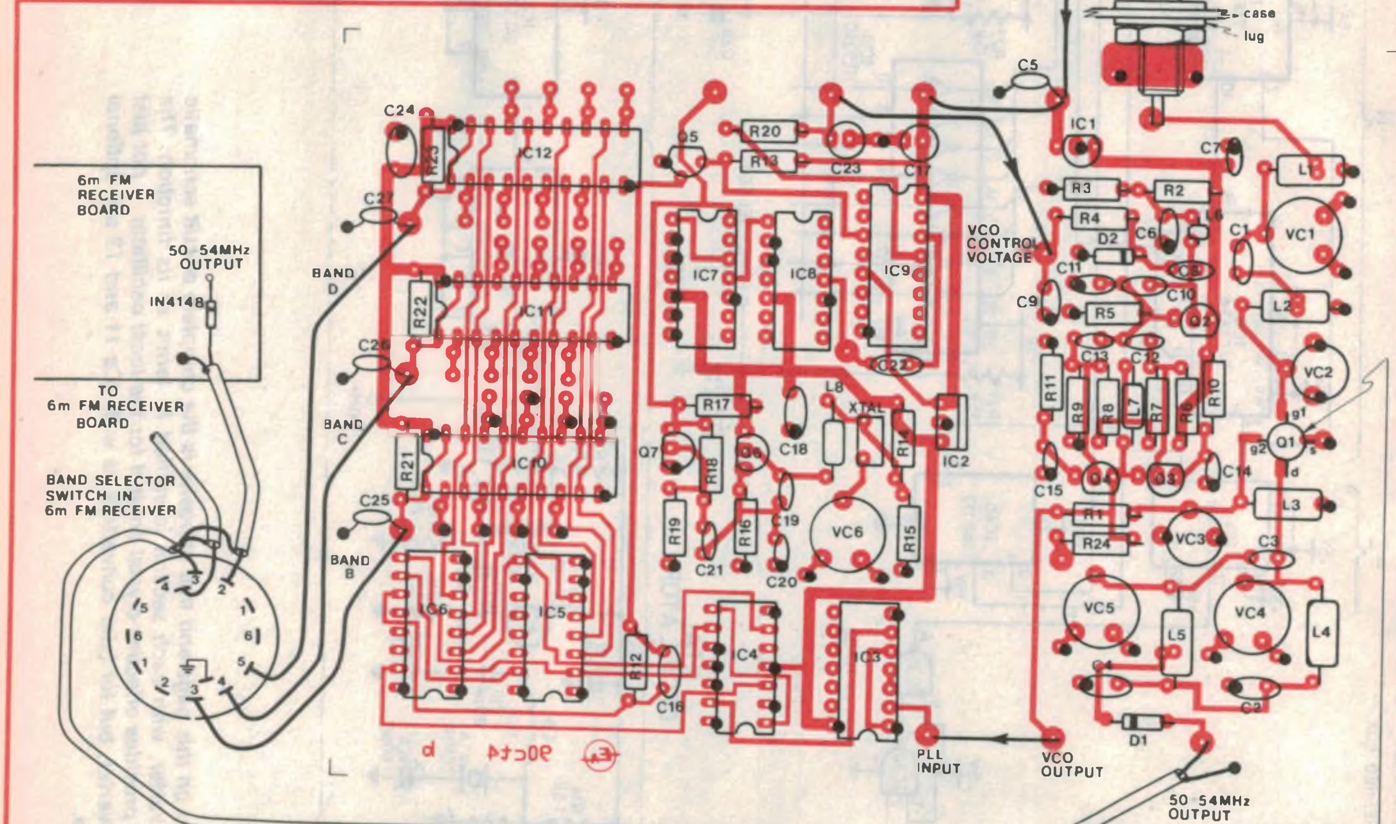
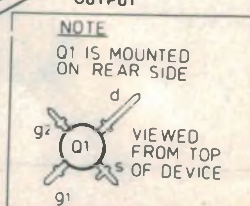
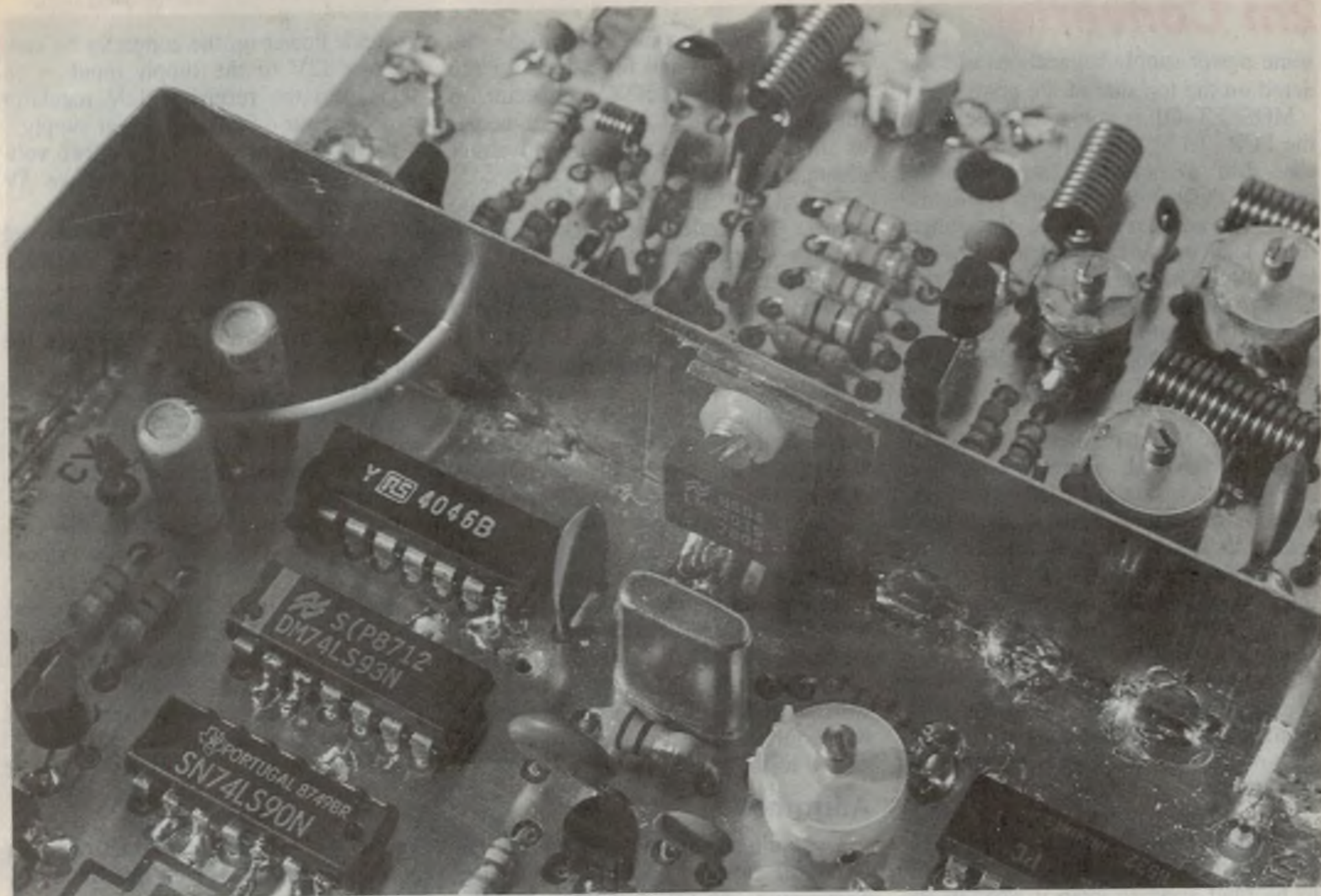


Fig.3 (above): Basic dimensions for the shield box, made from sheet brass.





Here is the PCB overlay and wiring diagram for the converter. Note that RF mixer transistor Q1 is mounted in a hole in the PCB, from the rear (solder) side. Its orientation details are shown at right, viewed from above the device itself – as viewed from the REAR of the board when fitted. Note also a 1N4148 diode added to the 50-54MHz output of the receiver PCB, at upper left.



Another closeup shot, showing the voltage regulator IC mounted on the shielding box wall.

counters are disabled for 2 clock pulses, as mentioned before. This gives the binary equivalent of 186, which is 1011 1010.

Flipflop IC4b is used to synchronise the parallel loading and give reliable counting for all possible variations in the timing characteristics of these ICs, according to the data sheets.

Transistor Q5 converts the divider's output to the 12V level required by the phase comparator IC9. Commutator capacitor C16 speeds up the transistor's switching action.

The reference path starts with the crystal oscillator around Q6. L8, C19 and C20 form a tuned circuit at the low impedance series-resonance of the crystal. R14 in parallel with R15 presents a low enough resistance to the tuned circuit, to prevent oscillation at the fundamental frequency of a third-overtone crystal.

The crystal oscillator output is buffered and amplified to TTL levels by Q7. Bias resistors R18 and R19 use the base-emitter voltage to compensate for variations in transistor beta.

Decade counter IC7 and binary counter IC8 divide the 20MHz crystal frequency down to 250kHz.

The reference and VCO frequencies are compared by the edge-triggered phase comparator of IC9, a CMOS 4046. Its tri-state output at pin 13 is filtered by R20 and C23. This signal is then used to adjust the VCO and lock it to the desired frequency. The time constant has been made quite slow to reduce phase noise, which would otherwise degrade the mixer's sensitivity.

Construction

The board layout comprises two separate sections, to allow for the screening of the PLL part of the circuit. Start by cutting (or sawing) out the two boards according to the edge markings. Round the edges of the boards with a file.

Fig.3 gives the approximate dimensions of the screened box. This is made from thin brass sheet, 0.38mm (.015") thick, available in small sheets from many hobby stores.

Using the PCB itself as a guide, fold a 28mm-wide strip of the brass sheet to form the sides of the box. Fold two 4mm-wide strips of brass so as to fit tightly inside these side panels. Keep track of their orientation.

Mark out the required size of the top and bottom lids and cut them out so that a slight lip will remain along the perimeter of the box. Solder the 4mm strips to the lids, along the inside junction. Start with spots of solder, to limit the buckling effect of heat on the brass. Make sure the lids fit properly. The solder joint should eventually be continuous. Mount the components before soldering the PLL board into the box.

As the boards have a number of fine tracks, make sure there are no unwanted shorts. Then solder the components according to the overlay diagram provided. Make sure the ICs are inserted with the correct orientation.

The winding details for coils L1 to L6 are given in Table 1. The coils that are tapped can be wound as two separate parts, as two central holes have been provided on the board for this purpose. Insert the two coils into the board and pass the former (the shank of a 3mm or 1/8" drill bit) through both coils to align them whilst soldering.

The other components are fairly straightforward. Some of the components will only be used for future converters and are optional at this stage. These are IC11, IC12, R22, R23, R24, C26 and C27.

All the ground connections, as well as

some power supply connections are soldered on the top side of the board.

MOSFET Q1 is soldered underneath the PCB. To fit the body of the transistor, drill a hole of 5mm diameter through the board. The lead configuration can be identified by the longer drain lead or by the protrusion at the base of the source lead. All the leads have to be cut shorter to fit onto the board. The heating time required to solder the transistor can be reduced by covering the PCB tracks with solder beforehand.

With all components soldered in place, fit the PLL board into its box, with the track side about 5mm from the edge of the box. Use several spots of solder to secure the board. Then drill 1.5mm holes in the sides of the box for the external connections. The other board (mixer and VCO) can then be soldered to the side of the box.

Use short pieces of hook-up wire to connect the VCO output to the PLL input and the control voltage (marked CV) of the PLL to the VCO. Also connect the two +12V supplies together.

The voltage regulator IC2 is secured to the side of the box, via a mica washer. Part of the rim of the top lid needs to be filed away to keep it clear of the IC mounting tab.

Finally, for those who have constructed our 6m FM receiver, the converter has to be mounted inside the case. Drill, ream and file a hole for the 144-148MHz input BNC connector in the back of the case, at the same height as the 50-54MHz connector and about 45mm away.

To anchor the other side of the board, drill holes for a 3mm screw through the back of the case and through the screened box. To ease assembly, use a brass nut that can be soldered to the inside surface of the screened box. But don't fix the converter in the case yet – not until the setting up has been completed.

The converter board will be powered from the 12V supply of the receiver board. The extra load placed upon the receiver's IC1 voltage regulator (*EA* January 1990), makes it necessary to affix a small heatsink to that regulator.

Another modification is required to the 6m FM receiver board, to improve the isolation between bands. Insert a diode where the cable from the selector switch is soldered to the 50-54MHz RF stage output. The cathode side is connected to the receiver board.

Alignment

The fault-finding and setting-up of the converter are best done outside the receiver case. To select division by 188, for the required 94MHz LO, temporarily take the enable input of IC10 (external connection marked Band B) to ground. Power up the converter by connecting 12V to the supply input – either from the receiver's 12V regulator or from your own bench power supply.

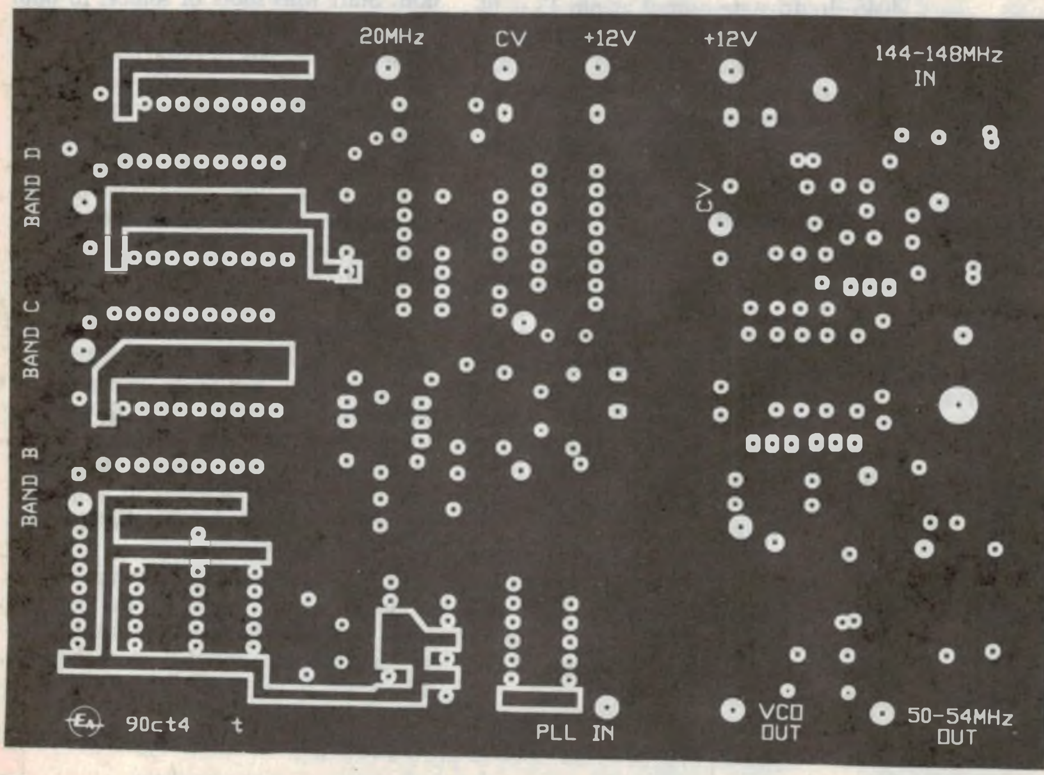
Start off by making sure the two voltage regulators IC1 and IC2 have 5V outputs.

Then check the output of the crystal oscillator (position marked 20MHz). Assuming it is operating correctly, adjust VC6 to obtain exactly 20MHz, when the circuit has stabilised (with the lid on).

Next, use a frequency counter or oscilloscope, with at least a 100MHz bandwidth, to check the output of the VCO. It should be exactly 94MHz. It is quite possible that you won't get this result the first time, as it requires the correct operation of the whole phase-locked loop.

Even if the PLL isn't operating correctly, the VCO will still be oscillating, but at the another frequency (probably around 105MHz). If there is no detectable VCO output, inspect that part of the circuit for construction faults.

Should the VCO be oscillating, but at the wrong frequency, follow the progress of the signal through the PLL. The VCO frequency should also exist at pins 3 and 6 of IC3. Half this frequency must be present at pin 9 of IC4. As far as the programmable division is concerned, see that the final output at pin 11 of IC6 or the collector of Q5 is



Here's the pattern for the top layer of the converter PCB, reproduced actual size for those who like to etch their own. Since it's largely a ground plane, there's a lot of copper left on...

1/188th of the VCO frequency.

Shifting to the crystal reference path, the output of IC7 (pin 11) should be 2MHz and that of IC8 (pin 11) 250kHz.

With the PLL operational, we can continue with the setting up of the mixer. You will need a small signal source at 146MHz to tune the RF and IF filters.

Connect this source to the RF input of the converter. Keep the end leads of the co-axial cable as short as possible. Use a short length of cable with a BNC connector on one end, to connect the 50-54MHz IF output of the converter to the EXT input at the back of the receiver. Switch the band selector switch to the EXT position.

Adjust trimmers VC1 to VC5 to their midway position. Apply a fairly strong (say 0.3mV) RF input signal around 146MHz. Tune the receiver to this signal. Using the signal strength meter of the receiver, do an initial adjustment of trimmers VC1 to VC5 to obtain a peak deflection.

Now we need to set the filters to their designed amplitude-frequency response. Bring the input signal level down so that the meter isn't limiting (about 10uV). Set VC1 to a maximum capacitance, and adjust VC2 for a peak meter deflection. Temporarily place a 22pF capacitor in parallel with L2 or VC2. Now adjust VC1 for a peak deflection. Remove the 22pF capacitor.

PARTS LIST

1 Double-sided PCB coded EA 90ct4, dimensions 140mm x 100mm
1 Small TO-220 heatsink
1 Quartz crystal, 20MHz series-resonant with about 20pF load capacitance.
1 BNC panel-mount connector

Semiconductors

1 BF981 dual-gate MOSFET
2 PN3563 or 2N918 NPN transistors
1 PN4258 PNP transistor
3 BC338 NPN transistors
1 1N4148 diodes
1 BB809 varicap diode
1 74F00 quad NAND gates
1 74F113 dual JK flipflop
2 74F163A binary counters
3 74LS240 or 74HC240 octal buffer (2 are optional)
1 74LS90 or 74HC90 decade counter
1 74LS93 or 74HC93 binary counter
1 4046 CMOS phase-locked loop
1 7805 voltage regulator
1 78L05 low power voltage regulator

Capacitors

1 1.4-5pF Philips trimmer (grey)
1 2-22pF Philips trimmer (green)
1 5-40pF Philips trimmer (grey)
3 5-65pF Philips trimmer (yellow)
1 1.8pF ceramic
1 4.7pF ceramic
2 10pF ceramic
1 27pF ceramic
1 33pF ceramic
2 56pF ceramic
1 180pF ceramic
10 1nF ceramic (2 are optional)
6 10nF ceramic
2 10uF 16VW PCB mount electrolytic

Inductors

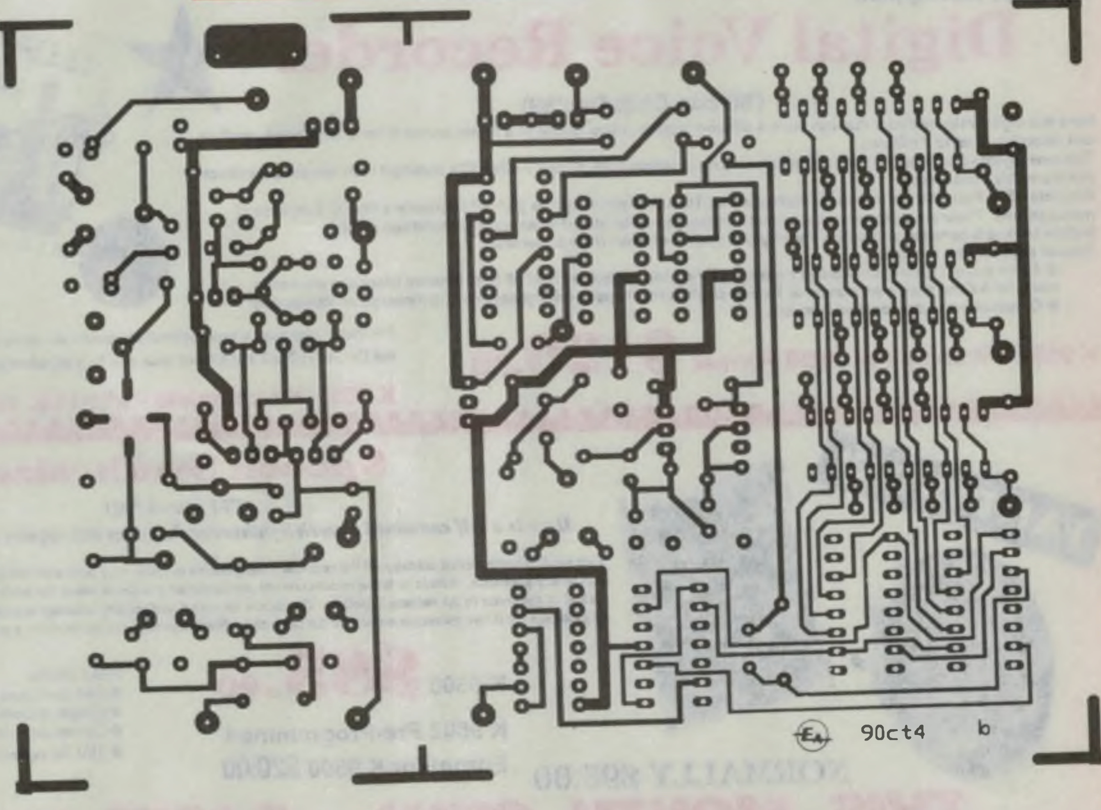
1 1uH RF choke
1 10uH RF choke
6 Air-cored coils

Resistors

Carbon film 5% 1/4W: 1 x 27, 1 x 51 (optional), 2 x 180, 1 x 220, 2 x 330, 1 x 470, 1 x 560, 1 x 1k, 1 x 1.2k, 3 x 1.5k, 1 x 1.8k, 1 x 2.2k, 1 x 2.7k, 1 x 4.7k, 2 x 5.6k, 1 x 10k, 3 x 15k (2 optional)

Miscellaneous

Brass plate 0.38mm (.015"); TO-220 isolating kit; solder lug; light hook-up wire; thin co-axial cable (e.g. RG-174); 0.5mm and 0.8mm enamelled wire; PCB pins, 3mm screw and nut.



And here's the matching pattern for the rear of the board. Note that the PCB must be sawn in two, along a line between the two short marks. The larger piece mounts the PLL circuitry, and goes inside the shield box.

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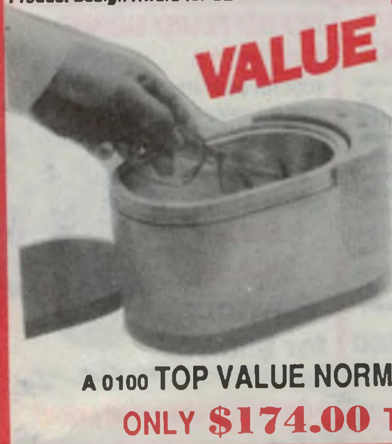

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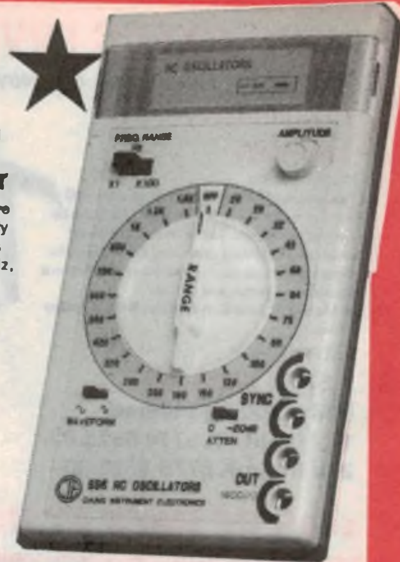

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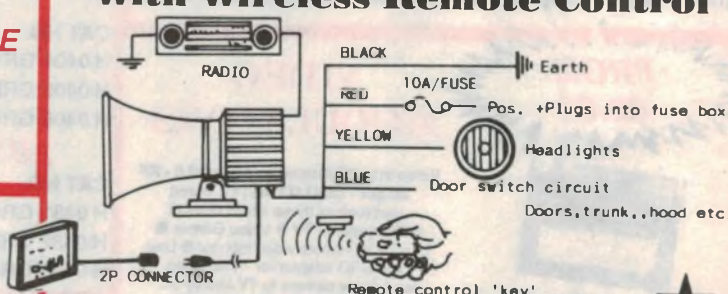

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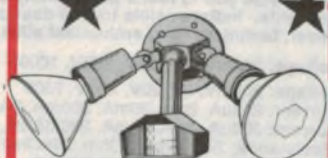

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Mini Construction Project:

Simple tester for phone answering machines

With so many telephone answering machines now in use, it's inevitable that from time to time some of them need servicing. Here's a testing unit designed to allow this to be done with a minimum of hassle.

by BILL JOLLY

Telephone answering machines are becoming very common and some have come my way for servicing. Mainly these have involved mechanical problems in the tape recorder section so far, but I expect there will be problems in the electronics as well.

In order to operate an answering machine, independent of Telecom, some way of ringing it up is required, so that any recorded message cam be heard and a message recorded. The tester to be described simulates a Telecom line, provides a ringing signal, and uses another phone for listening to and recording messages.

After some research and testing, the basic requirements for a Telecom line interface for this purpose were found to be as shown in Table 1.

'Open loop' refers to the line state with the handset hung up, and 'closed loop' to the line state with the handset off the hook. Lifting the handset places a virtual short circuit across the line pair and provides current to operate the microphone; it also signals the exchange.

Referring to the circuit diagram, an M2155-type transformer with a 15V/1A multitapped secondary is used to produce 10V DC for the ringing logic, 50V DC for the line voltage – via a voltage tripler – and 2.5V AC for the signalling transformer. The DC supplies are both halfwave rectified in order to have a common negative.

The line voltage is regulated by TR1, a 2N3055 connected as a pseudo zener, which sinks all the line current when both outputs are in the open loop state. The 50V line is at earth potential so TR1, which requires a heatsink, can be bolted directly on to the front panel.

The line voltage is coupled to the outlet sockets via 1.5k/5W resistors, which represent the Telecom line resistances. The socket voltages are monitored via divider networks feeding a 4011 NAND gate. This resets the ring counter, a 4022, when either of the phone lines change from open to closed loop.

As the 4011 is connected to both DC supplies it is important to check when first powering up the system that its input voltage is not greater than its supply voltage.

The ringing signal pattern is generated by a 4022 octal divider (IC2), clocked by a square wave with a period of 200ms generated by IC1, a 555 timer connected as an astable. The 1, 2, 4, and 5 outputs of IC2 are diode OR'd together to produce the required pattern.

The negative edge of IC2's output 6 is used to trigger IC3, another 555 connected as a monostable, with its output adjusted to disable the counter for 2 seconds. Closing SW1 will hold the output of IC3 high and put the ring cycle on hold.

The combined outputs of the 4022 drive a relay via TR2. The relay in turn connects the 2.5V AC to half the normal secondary of a second transformer, type M2851 (240V to 6.3V). This has its normal primary connected in series with the return lead from both sockets, and performs three functions:

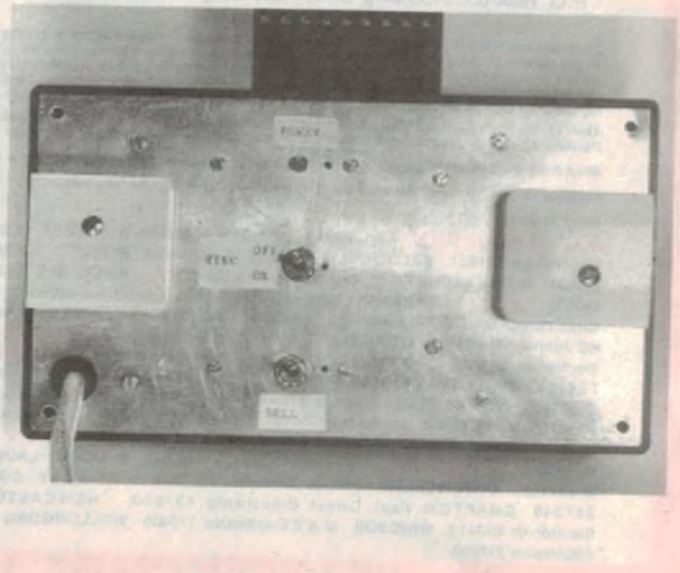
1. When powered up in the open loop state, the return lead is modulated with 100V RMS AC, 50Hz which is the required ringing signal.
2. In the closed loop state, it provides a DC path for the line current.
3. It presents a high impedance path for audio signals.

As you can see from the photographs, all of the required hardware can be crammed into the largest available Jiffy box (which happened to be the only one to hand when the instrument was needed). But for a more comfortable job, something larger is recommended. The lower switch was to be part of a system to operate the bell of a dial phone, but was found not to be necessary.

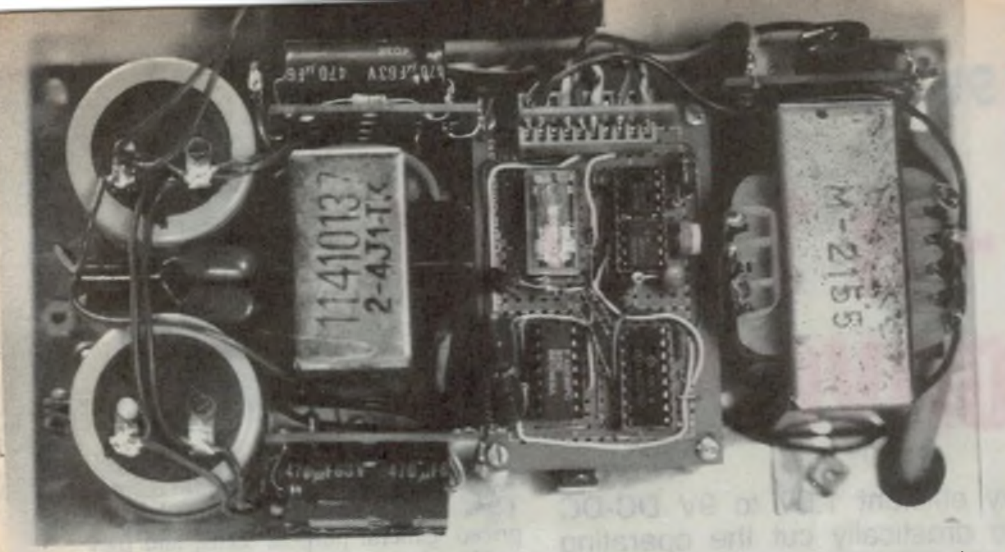
Using it

To use the tester, plug in the answering machine to one of the sockets, and a telephone to the other. Then switch on.

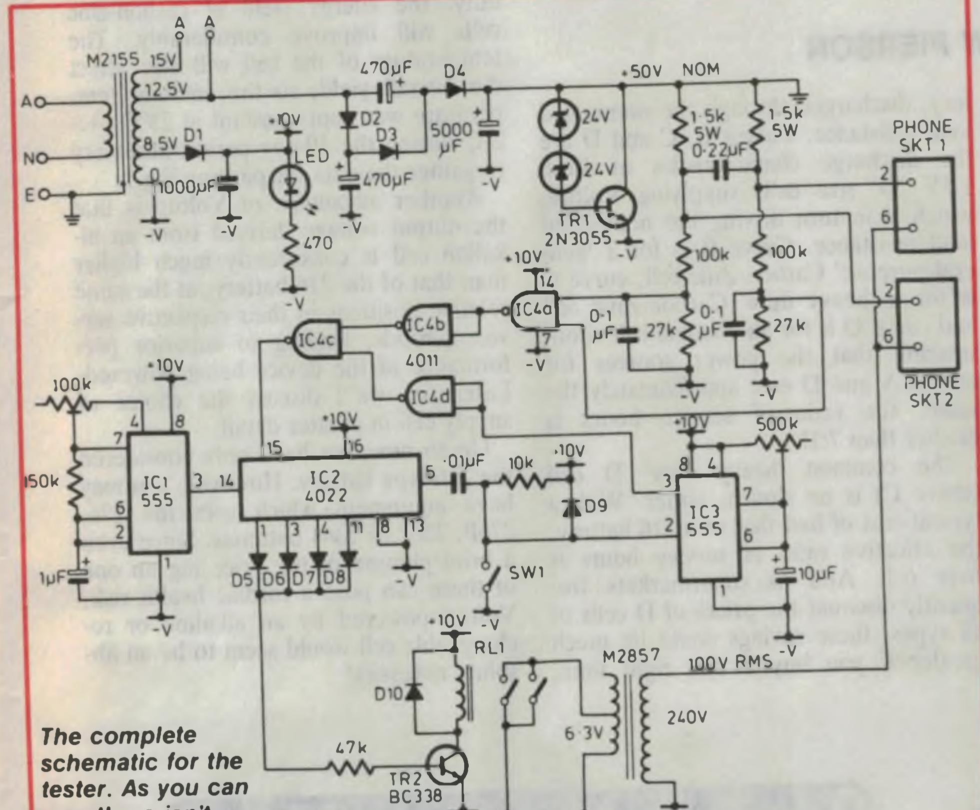
Allow a few seconds for the line voltage to build up and then switch on the



The completed prototype, built in a Jiffy box with the two telephone sockets mounted on each end of the lid.



Inside the author's prototype tester. Rather than make a custom PCB, he wired it up using a utility board.



The complete schematic for the tester. As you can see, there isn't much in it.

ringing cycle with SW1. When the answering machine closes its loop to 'answer', the ring cycle should stop. By lifting up the handset of the phone, any recorded message should be heard; a message can also be recorded. The volume control on the answering machine may need to be turned down to avoid microphone howl.

In another article I propose to describe how the power supplies and ringing circuits used in the tester can, with some modification, be used to operate an intercom using standard telephones.

PARTS LIST

1 Jiffy box, 196 x 113 x 60mm
1 Transformer, 240V to 15V multi-tapped at 1A (M2155 type)
1 Transformer, 240V to 12.6V CT at 150mA (M2851 type)
2 Sockets, Telecom type 610
1 Length of printed mounting strip
1 Utility PCB - Tandy Cat 276-158 or similar
1 Low voltage DPST PCB mounting relay - Tandy Cat 275-213 or similar
1 14-pin DIL IC socket
2 16-pin DIL IC socket
1 SPDT miniature toggle switch
Sundry mounting hardware, power lead and plug, etc.

Semiconductors

1 4022 octal divider
2 555 timer
1 4011 NAND gate
1 MJE3055 transistor
1 BC338 transistor
4 1N4002 diode
6 1N4148 diode
2 1N4749 24V Zener diode

Resistors

2 1.5k 5W
1 150k 1/4W
2 100k 1/4W
2 27k 1/4W
1 10k 1/4W
1 4.7k 1/4W
1 500k mini trimpot
1 100k mini trimpot

Capacitors

1 5mF (5000uF) 63V electrolytic
1 1mF (100uF) 16V electrolytic
2 470uF 63V electrolytic
1 10uF 16V tantalum or electrolytic
1 1uF 16V tantalum or electrolytic
1 0.22uF metallised polyester
2 0.1uF metallised polyester

TABLE 1

Open loop line voltage	50 volts DC
Line resistance	400 ohms minimum 1900 ohms maximum
Closed loop line current	23mA minimum
Signalling voltage	100 volts RMS AC
Signalling frequency	50Hz
Signalling repetition pattern	On - 400ms Off - 200ms On - 400ms Off - 2 seconds

References: *EA* November 1985, June 1986, September 1987

Sick of replacing 9V batteries? You need...

'Voltup' - a 1.5V/9V DC/DC converter

Here is a very simple yet very efficient 1.5V to 9V DC-DC converter, which allows you to drastically cut the operating costs of 9V equipment by powering it from a single 'D' size cell. You can choose from a wide variety of primary or secondary cells.

by ANDREW PIERSON

If you own a number of 9V battery operated devices, you will know that running them can be a costly business. A carbon-zinc cell can only develop an EMF of 1.5V, so a 9V battery contains six separate cells connected in series.

Due to their manufacturing costs, 9V batteries are a very expensive way to buy energy. At typical supermarket prices, a 9V No. 216 'heavy duty' battery costs about the same as a single 1.5V 'D' size alkaline cell. The alkaline cell contains much more energy, but with a potential of 1.5V the only way to make use of it was to have six cells in series – a very bulky proposition.

As it happens a much more elegant solution is possible – by using a simple 1.5V to 9V DC-DC converter with the right characteristics for the jobz

The blocking oscillator inverter is very flexible, and I have found that it is possible to develop a modified version which would operate reliably with a supply voltage of only 750mV, which is the lowest practical 'end-point' for primary cells. I have been able to achieve a peak efficiency of approximately 60%, which is a very reasonable figure when the low supply voltage is taken into account.

How much can you expect to save with Voltup? Look at the four discharge characteristic curves in Fig.1, which have each been plotted for a load resistance of 600 ohms (i.e., a starting current of 15mA at 9V). This represents the average current drain of a typical small transistor radio receiver.

Curve A is the discharge characteristic of a fresh 9V 216-type 'heavy duty' battery, discharged through the nominated load resistance. Curves B, C and D are the discharge characteristics of fresh 1.5V 'D' size cells supplying Voltup, which is in turn driving the nominated load resistance. Curve B is for a 'general purpose' Carbon-Zinc cell; curve C is for a 'heavy duty' Carbon-Zinc cell and curve D is for an alkaline cell. Considering that the power sources for curves A and D cost approximately the same, the ratio of service hours is greater than 7:1!

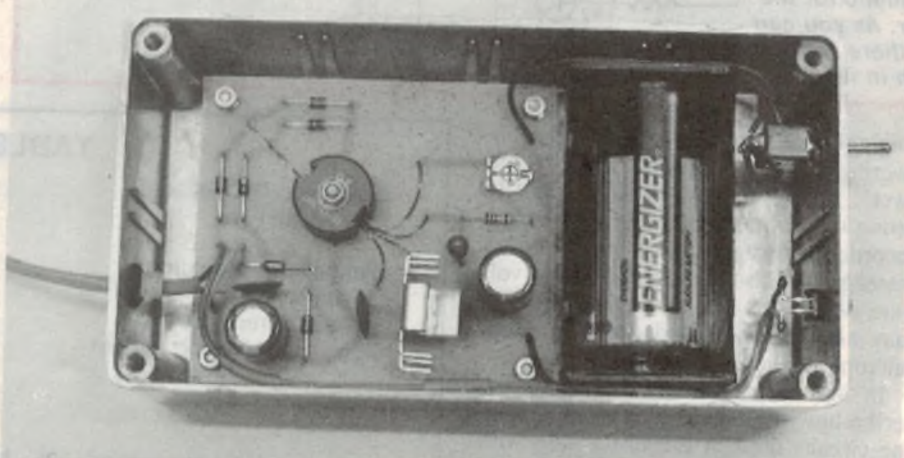
The common 'heavy duty' D cell (curve C) is no slouch, either. With a typical cost of half that of a 216 battery, the effective ratio of service hours is over 6:1. And as supermarkets frequently discount the prices of D cells of all types, these savings could be much greater if you buy at the right time.

Tests were carried out with bargain priced 'general purpose' cells, and they produced a saving of almost 12 times!

Note that the curves in Fig.1 are for continuous discharge. With intermittent duty, the energy yield of carbon-zinc cells will improve considerably. The temperature of the cell will also affect the overall yield, so the ambient temperature was kept constant at 25°C, +/-2°C during the 10-day period necessary to gather the data for plotting Fig.1.

Another advantage of Voltup is that the output voltage derived from an alkaline cell is consistently much higher than that of the 216 battery, at the same relative positions in their respective service periods, leading to superior performance of the device being powered. Later on, we'll discuss the choice of supply cell in greater detail.

Up to now, we have only considered the 216-type battery. However, you may have equipment which uses the 276, 276P, 2362 or 2364 batteries. Since even a brief glimpse of the price tag on one of these can pose a cardiac health risk, Voltup powered by an alkaline or rechargeable cell would seem to be an absolute necessity!



Compact and efficient: Voltup inside its diecast aluminium box.

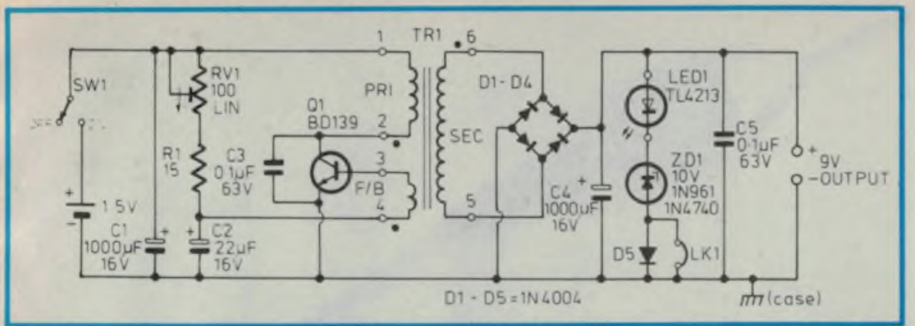


Fig.2: The circuit schematic for Voltup.

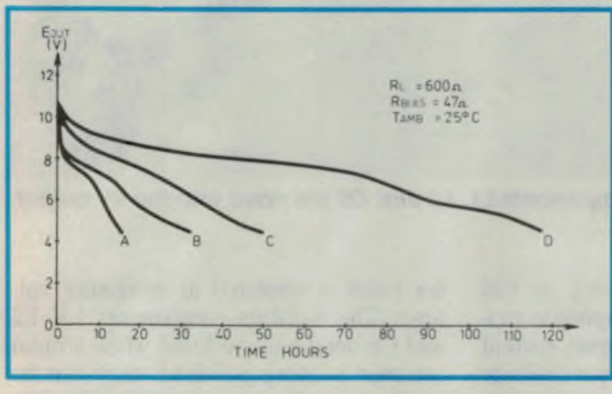


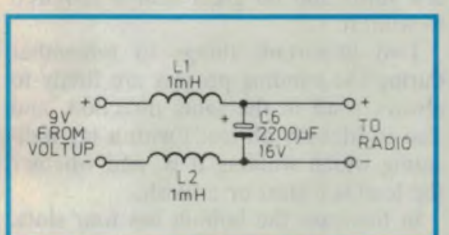
Fig.1: Comparison of the discharge characteristics of a 216-type 9V battery (A) and those obtained with Voltup and D-type 1.5V cells. B is a general purpose cell, C a heavy duty type and D an alkaline cell. As you can see, there's a healthy improvement!

Circuit description

Let us now turn to the circuit schematic (Fig.2), to see how Voltup works.

Transformer TR1, together with Q1, RV1, R1 and C2 form a power blocking oscillator. The base of Q1 is supplied with forward bias via RV1 and R1 (we'll call the total resistance R_{bias}) and the feedback winding. C2 is used to partially bypass R_{bias} at the operating frequency of the oscillator.

The primary and feedback windings of TR1 are so phased that the feedback is positive, with the result that the circuit oscillates. As Q1 is alternately switched on and off, the primary of TR1 is connected across the 1.5V supply cell for the first 50% of the oscillation period, and left open-circuit during the remainder. As a result, an alternating magnetic flux is set up within the core of TR1.



This optional output filter is only required if Voltup is used with a radio.

As this flux cuts the secondary winding it induces in it an alternating voltage, which is a symmetrical square wave. This is rectified by the bridge rectifier D1-D4 and filtered by the storage capacitor C4.

A bridge rectifier configuration was chosen because it forces both the power and induction strokes of the blocking oscillator to share the same load (parallel loading), thus equalizing the power in each. By contrast, a voltage doubler configuration would place the rectified outputs from each stroke in series. This would give poorer regulation, together with varying waveform symmetry, and for these reasons it wasn't chosen.

If Voltup were to be operated in an unloaded condition and without protection, the induction stroke from the blocking oscillator would push the output voltage up to dangerous levels. LED1, ZD1 and D5 (a component that is optionally selected after testing) form a simple 'crowbar' protection circuit, which starts to conduct at about 11V, and simply draws sufficient current to stabilize the output at about 12V. The quiescent current of a typical transistor radio will normally provide sufficient load to prevent the protection circuit from operating, so the conversion efficiency will not be adversely affected.

C1 ensures that the inverter's AC supply impedance will remain low as the 1.5V supply cell is discharged. C3 is used to reduce radiated RF energy, and also to curb any tendency toward parasitic oscillation in Q1, which has a much higher transition frequency (f_T) than is required for this application. The value of C3 is not large enough to significantly degrade the oscillator's switching time, and it therefore has little effect upon the overall conversion efficiency. C5 reduces RFI by keeping the output DC supply rail impedance low at radio frequencies.

If Voltup is used to power a radio receiver, the extra components L1, L2 and C6 are required. These are fitted to the 9V output connector, and serve three important functions.

The RF chokes L1 and L2 isolate the 9V supply lead from the RF circuitry in the receiver. This reduces any tendency for the lead to pick up signal by becoming a counterpoise antenna. Also, any remaining harmonics of the oscillator's operating frequency which fall within the tuning range are prevented from reaching the receiver.

Capacitor C6, in combination with the DC resistance of L1 and L2, forms a current dump (reservoir) circuit which is able to supply the peak demands of class B audio output stages without imposing a violently swinging load on the converter. This reduces the likelihood of Voltup being instantaneously overloaded by large current peaks, and also minimises interference by reducing frequency 'swish'.

The above circuit description has been necessarily brief, as the operation of power blocking oscillators is very complex. For more information on how these interesting devices operate and how they can be put to work for you, I would refer you to the series of articles which are shortly to be described in *Electronics Australia*. Voltup was designed using the guidelines to be given in this series, with minor modifications to allow for operation at very low supply rail potentials.

Performance

When the design of this project was being considered, a very important requirement was for the relationship between the input and output voltage (i.e., the 'transfer characteristic') to be as linear as possible, and to extend down to the lowest practical end-point voltage of the supply cell. Fig.3 shows that this has been achieved, with operation being possible down to below 700mV.

Of critical importance in a very low voltage power blocking inverter is the choice of forward bias resistor, R_{bias}. The intrinsic base-emitter voltage of Q1 (V_{BE}) must be subtracted from the lowest input voltage likely to be encountered, and this leaves very little potential available to generate base current, especially when the supply cell is nearing the end of its life.

Voltup converter

The value of R_{bias} must therefore be low enough to produce an adequate load current capability, but if it is too low conversion efficiency will suffer, particularly at low output load currents. In order to cater for all output load requirements and still keep the efficiency as high as possible, the value of R_{bias} has been made adjustable between 115 ohms and 15 ohms.

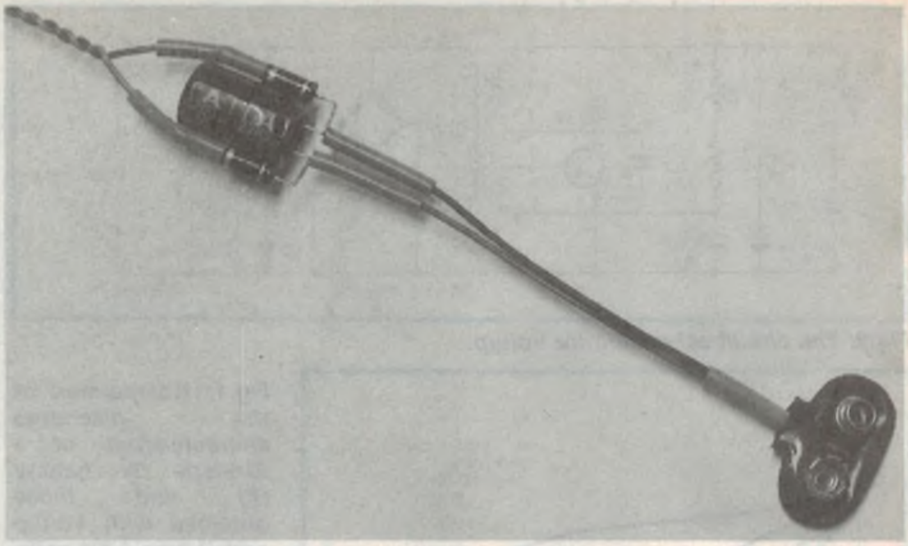
Fig.4 shows the relationship between output load current and output voltage when R_{bias} is equal to 47 ohms (32mA maximum output) and 15 ohms (50mA max. output). These are representative characteristics only, as they are influenced by the DC gain parameter (h_{FE}) of Q1. The points to plot Fig.4 and the following efficiency measurements were taken from a circuit in which the h_{FE} of Q1 was 77 at Ic = 200mA. This would be a typical figure (about twice the minimum and half the maximum specification).

With R_{bias} = 47 ohms, the overall conversion efficiency of Voltup was 59% at 10mA load current and 57% at 25mA. When R_{bias} was lowered to 15 ohms the efficiency was 44% at 10mA load current and 52% at 40mA. The minimum value of R_{bias} (15 ohms) was arrived at by calculations based on the 47 ohm curve in Fig.4, and should allow a reasonable high current characteristic if the h_{FE} of Q1 falls near its lower specification limit of 40.

When Voltup is being driven from an alkaline cell and is supplying considerable output current, the drop in efficiency at low values of R_{bias} will make little difference to operating costs, due to the increased energy yield of the cell at high current densities. RV1 has been included mainly for low current applications, where the user wishes to maximize battery life.

When R_{bias} is equal to 115 ohms (i.e., when RV1 is turned fully anticlockwise) the output current is further limited, but the overall conversion eficiency rises above 60%.

When Voltup is overloaded Q1 cannot maintain saturation during its ON period, so the oscillation amplitude rapidly diminishes and the input current sharply increases. The output voltage therefore falls away quickly, accompanied by a commensurate fall in efficiency. Voltup can take this treatment, but it clearly isn't conducive to long battery life.



How the optional filter components L1, L2 and C6 are fitted into the 9V output lead, for use with a radio.

Note that the characteristics in Fig.4 are plotted for the maximum input supply voltage (1.5V). With 1.5V input, up to 360mW of output power is available from Voltup when R_{bias} = 15 ohms (i.e., when RV1 is turned fully clockwise). Obviously, the maximum currents and power available will be reduced as the supply cell's terminal voltage falls during use.

Voltup operates at frequencies ranging from approximately 10kHz (R_{bias} = 15 ohms, 1.5V input and a 200 ohm load) to 50kHz (R_{bias} = 115 ohms, 750mV input and no-load).

When a radio receiver is being powered, the 9V DC feed from Voltup is via the two RF isolation chokes, L1 and L2. Since these have a maximum resistance of some 18 ohms each, they will result in a total voltage drop of about 900mV when the average small transistor radio is operated at maximum volume. The isolation components L1, L2 and C6 need only be fitted when a radio receiver is being powered; they can be omitted for all other purposes. The data given (including the graphs) does not take account of these components.

Construction

Using the component overlay as a guide, mount R1, all capacitors and all diodes. Be particularly careful that the electrolytic capacitors and diodes are correctly orientated. Mount RV1 and fit the link LK1, which should be formed into a 'U' shape so that, if necessary, it can be cut easily during the testing procedure.

Now, it's time to wind the transformer. If you haven't wound transformers before, don't panic. This one has very few turns and no great skill is required to wind it.

Two important things to remember during the winding process are firstly to always wind in the same direction, and also to identify all leads with a tag indicating which winding it is, and whether the lead is a start or a finish.

In this case the bobbin has four slots; two on each side, 180° apart. The pri-

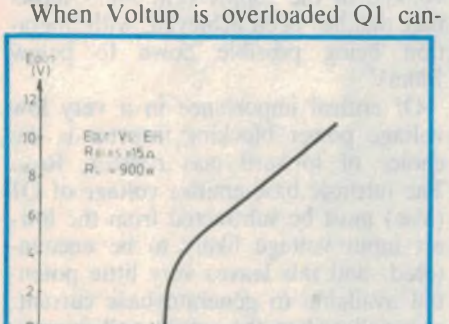
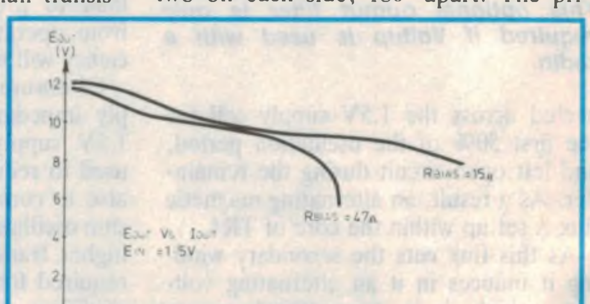
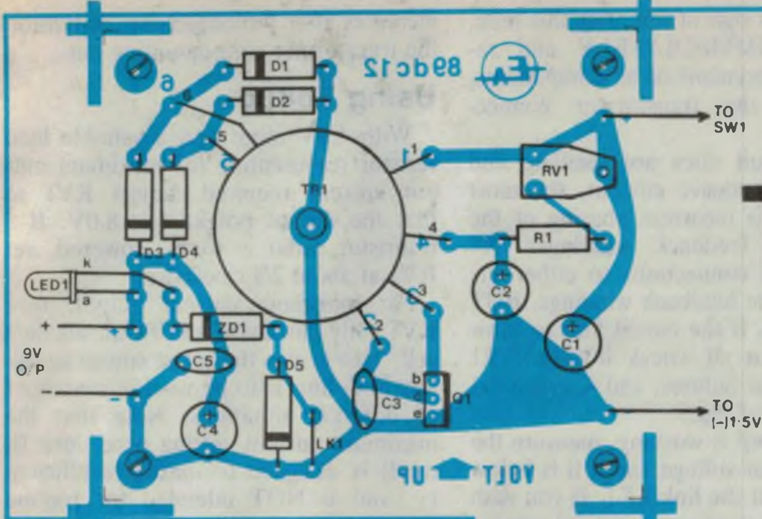


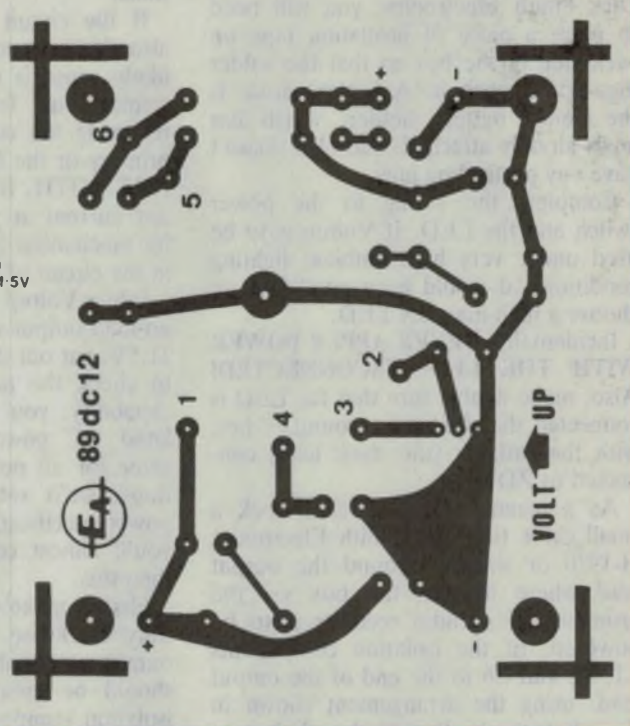
Fig.3 (left): Output voltage vs input voltage for Voltup. Note that it operates for inputs down to below 700mV.

Fig.4 (right): Output regulation characteristic for two different values of bias resistor, and 1.5V input.





The PCB wiring overlay at left should help you with the assembly of Voltup. Take special care with the transformer connections.



This PCB etching pattern is shown actual size, for those who etch their own boards.

mary (6 turns, 26 B&S) is wound first on the left hand side of the bobbin, with the start and finish passing through the same slot on the left. The feedback winding (1 turn, 26 B&S) is then wound on the right hand side of the bobbin, with its start and finish passing through the same slot on the right.

Apply a couple of layers of insulation tape to keep the windings in place, and then rotate the bobbin 180° axially, to bring the two unused slots uppermost. The secondary (52 turns, 30 B&S) can then be neatly scramble wound (i.e., not in distinct layers), with its start entering through the slot on the left and its finish passing out through the slot on the right. The job can now be finished off by applying a couple of layers of insulation tape.

After ensuring that the mating faces of the cores are clean, assemble the transformer and hold it together temporarily with the 3/4" 6BA bolt and nut. The leads can now be dressed (shaped to fit the PC board), cut to length and the ends tinned. Remember that, by convention, the starts of windings are identified by a dot on the circuit schematic.

To assist you further, the transformer connections are numbered identically on both the PCB overlay and the circuit schematic.

Mount the transformer on the PC board with the 6BA bolt and nut. Place the head of the bolt, together with a 6BA flat washer, on the track side of the PC board, and use a 6BA flat nylon washer and a 6BA nut against the core. This arrangement will avoid any metal-to-ferrite pressure points. Tighten the bolt firmly (but not excessively), and solder all the transformer leads to their correct points.

If you want to be sure of getting the best possible high current output characteristics, or if you wish to optimise efficiency at low load currents by means of RV1, you should make sure that Q1 has a gain of at least 80. Use a transistor tester or the circuit in Fig.5 to check the current gain, which in the latter case will be equal to the collector current in milliamps. Take the reading immediately after power is applied, and then switch off. Do not test the transistor for more than a few seconds, as considerable heat can be generated.

Before mounting Q1, fit the clip-on heatsink. Although the H-3415 heatsink (Dick Smith Electronics) is designed for the TO-220 case, it fits the BD139 quite well. Lift up the spring clip, and slip the body of the BD139 in as far as it will go, ensuring that the collector mounting surface is in contact with the large face of the H-3415 heatsink.

It's worth mentioning here that Q1 normally dissipates very little power,

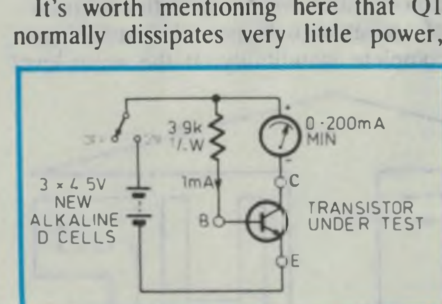


Fig.5: Simple transistor test circuit.

and the heatsink will be required only under conditions of gross overload. Make sure that the transistor leads adequately clear the surface of the heatsink, and also that the bottom of the heatsink rests against the PC board for added rigidity. Double check the transistor connections before soldering; the emitter lead should be facing the edge of the PC board.

A metal diecast box is used for both acoustic and RF screening purposes, and also because the lid is readily removable for battery replacement. Drill the holes for the power switch, the warning LED, the output cable grommet and the four countersunk mounting holes for the PC board.

Make up a twisted twin output lead about 1m long and attach it to the PC board. Fit a short length of spaghetti sleeving or heatshrink tubing to this lead where it will pass through the grommet. Also attach the leads which will connect to the LED, the negative battery lead and the positive lead which will go to the power switch.

Mount the PC board on 1/4" long 4BA spacers using the four countersunk-head bolts. The spacers used must be metal types, as one of them forms the single-point earth link between the track side of the PC board and the case.

Attach the battery holder by means of

Voltup converter

double-sided foam adhesive tape. If you're using the battery holder sold by Dick Smith Electronics, you will need to place a piece of insulation tape on each side of the box so that the solder lugs don't touch it. A better choice is the Tandy battery holder, which has leads already attached, and also doesn't have any protruding lugs.

Complete the wiring to the power switch and the LED. If Voltup is to be used under very high ambient lighting conditions, it would be a good idea to choose a high-intensity LED.

Incidentally, **NEVER APPLY POWER WITH THE LED DISCONNECTED!** Also, make doubly sure that the LED is connected the right way around – i.e., with the cathode (the short lead) connected to ZD1.

As a means of strain relief, lock a small cable tie (Dick Smith Electronics H-1970 or similar) around the output lead where it exits the box via the grommet. If a radio receiver is to be powered, fit the isolation components L1, L2 and C6 to the end of the output lead, using the arrangement shown in the photograph. Secure the chokes to the body of the capacitor by means of insulation tape or silicone adhesive sealant.

If equipment other than radio receivers is to be powered, do not fit these components, as they degrade Voltup's performance slightly. When wiring the battery 'snap' connector, remember that since it is 'masquerading' as a battery, it will be necessary to reverse the connections (i.e., the black lead will be connected to the positive output). Sheath all connections with heatshrink tubing, or similar.

Testing

Turn RV1 2/3 clockwise. Then insert a fresh 1.5V cell into the holder, and switch on the power. (Use an ordinary carbon-zinc cell for these tests, as its poorer regulation will give better protection if things go wrong.)

If the warning LED illuminates within a few seconds, all is probably in order. If there is no sign of life after this time, switch off IMMEDIATELY and re-check the placement of all components, particularly the transformer connections.

If the circuit does not oscillate and also draws excessive current, the most likely cause is incorrect phasing of the primary or feedback windings. Try reversing the connections to either the primary or the feedback windings, BUT NOT BOTH. If the circuit fails to draw any current at all, check RV1 and R1 for mechanical failures, and also test Q1 in the circuit of Fig.5.

When Voltup is working, measure the no-load output voltage and if it is below 11.5V, cut out the link LK1. If you wish to check the maximum output current capability, you will need a 1.5V regulated DC power supply. In order to cater for all possible component variations, we'll set the maximum output power specification at 320mW, although you'll almost certainly do much better than this.

Firstly, make sure that RV1 is turned fully clockwise. With 1.5V input, the output potential across a 200 ohm load should be greater than 8.0V. (If the isolation components have been fitted, place the load across the supply side of the RF chokes.)

If you have a CRO, you can look at the voltage waveform between the negative rail and the collector of Q1. The no-load amplitude should be 3V p-p, and with a 200 ohm load the lowest point of the swing (the saturation voltage of Q1) should be about +300mV.

After testing is complete, you can attend to a small sound-proofing matter. Cut a 50mm x 65mm piece of 25mm 'Innerbond' or foam plastic, and place it over the transformer area of the PC board, with one corner resting against the pillar and the corner diagonally opposite resting in the heatsink of Q1. This, together with the acoustic damping afforded by the closed diecast box, will render the inverter very quiet at high power levels.

At low power, the core magnetostriction is much weaker and the frequency of operation is higher, thus resulting in complete inaudibility. If the noise level increases after prolonged use, re-tension the transformer core mounting nut.

Using Voltup

With 1.5V input and a suitable load resistor representing the maximum output current required, adjust RV1 so that the output potential is 8.0V. If a transistor radio is to be powered, set RV1 at about 2/3 clockwise.

For maximum current output, turn RV1 fully clockwise and fit an alkaline cell. This is also the safest course to follow if Voltup is to be used in a number of different situations. Note that the maximum current setting procedure (if used) is designed to maximize efficiency, and is NOT intended for routine current limiting purposes.

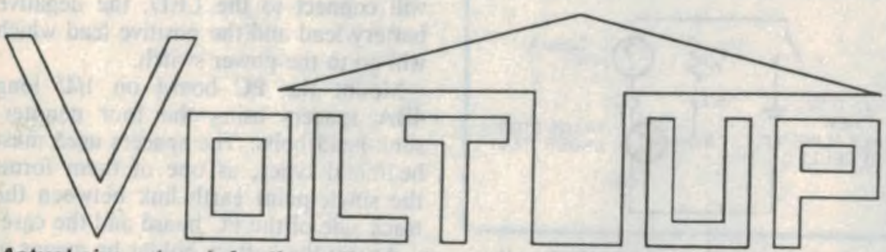
If Voltup is used to power a transistor radio, the output lead MUST be fitted with the isolation components L1, L2 and C6 as previously described. The quiescent current drain of a typical small receiver is between 10 and 15mA, with peak current demands of 30mA or more. Attach the output connector of Voltup to the battery connector in the radio, and place the isolation components in the battery compartment. It may be necessary to file a small 'mouse-hole' in the battery compartment cover to bring out the lead.

Leave the switch on the radio in the ON position, and use the power switch on Voltup instead. This is where the warning LED comes in handy. If you forget and turn the radio switch off (perhaps the user will be a non-technical person), the warning LED will come on as a reminder that Voltup is still active.

RF interference

If Voltup is built and used with a radio receiver exactly as described, broadcast band interference from the converter should be reduced to a very low level. Stations of reasonable strength can be received, totally free from interference. However, because of the great variety of different receivers which could be used, it is impossible to give a guarantee that very distant stations will always be free of interference, which is evident as a 'swishy' heterodyne.

If the receiver is placed directly adjacent to Voltup, the magnetic leakage field from the converter transformer will couple directly to the ferrite loopstick antenna in the receiver, and interference will be heard. This is only a short range effect, and will disappear when the two units are separated by about 100mm.



Actual-size artwork for the author"s front-panel logo.

Choosing a 1.5V cell

When considering the choice of cell type, remember that the overall regulation figure is the sum of the characteristics of both the supply cell and Voltup. The curves in Fig.4 were plotted using a regulated power supply, and so they reflect only the regulation characteristics of Voltup itself.

Under practical operating conditions, the drop in cell voltage under load must be taken into account. That's why the output voltage of Voltup is initially higher than 9V (see Fig. 1).

In use, the cell voltage won't stay at 1.5V for very long, and the number of secondary turns has been chosen to provide a good compromise in performance for all common primary cell types and their inevitable drop in voltage during use. When the load current is moderate but high peak demands are required, it is wise to choose a supply cell with good regulation characteristics.

Because of the current density at which they must operate, conventional carbon-zinc (i.e., 'general purpose') cells should generally be used only when the 9V output current does not exceed 10mA. Curves B and C in Fig.1 show that the general purpose cell is obviously down in performance compared to the heavy duty type, when driving a typical 9V radio receiver. However, general purpose cells are often available at such ridiculously low prices that you just can't afford to ignore their cost-effectiveness.

For output currents in the range 5mA-15mA, the 'heavy duty' cell is a good choice. Based on typical supermarket prices, the cost-effectiveness 'break even' point for manganese dioxide alkaline cells (compared to heavy duty types) occurs at an output current of about 15mA.

Alkaline cells have the marvellous quality of increasing their energy yield as the current demand is increased, and so extra power can be delivered at very little cost. Therefore, alkaline cells are recommended for output currents in the range 15mA-50mA, and for all applications where Voltup is set to the maximum power level.

Not included in Fig.1 is the 'super heavy duty' or zinc chloride cell. These types offer higher capacity, better low temperature performance, superior leak resistance and increased shelf life, when compared to carbon-zinc cells. Their performance characteristics fall between those of the 'heavy duty' and alkaline types.

If you wish to use a rechargeable nickel-cadmium cell with Voltup, increase the secondary winding to 58 turns to compensate for the reduced (but more constant) supply voltage.

A more desirable rechargeable power source would be a D size 2V Lead-Acid gel-cell. These have two terminals on top, so you would need to rearrange the physical layout inside the box, as well as organising some means of charging the cell. The advantages of a 2V supply are that Voltup will operate at a higher efficiency, and that more output current can be delivered. Of course, you would need to scale down the number of secondary turns to provide the correct output voltage.

Other uses

For those applications which require only a few milliamps of output current, I would suggest reducing the number of secondary turns so that with the specified load current, the chosen value of R_{bias} and a fresh supply cell the LED is dimly illuminated – i.e., the crowbar protection circuit is just on the point of dropping out. This will enable maximum conversion efficiency (and therefore maximum battery life) to be achieved.

If an accurately regulated supply is required (e.g., for instruments, etc.), the best course is to use two or three supply cells in series, and drive Voltup via a feedback regulator circuit. This technique is described in Part 1 of my series of articles on DC-DC converters, while examples of this type of regulator are given in Part 3.

There is no reason why the number of secondary turns cannot be increased to raise the output voltage, as there is some free space available on the bobbin. If necessary, a finer gauge of wire can be used to wind the secondary. Remember that the zener diode in the protection circuit must also be changed so that the output voltage will be limited to about 4/3 of the working voltage when the crowbar circuit operates.

As described here, Voltup can be built using readily available hardware. However, by making use of an efficiently shielded custom made case, a smaller transformer and a more compact PC card, its volume could easily be reduced to less than a half of what it is now. Alternatively, the electronics of Voltup could be incorporated into new equipment, so changing our ideas about how we use batteries.

And there you have Voltup – my contribution to energy conservation. Have you just bought your last 9V battery?

PARTS LIST

1 PC board, 70 x 80mm, code 89dc12
2 Ferrite potcores, Philips P18/11-3B7 (4322 020 21500)
1 Single section former for above (4322 021 30270)
1 Diecast aluminium box, 150 x 80 x 50mm
1 SPST switch, 1A DC minimum rating

Resistors

1 15 ohm 5% 1/4W carbon or metal film (R1)
1 100 ohm trimpot, 1/4W carbon (RV1)

Capacitors

2 0.1uF 63V disc ceramic (C3, C5)
1 22uF 16VW TAG tantalum (C2)
2 1000uF 16VW electrolytic, PCB mounting type (C1, C4)

Semiconductors

5 1N4002/1N4004 silicon diodes (D1-D5)
1 10V/400mW (or 1W) zener diode (1N961/1N4740 or similar – ZD1)
1 Red LED (LED1)
1 BD139 silicon power transistor (Q1)

Optional

(For use with radio receivers):
2 1mH RF chokes with axial leads (L1, L2)
1 2200uF 16VW electrolytic capacitor, PCB type (C6)

Miscellaneous

Clip-on heatsink for Q1 (DSE H-3415 or equivalent); single D cell battery holder; 9V battery 'snap' connector; 4 x 6BA, 3mm or 1/8" bolts, countersunk-head, 12mm (1/2") long; 4 each shakeproof washers and nuts to suit above; 4 x 4BA metal spacers, 6mm (1/4") long; 1 x 6BA cheese-head bolt 18mm (3/4") long with matching nut, nylon washer and flat washer; self-fluxing enamelled copper winding wire for winding TR1 (approx. 750mm of 26 B&S, 2.5m of 30 B&S); LED mounting bezel; small PVC grommet; small cable tie; hookup wire; tinned copper wire; adhesive foam mounting tape; insulation tape; 50 x 65mm rectangle of 25mm 'Innerbond' or foam plastic; spaghetti sleeving or heatshrink tubing.

NEW BOOKS AND LITERATURE

Packet radio

PACKET USER'S NOTEBOOK, by Glynn 'Buck' Rogers Sr, K4ABT. Published by CQ Communications, 1988. Soft covers, 226 x 154mm, 125 pages. ISBN 0-943016-01-0. Recommended retail price $18.50.

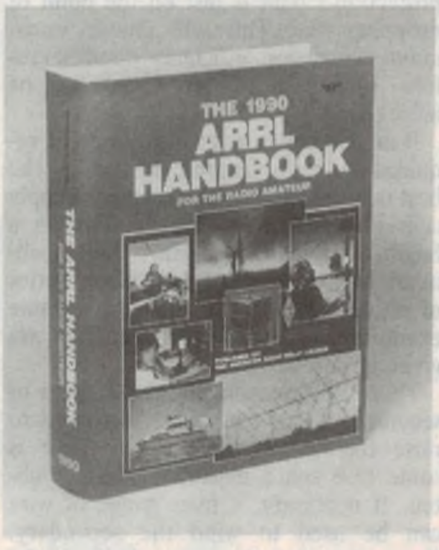
Another book on packet radio, this time published by the people who produce *CQ* magazine in the USA, and written by a very experienced and pioneering packet operator.

Buck Rogers has not only been a ham for 40 years, but is also a very experienced RF and data communications engineer and the holder of a first-class FCC commercial broadcasting licence. He is also currently the packet radio editor for *CQ*, and writes that magazine's monthly packet radio column. He has previously written four other books on the subject – so he really knows what he has written about!

In this case he's produced a basic introduction to packet radio, written in down-to-earth language and intended specifically for the amateur wanting to break into this 'hobby within a hobby'. It covers basic principles, the origins of PR, getting started, terminal node controllers, controller configuration, standards and protocols, flow control and the hardware/software interaction, HF operation, regulations, modes and speeds, options and enhanced operating modes, program/data/picture transmission and PBBS's. There's also a comprehensive glossary of terms, together with a lot of practical reference information regarding interconnection of specific computers, TNC's and transceivers. While a good deal of this is specific to equipment on the US market, at least a proportion will be applicable out here.

The text is clearly written and friendly, and well supported by illustrations. My impression is that it should be found very easy to read, and very informative for the amateur wanting to break into packet. And for the very reasonable price asked, it seems excellent value for money.

The review copy came from Stewart Electronic Components, of 44 Stafford Street, Huntingdale 3166 (PO Box 281, Oakleigh 3166), which can supply copies by mail for the price quoted. (J.R.)



THE 1990 ARRL HANDBOOK, edited by Kirk Kleinschmidt, NT0Z. Sixty-seventh edition, published by the American Radio Relay League, 1989. Hard covers, 284 x 215mm, over 1200 pages. US price US$23 plus handling and shipping (Aust. price approximately $50).

The ARRL handbook is now an institution, valued around the world not just by radio amateurs, but also by many engineers and technicians as a reference work on practical radio communications technology. First published in November 1926, it met with such a positive response that a second edition had to be produced the following January, and a third edition in October 1927. The fourth edition appeared in December 1928, and since then it has been revised almost every year – to keep pace with over 60 years of developments in technology. An enviable record of achievement!

The new 67th edition continues the tradition. Like the last few editions it's in a handy 'large' format, with hard covers to give it a longer life. This time the overall cover colour is red, to distinguish it from last year (green) and the one before (yellow).

The differences from last year are not enormous, but significant. Chapter 23, dealing with space communications has been completely revised, with up-to-date information on OSCAR 13 and details of a new 4-element helical array for Mode L operation (1260-1270MHz uplink). There's also a new section dealing with amplitude compandored single-sideband (ACSSB) operation, and a description of three new high-performance VHF/UHF Yagi antenna designs by Steve Powlishen K1FO.

As before, there's a wealth of information on almost every aspect of radio communication – both theory and practical, and ranging in level from 'raw beginner' to 'advanced'. Highlights include a quite comprehensive chapter on digital communications (from Morse to packet), another on image communications (ATV, SSTV, fax and weather satellite fax), a chapter with an introduction to practical construction techniques and another giving a lot of useful reference data on components.

There are now 10 chapters devoted specifically to descriptions of practical construction projects – but many of the other chapters also give details of practical and 'buildable' designs as well.

In short, this latest edition is just as worthy of the description 'the radio amateur's bible' as any of its predecessors, with the additional benefit that it's the most up-to-date of all. So if you haven't updated for a couple of years and your present edition is therefore getting a little dated, this one would be a good choice.

The review copy came directly from the ARRL (thanks, folks!), but I gather that copies are now available locally from a number of bookstores and electronics chains. (J.R.)

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80k-40 40kV dc or 28kV rms ac

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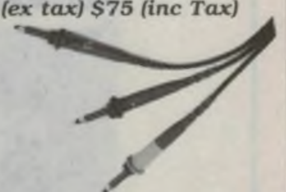

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Inductors, transformers and capacitance

The resistor, the inductor and the capacitor are all very common components in an electronic circuit. In this chapter, we examine the inductor more fully and introduce capacitance, capacitive reactance and impedance. We also look at what happens when a capacitor and an inductor get together. You'll be amazed at the possibilities...

by PETER PHILLIPS

In the last chapter, alternating voltage was described. As well, the effect of inductance was introduced and we ended with a brief look at the transformer. Because inductors and transformers are such important components, the first half of this chapter is given to their description.

Next is the capacitor. This simple component is probably as common as the resistor, with prices to match. However, its role is entirely different and it is used in a wide variety of interesting applications. But first, back to the transformer...

The transformer

A transformer, as described in the previous chapter, is an inductor that generally has two or more windings wound on some type of ferro-magnetic core. There are two basic types of transformers: those used in power applications, and those used with electrical signals.

The word transformer gives a clue as to what the device does: it *transforms*, or changes an electrical quantity from one value to another. Let's first examine a power transformer to see what this means.

The circuit diagram of Fig.1 is a schematic of the transformer shown in the accompanying photo. This transformer is a very common type, available from most electronic parts suppliers for around $9.00. As the diagram shows, it can provide a number of useful voltages from the secondary winding if the primary winding is supplied with 240V.

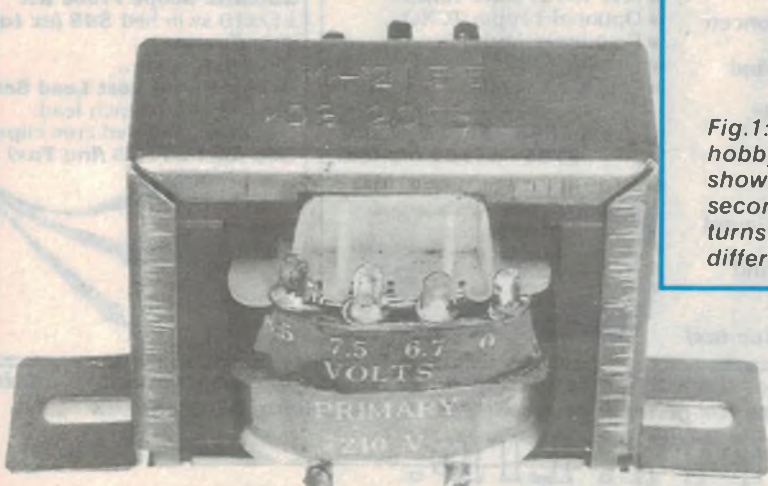
As we described last month, the voltages from the secondary are dependent on the *turns ratio* between the primary and secondary windings, as well as the voltage applied to the primary.

If we assume 1000 turns on the primary (a reasonable figure by the way), then the *total* secondary turns, that is from the common (0V) terminal to the 15V terminal, will be 62 turns. To check this, divide 1000 by 62, (which gives the turns ratio) then divide 240V by this figure and you should end up with 15V.

To get other voltages from the secondary, tappings are taken from the winding, as shown in Fig.1. This type of transformer is referred to as a *step down* transformer, as the secondary voltages are less than the primary voltage. But what about the *currents* in the primary and secondary windings?

The golden rule to remember with any transformer is that the *output* power can never be greater than the *input* power. In fact, it will be slightly less due to losses in the transformer – perhaps around 5% to 10% less, depending on how efficient the transformer is.

Because power is the product of voltage and current (V x I), we can work backwards to see how much primary current is required if the secondary winding is delivering, say 1A to a load. If, as shown in Fig.2, a 15 ohm load is connected across the 15V winding, then by Ohm's law, 1 amp of current will flow. By the way, notice how the same



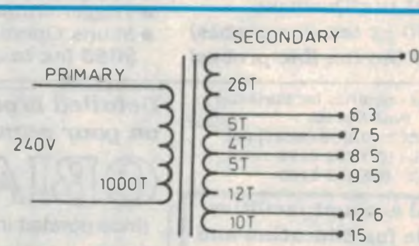


Fig.1: This transformer is one commonly used by hobbyists. The secondary current is rated at 1A, and as shown in the schematic, it features a multi-tapped secondary, giving 21 possible output voltages. While the turns ratios are correct, the actual number of turns may differ from those shown.

rules apply for AC as they do for DC – at least when we talk about a resistive load.

The power dissipated in the load will equal 15 watts, meaning 15 watts of power must come from the mains. To find the primary current, we divide 15W by 240V (as I = P/V) which gives 0.0625A, or 62.5mA. As expected, because the primary voltage is higher than the secondary, the primary current is correspondingly less.

In other words, a transformer that steps the voltage *down*, also steps the current *up*, in the same proportion. And the opposite is also true, as it happens.

The secondary current that can be taken from a transformer is determined by the size of the magnetic core and the gauge of the wire used in the windings. Transformers are usually given a 'VA' rating, (Volts times Amps rating), which specifies the maximum output available from the transformer.

The VA rating is rather complex, as it doesn't always equal the actual *power* the transformer can deliver, unless the load is a pure resistance. However, it does clearly identify the maximum current for a given voltage, and exceeding this will overload the transformer.

For example, a transformer with a 100VA rating should, theoretically be able to deliver 10A at 10V, or 1A at 100V. However, if this transformer is also given a current rating of 1A then it can only provide 1A at 10V, but also 1A at 100V. A 10VA, 1 amp rated transformer can supply 1A at 10V or 0.1A at 100V.

The transformer is a form of inductor, and as both the transformer and the inductor are used in many applications, there are predictably lots of different types. Because they are such a fundamental component, here's a brief description of the different types, shown photographed in Figs. 3 and 4.

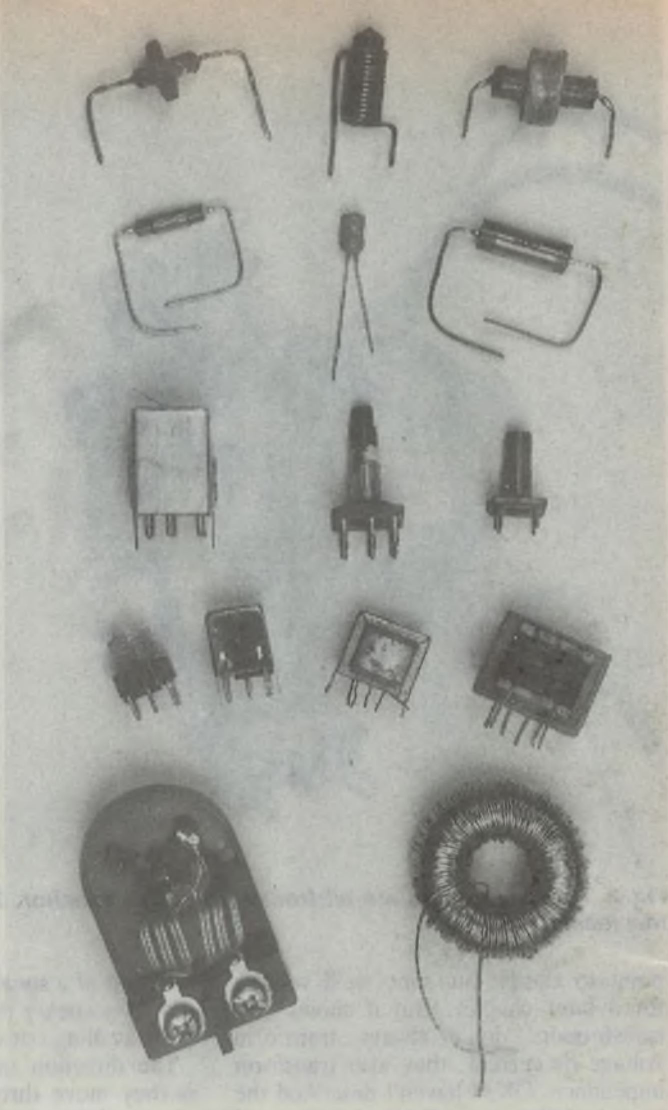


Fig.3: This photo shows typical inductors and transformers used with electrical signals. The top six coils are called radio frequency chokes, and have values ranging up to 100uH. The aluminium can (left, centre row) contains an IF transformer (centre) which is wound on the former shown to its right. Another IF transformer is shown in the next row down, to the left of some small audio transformers. The bottom row shows a balun (left) and a toroid (right).

Transformers & coils

The small transformers and coils shown in Fig.3 are all designed to work with electrical *signals*, rather than handle power. The six coils shown at the top of the photograph are used to block high frequencies, and are often called RF (radio frequency) *chokes*. These are sometimes also found in low frequency applications, to prevent high frequency signals interfering with the operation of the circuit.

The transformers shown in Fig.3 range from those that operate with audio frequencies to the so-called IF (intermediate frequency) transformers found in radios. In an AM radio, the intermediate frequency is usually 455kHz. (Sorry, you'll have to wait a while before we explain this one any further).

A high frequency transformer such as the IF transformer cannot use iron as the magnetic core, because iron becomes very inefficient at high frequencies; instead a ferrite core is used. Sometimes the core is adjustable – referred to as a *slug* – which allows the inductance of the transformer to be varied for the best results. This forms part of the *alignment* procedure in a radio.

The transformers at the bottom of the photograph look unusual, but are very common. The transformer with the shape of a donut is called a *toroid*, and toroidal transformers can vary from the small one shown to large types able to handle high powers. The toroidal transformer is rather difficult to wind, but it provides a very good magnetic path, with minimal leakage of the flux. Magnetic flux leakage can be a problem, particularly in a TV set, where the flux can interfere with the picture, giving a wobbling effect to the picture.

The transformer in the black plastic former with two screw terminals is known as a *balun*, and is used to connect a TV antenna to the TV set. The term balun is short for *balanced-unbalanced and this device transforms the impedance* of the antenna to match that of the TV set. This is a fairly complex

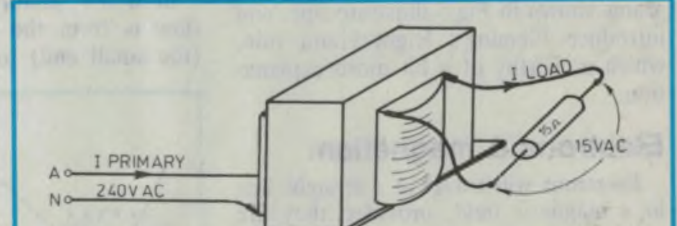


Fig.2: If a 15 ohm resistive load is connected to the 15V tapping of the transformer shown in Fig.1, a current of 1A will flow. This will cause a current of 62.5mA to flow in the primary, if 100% efficiency is assumed.

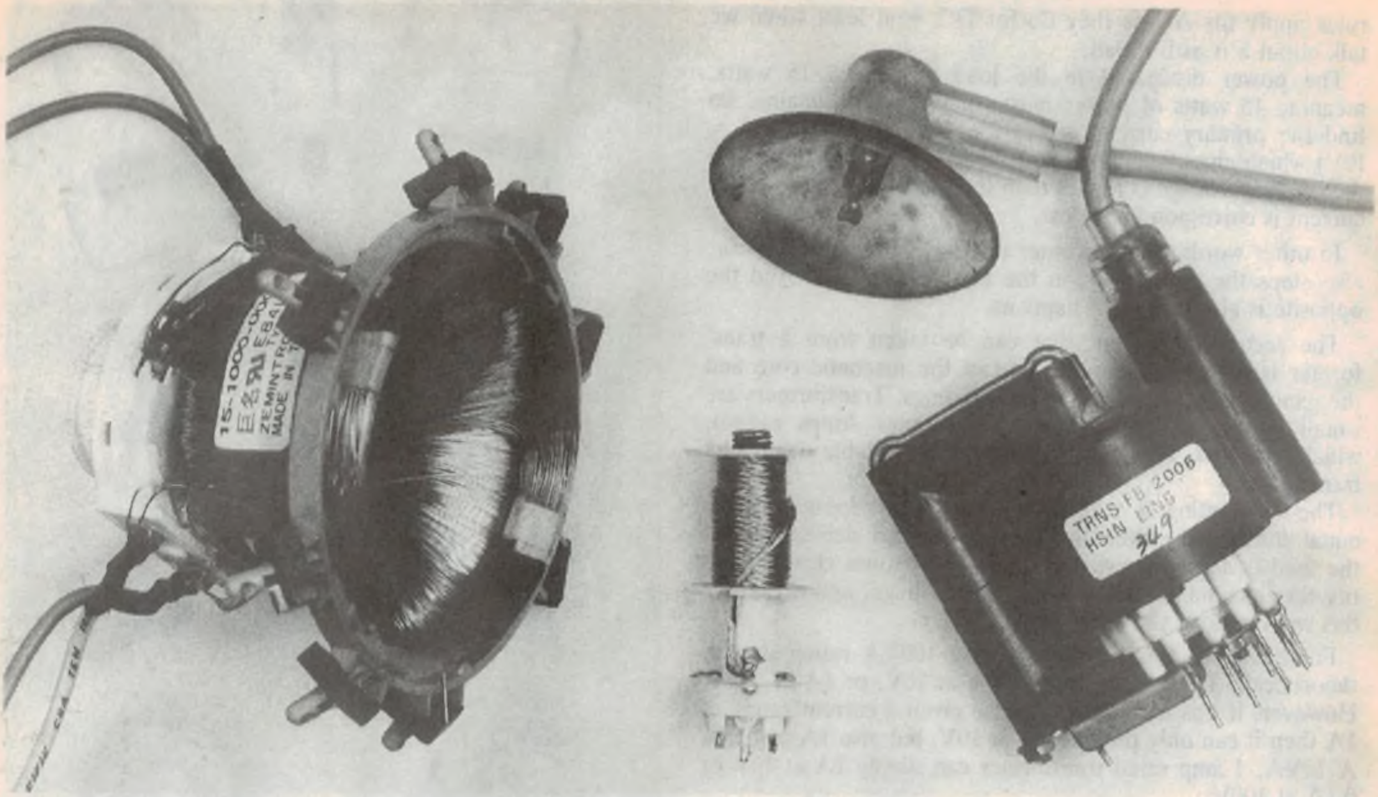


Fig.4: These inductors are all from a computer monitor. The small coil in the centre is wound with Litz wire to ensure low losses in the coil.

point to clarify, and one we'll reserve for a later chapter. But it shows that transformers don't always transform voltage or current, they also transform impedance. OK, I haven't described the term impedance yet, but read on – all will be explained.

The transformers and coils of Fig.4 are all from a TV set. The bell-shaped unit in the photo is called a *deflection yoke*, and is used to move the electron beam inside the picture tube. It does this by magnetism, as electrons are deflected by a magnetic field. The diagrams shown in Fig.5 illustrate this, and introduce Fleming's Right Hand rule, which is worthy of a bit more explanation.

Electrons & magnetism

Electrons will travel in a straight line in a magnetic field, provided they are moving in a direction *parallel* to the lines of force. But when the electrons are moving *across* magnetic lines of force, they will move in a curved path and at right angles to the lines of force, as shown in Fig.5(a). The flux is represented by the crosses, which is a way of depicting that the lines are travelling, as always, from a north pole to a south pole – but in this case into the page. The cross can be regarded as the feathered end of a spear and a dot (the sharp end of a spear) therefore shows a flux line travelling out of the page.

The direction taken by the electrons as they move through a magnetic field can be determined by using the *right-hand rule*, as illustrated in (b). The rule is: hold the thumb, first and second finger at mutual right angles, then point the first finger in the direction of the magnetic field and the second finger in the direction of the electron flow. The thumb will then show the direction of the deflection.

In a TV picture tube, the electron flow is from the cathode of the tube (the small end) to the anode end (the screen), and the yoke is fitted over the neck of the tube. The magnetic field created by currents flowing in the yoke is therefore at right angles to the electron flow, and by varying the strength of the magnetic field by regularly changing the current in the yoke, the electron beam is moved across the screen to create the picture.

The last two TV components shown in the photograph of Fig.4 are the EHT (extra high tension) transformer and a small coil used to vary the width of the picture. If you look carefully at the coil,

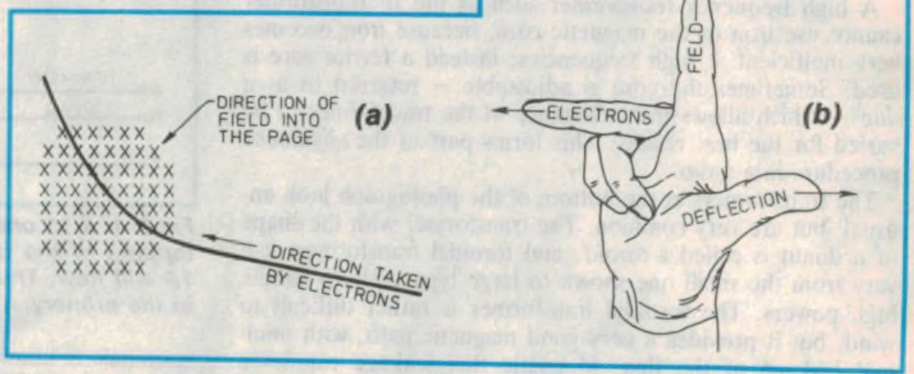
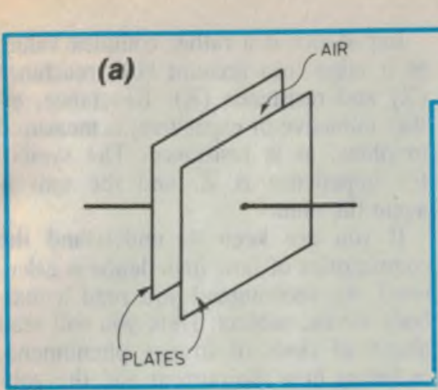


Fig.5: (a) shows the manner in which an electron beam is deflected by a magnetic field, and (b) illustrates how Fleming's right hand rule can be used to determine the direction of the deflection.



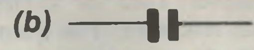


Fig.6: A capacitor, as shown in (a) is simply two conducting materials separated by a dielectric. The dielectric can be air or some other form of insulator. The schematic symbol for a fixed value, non-polarised capacitor is shown in (b).

you may notice that the wire used in the winding is not a single strand, but rather a number of insulated strands all joined at the ends of the windings. This is called *Litz* wire, and many high frequency transformers use this type of wire.

Litz wire

At higher frequencies, electrons flowing in a wire travel nearer the surface, as a result of the rapidly changing magnetic field. The effect is that only a portion of the wire is being used to carry current, giving an apparent increase in the resistance of the wire. In fact, at very high frequencies, (UHF and higher), hollow tubing is used in coils and even for straight conductors, as the centre of a solid wire is not used at all by the current.

Litz wire (after Litzendraht) uses numerous strands of insulated wire to form the complete conductor. The idea is that as each wire only carries current on the surface of the wire, a number of wires are necessary, all carrying current on the surface, but combined to give the same low resistance an equivalent solid wire carrying DC.

The width coil shown in Fig.4 is required to pass currents at a frequency of around 16kHz, and because the current can be high, Litz wire is essential. Certain transformers, especially those used in computer power supplies are wound with Litz wire, as the frequency of operation is usually quite high, often 20kHz or more.

Leaving inductance

We have shown that inductance is linked very closely to magnetism, and that the inductor finds many applications in electronics. The few we have looked at illustrate this, but there are many more uses we haven't yet described. There is one most important use that needs to wait until we describe capacitance, called *resonance*. The whole foundation of radio communications is based on resonance, and this is obviously a topic in itself.

By now you have seen that the transformer is an important application of inductance, and that transformers come in all shapes and sizes. A single coil is also very common, and again these are used in many different ways. Excepting those used for transforming power at 50Hz, most coils and transformers use a ferrite core rather than one made with iron laminations. A ferrite core reduces losses, as its insulating properties prevent circulating currents being induced in the core. An iron core comprises a stack of thin, soft iron laminations covered with an insulating oxide that prevents circulating currents.

We will return to inductance later on, but first we need to describe capacitance.

Capacitance

Like the inductor, a capacitor is simple in concept, and is one of the fundamental components used in electronics. A capacitor is formed whenever two conductors are separated by an insulator, and as this occurs quite a lot, capacitance is virtually everywhere. For example, two tracks running next to each other on a printed circuit board form a capacitor. Insulated wires in a cable have capacitance between them; windings on a transformer have capacitance between the turns and between each layer and so on. Fortunately, the capacitance produced by all these effects is usually not very large, but it illustrates the point.

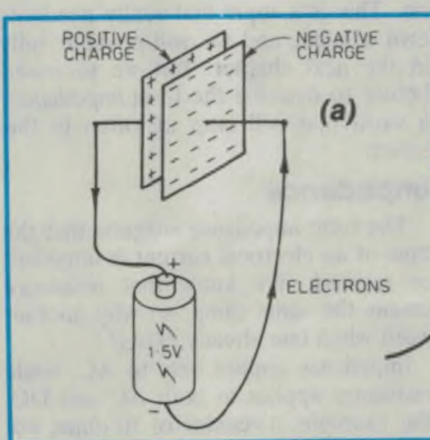
Commercial capacitors are made in a variety of ways, and they all conform to the principle of two conductors, usually referred to as plates, separated by a layer of insulation. The value of the capacitor is directly related to the size of the plates and inversely proportional to the distance between them. But first, what is capacitance?

Fig.6(a) shows the basic construction of a capacitor, where air is the insulating medium, also called the *dielectric*. The electrical symbol for a capacitor is shown in Fig.6(b), and as can be seen, it symbolises the actual construction of a capacitor.

The term *capacitance* comes from the word 'capacity', which implies the ability to hold or store something. In electronics, as you would expect, a capacitor stores electrons. Fig.7 shows how this happens, in which, as shown in (a), a capacitor is first connected to a battery.

When the voltage is initially applied, electrons flow from the negative terminal of the battery into the plate connected to it. Each electron will repel a corresponding electron from the other plate of the capacitor, due to the formation of an electric field in the space between them. As a result, for every electron that flows into one end of the capacitor, another flows out of the other and back to the battery.

This current is known as the *charging* current, and flows until the capacitor is full, or charged. Once charged, no further electrons can flow into the capacitor, and their flow ceases. If the capacitor is then disconnected from the voltage source as shown in (b), the electrons on the negative plate, and the corresponding lack of electrons on the positive plate have nowhere to go, and the capacitor will have a potential difference across it equal to the original voltage source.



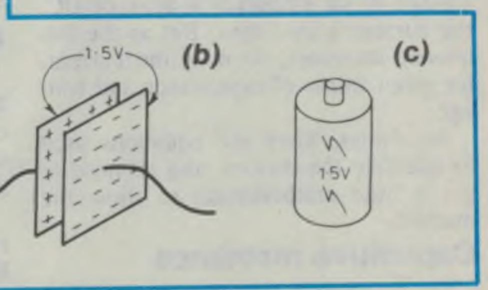


Fig.7: If a capacitor is charged as shown in (a), then disconnected from the charging source (b), the voltage across the capacitor will equal that from the charging source.

After a while, electrons will leak across the dielectric and eventually the capacitor will lose its charge; but if the dielectric has a very high resistance, this may take quite some time. It is not uncommon for technicians to get an unexpected shock when working on electronic equipment that is turned off. This is due to capacitors holding their charge since the last time power was applied, and some capacitors will hold a charge for several days.

Capacitors and AC

We've seen that a capacitor takes a charging current when connected across a DC voltage source, and that this current only flows for the time taken to charge the capacitor. In other words, a capacitor, when charged, is an open-circuit to DC. But what happens if the voltage source is reversed, as happens many times a second with an alternating voltage?

As you might have guessed, when connected to an AC source, a capacitor alternatively charges first in one direction when the applied voltage is, say, positive. Then, when the polarity of the voltage reverses, the capacitor will discharge back to zero, then charge up again in the reverse direction. This sequence continues while the AC source is applied, giving a current flow at all times. Naturally the current is also alternating, showing that a capacitor passes an AC current, while blocking a DC current. This is a most important use of the capacitor, and one that is often used in electronic circuits.

The question now is: what is the value of the current? Is there a limit, or is a capacitor simply a short-circuit to AC?

Like any electronic component, the value of the capacitor determines the value of the current, along with other variables. For example, the higher the voltage, the higher the current for a given value of capacitance. Another variable is the frequency of the applied voltage. If the frequency is zero, or DC, the current is also zero. But as the frequency increases, so does the current, for given values of capacitance and voltage.

As always, there are equations used to calculate the current, and we need to get a little mathematical to show the method.

Capacitive reactance

We saw before that an inductor has a certain value of *inductive reactance* at given frequencies, and an equation to calculate this was presented in the previous chapter. Like the inductor, a capacitor has reactance. This quantity is referred to as *capacitive* reactance, denoted mathematically as 'XC' and is measured in ohms.

The value of XC is calculated in a similar way to that for an inductor, but because the value of XC *decreases* as frequency increases, the equation is the opposite to that for calculating XL. You may remember that XL = 6.28fL ohms, or two times π times frequency times inductance.

The equation for XC is 1/6.28fC, where XC is in ohms and C the capacitance in *farads*.

See how the equation is a reciprocal! This shows that XC decreases as frequency (f) increases, for a given value of capacitance (C). Capacitive reactance is an important value to know, particularly when designing an audio amplifier, as too high a value (due to a small value of capacitance) will mean the low (bass) frequencies are not passed to the rest of the amplifier.

So to determine how much current a certain capacitor will pass, first the capacitive reactance (XC) must be calculated. The frequency of the applied voltage and the value of the capacitor must be known to do this. Then, when XC has been found, it is a simple matter to determine the current by using Ohm's Law, where current (I) equals voltage (V) divided by XC.

The same rules apply with XL, as reactance, whether capacitive or inductive is simply regarded as a resistance value when calculating current.

So far we haven't described the *unit* of capacitance, except to say that the capacitance is measured in farads. Nor have we described how capacitors are made, what types are available, what limits are imposed on their use and so on. This is a topic that really needs its own section, and we will cover it fully in the next chapter. But we promised before to describe the term *impedance*, a word that will crop up often in this series.

Impedance

The term impedance suggests that the flow of an electrical current is impeded, or resisted. We know that resistance means the same thing, so why another word when one already exists?

Impedance applies only to AC, while resistance applies to both AC and DC. For example, a resistor of 10 ohms will pass 1A if the applied voltage is either 10V DC or 10V AC. The current will be DC in the first case and AC in the second.

Impedance is a rather complex value, as it takes into account both reactance (X) and resistance (R). Reactance, either inductive or capacitive, is measured in ohms, as is resistance. The symbol for impedance is Z, and the unit is again the ohm.

If you are keen to understand the complexities of how impedance is calculated, we recommend you read a textbook on the subject. Here you will read about all kinds of strange phenomena, including how the current and the voltage are no longer in phase, and that impedance is not simply the sum of both X and R.

It is not really important to know how impedance is calculated in most cases, and for this reason we are not going to pursue the topic here. Just remember that when the term impedance is mentioned, reactance and resistance are both present, and the combined effect is to impede the flow of an AC current.

One other interesting point about impedance is that capacitive reactance is opposite in effect to inductive reactance, and if the two exactly cancel, which they must do at one particular frequency, the only component left is resistance.

Resonance

The frequency at which this mutual cancellation of a circuit's capacitive and inductive reactance occurs is called the *resonant* frequency, and as already mentioned, resonance is the basis for radio communications. As we will see in later chapters, a radio or a TV set is tuned to pick up a particular signal by varying either the value of an inductor or a capacitor. Such a circuit therefore needs to have both inductance and capacitance, with one of them adjustable if the circuit is being used to select a particular frequency. In a radio, the capacitor is usually adjustable, while many TV tuners vary the inductance value.

Resonance is a most fascinating phenomenon, and is one that occurs in mechanical applications as well as in electronics. The interesting thing is that resonance in the electrical sense needs an inductor and a capacitor, and that is all.

Of course a radio needs amplifiers and other sections to work, but the fundamental parts of a radio have now been described. It's simple when you think about it – just select the signal you want with two basic components, and all that remains is what to do with the signal you've selected. That's another story, of course, and we will be discussing it in future chapters.

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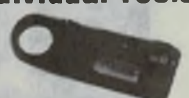

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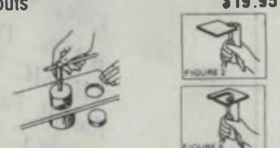

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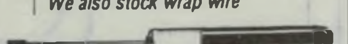

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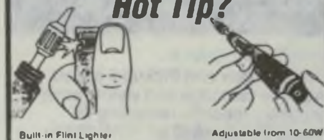

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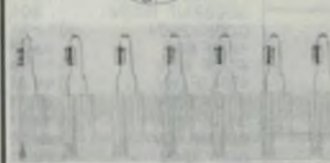

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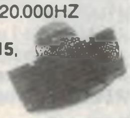

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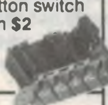

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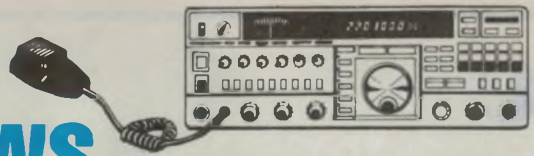
Amateur Radio News



Amateur cleared of harassment charge

In Penrith Court recently Sydney amateur Zigmunt Malter VK2TN faced a charge brought under the Radio Communications Act, Section 25, of using a radio transmitter for the purpose of harassing Paul Cudmore VK2AMK (deceased). The Prosecutor and Informant was Robert Lear, who held the callsign VK2ASZ for many years, until it was cancelled by the Minister for Communications in 1987.

Tapes were played to the court, and introduced into evidence, with conversations alleged to have taken place on 2 metres. Also both the WIA's NSW Divisional Councillor David Horsfall VK2KFU and Mitchell McCreath VK2XMM were sub-poenaed to appear as witnesses for the prosecution. In addition Robert Lear appeared as his own witness.

After considering the evidence, the Magistrate found that Malter had no case to answer. He found that Malter acted well within his rights to admonish Cudmore, as Cudmore had admitted to jamming transmissions, and he also found that Cudmore had a habit of butting into other conversations and sounded 'as though he might not have been capable of rational behaviour'.

The magistrate found that Cudmore's activities annoyed other amateurs, and that the admonishments were well deserved. In conclusion the charge was entirely dismissed, and Lear ordered to pay Malter's costs of $1500.

Famous DX-ers visit Australia

Most HF DX-ers will have heard of Iris and Lloyd Colvin, and the Yasme Foundation. The Colvins are known around the world, having travelled to many exotic countries to 'activate' them for radio amateurs. Recently it was Australia's turn to receive a visit, and the NSW Division of the WIA was pleased to host them during their time in VK2.

The Colvins gave a lecture at Amateur Radio House on February 7, and to mark the occasion they were made honorary members of the NSW Division.

Storm damages VK2RWI PRBBS

A recent thunderstorm was apparently the cause of extensive damage to the NSW divisional packet radio bulletin board VK2RWI, normally found on channel 4850 in Sydney. Quite a few components were damaged in the power supply of the PC-clone which forms the heart of the PRBBS, and it is taking a while for repairs to be completed.

Note that when operational, the PRBBS runs under the 'WORLI' software (V.11.8), rather than the 'MBL' software used by other Australian PRBBS's. The 'WORLI' system is said to offer more operational facilities, and is apparently in common use overseas.

WIA VK2 office hours

Although the office of the NSW Division of the WIA is open for personal visits between 11am and 2pm weekdays, the telephone can only be answered in person between 12 noon and 1pm due to workload. At all other times, callers are asked to leave a message on the machine.

The Divisional office is at 109 Wigram Street, Parrammatta, and the phone number is (02) 689 2417.

Silent Key

It is with regret that we note the passing of Keith Howard VK2AKX, late of Teralba in NSW. Keith passed away on the morning of March 1, from a heart attack. Our sympathies to his family.

Silent key

With regret we note the passing of John Zwart VK2FCZ, late of the Waverley Amateur Radio Society.

Born in Holland in 1932, John was a qualified fine instrument maker and electronics technician who most recently worked at Ainsworth Industries as a writer of technical manuals and bulletins. His interest in amateur radio started during the mid 1970's, and he became a strong driving force within the WARS, where he was Treasurer.

Vintage Radio

by PETER LANKSHEAR

The first moving coil speaker

Radio historians find that it is very unwise to claim a particular piece of equipment as being the first, the last, the only – or for that matter, to use any superlative. Invariably, someone will come up with some obscure model that shoots down the argument. But there is an exception. There is general agreement that the first commercially successful moving coil paper cone loudspeaker system was the RCA 104, introduced late in 1925.

Loudspeakers were vital to the early success of broadcasting. Had listening been restricted to headphones, the rapid and universal acceptance of domestic radio would have been unlikely. The problem was to translate a wide range of audio frequency alternating voltages into accurate mechanical motion of a piston coupled to the surrounding air.

By 1923, three systems, two of which have been described previously, were evolving. The earliest was to couple the transducer, generally a headphone type, to the air by means of a horn. An improvement on this was the magnetic speaker, based on the polarised telegraph relay with the armature connected to a lightweight cone.

Fig.1: In 1926, the long legs of the RCA 104 Loudspeaker System were very fashionable.

The third method used a moving coil in an annular magnetic field – a principle first patented by the Siemens Company in 1877, with improvements filed by Oliver Lodge in 1898. Lack of efficiency and the need for a massive magnet resulted in its remaining a good idea with few applications, for more than 20 years.

In 1921 the 'Phonetron' appeared, for converting telephone and telegraph signals into sound. With an electromagnetic field, a voice coil and a cone diaphragm, it had all the elements of a moving coil speaker, but was not a commercial success. Dependence on battery power for receivers limited the available audio power to a few dozen milliwatts.

The prime requirements of early speaker designs were high sensitivity and the use of permanent magnets, conditions met by the horn and magnetic types.

Rice and Kellogg

Prior to 1930, RCA was solely a marketing and operating organisation – much of their research being carried out by one of their shareholders, the giant General Electric Company. Two of GEC's talented group of electronic engineers, Chester W. Rice and Edward W. Kellogg considered that the moving coil speaker was worth developing further. (Despite their names, this pair had nothing to do with breakfast cereals!)

The two researchers realised that if they accepted its inherent lack of sensitivity, the moving coil system had many potential advantages over the moving iron type. But the immediate problem was that there was no way that receiver output stages using the standard 201A valve could deliver enough power, with an anode current of 3mA at 135 volts.

Priority was given to the design of a mains operated high powered audio amplifier. The first requirement was a high

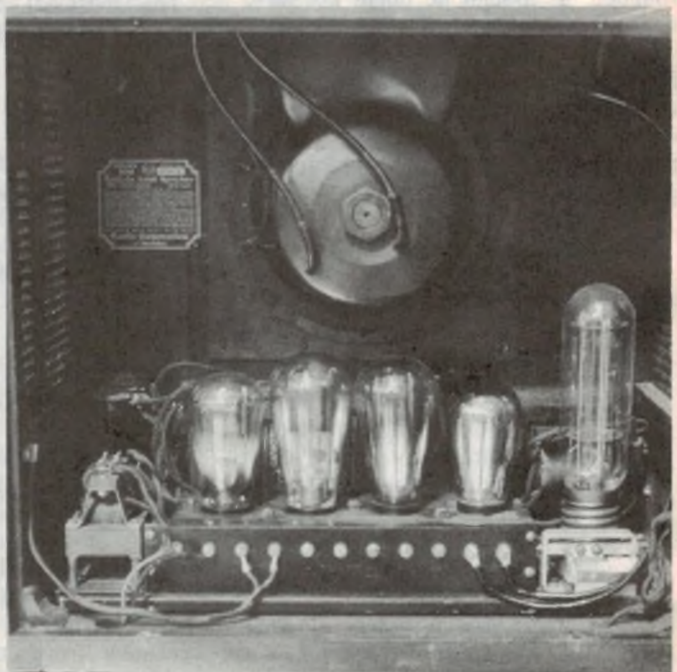
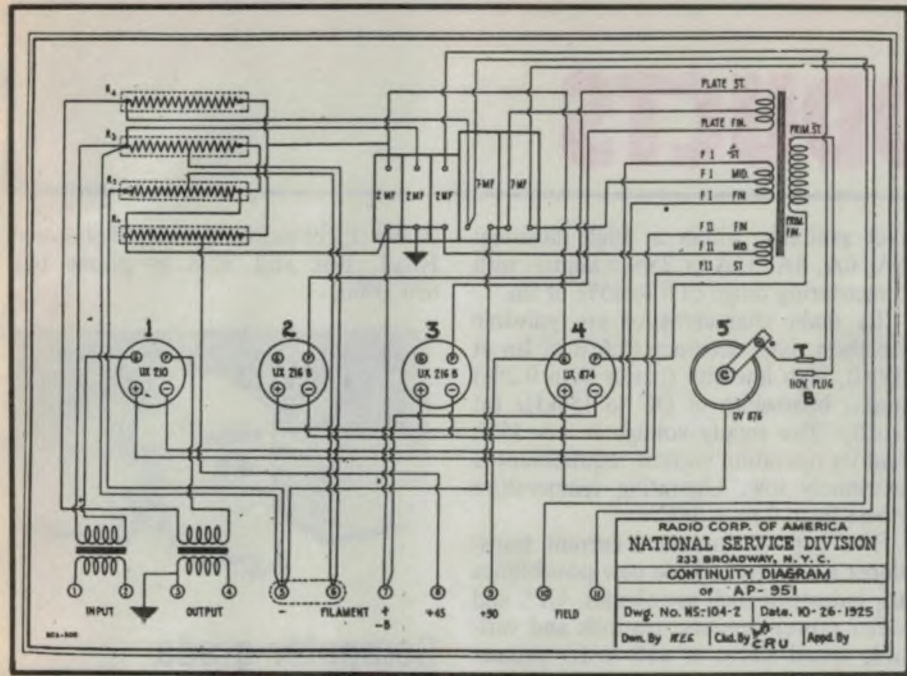


Fig.2: The combined audio amplifier and power supply was quite an impressive unit. Not shown is a black steel shroud which prevented accidental contact with the terminals – some carrying 425V HT!



The 'continuity diagram' for the RCA 104. RCA frequently published these diagrams, which related to the physical layout of the equipment, and made it look much more complicated than with a conventional schematic.

power valve, so GEC scaled up the 201A to create the type UX210. The amplification factor remained the same at 8, with the mutual conductance doubled to 1.6mA/V, but the anode voltage rating was increased by a factor of three to 425 volts and the anode current six times to 18mA. These massive increases enabled the 210 to deliver more than one WATT – at the time, a large amount of audio power!

Favourite valve

Used in carrier current telephone systems, the RCA transoceanic radio telephone service and later in RCA's 'Photophone' movie sound systems, the 210 also proved to be most successful for low powered transmitters. Amateurs loved the '10, and for more than a decade it filled the niche that eventually was occupied by the equally ubiquitous 807.

Rice and Kellogg's amplifier was simple enough, consisting of a single transformer-coupled 210 operated as an 'add on' to standard radio receivers. Its associated power supply was however quite large and complex. Not only did it supply the 7.5 volt filament and 425 volts HT for the 210, but there was also DC power available for a speaker field coil.

For good measure the power unit incorporated a regulated HT supply for its associated receiver, and for use with the RCA superhets there was a 60mA filament supply for series-connected UV199 valves.

A UV876 voltage regulating ballast resistor was used to counter voltage variations in mains power. This consisted of a long length of fine wire, probably iron, in an evacuated bulb, much like a large tall tubular lamp. Two large half-wave UX216B rectifiers and a UX874 90-volt gaseous voltage regulator completed the valve lineup.

Giant 6" speaker

The essentials of the ancestral moving coil 'dynamic' loudspeaker that Rice and Kellogg developed are still fundamental to today's speakers. These are a lightweight voice coil connected to the apex of a paper cone with compliant surround and centering spider, operating in a strong magnetic field concentrated in a circular gap. Several of the parameters were to become industry standards.

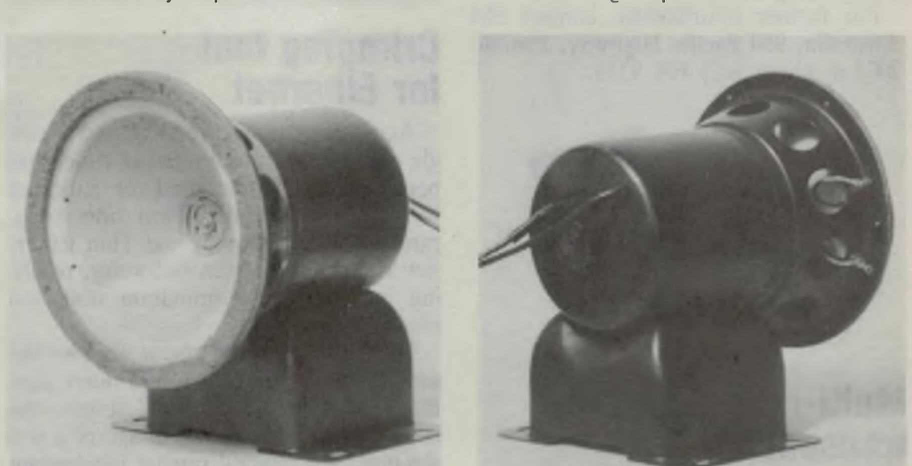
Weighing 11 kilograms (25lb), there can hardly ever have been a more massive 150mm or '6 inch' speaker. Much of the weight was contributed by the huge electromagnetic field magnet, whose 125mm (5") diameter was nearly as large as the paper section of the cone! The field coil resistance was 1000 ohms, a standard value for later electromagnetic (EM) speakers.

The cone surround was of very fine leather, considered to be superior to the cheaper corrugated paper that was generally used in later speakers. Compliant materials other than paper have always been popular in high quality models.

Nominal impedance of the voice coil was around 15 ohms and its diameter was 1" (25.4mm), even today a popular size for medium sized speakers. The toughened paper cone centering spider was mounted at the front of the centre polepiece. This type gradually gave way to the wider diameter and longer throw rear mounted spider, and eventually to the modern corrugated annulus.

Separate cabinet

Although the combination of the new moving coil speaker and a modified version of its associated power unit was incorporated in late 1926 'top of the market' RCA and RCA Victor radios and phonographs, the Rice Kellogg speaker, amplifier, and power supply units were first sold as an independent system in a free standing separate cabinet – the



Figs.3 and 4: Front and rear views of the 104's 6" speaker unit, giving some idea of the relatively enormous electromagnetic field magnet. The voice coil leads are terminated on the rim of the basket.

Continued on page 119

NEW PRODUCTS

Service vacuum cleaner

Weighing in at 4 kilos and featuring dimensions smaller than the average tool kit, the 3M service vacuum cleaner is easy to handle, travels well and is completely self contained for maximum efficiency.

With a choice of filters, the cleaner can be used to remove toner/dust from computers, printers, copiers, microfilm reader printers, and associated office equipment.

Everything a service technician needs for a professional cleaning job is neatly tucked away in one compact unit. Easy-close latchings hold the hose, hose attachments and electrical cord securely inside the carrying case, leaving no extra pieces to carry or juggle. When assembled for operation, a hose 1.5 metres long and special hose attachments make it easy to reach awkward places. The unit is also static grounded from nozzle to wall plug, for safe use around even the most sensitive electronic equipment.

For further information, contact 3M Australia, 950 Pacific Highway, Pymble 2073 or phone (02) 498 9333.

Multi-range current transducer

LEM's LA25-NP current transducer works on the principle of magnetic field compensation.

Five different current sensors are in fact available within a single housing: 5A, 6A, 8A, 12A or 25A nominal, with a measuring range of 0 to 15% of Iin.

Its main characteristics are galvanic isolation, high accuracy (0.6% of Iin at 25°C), high linearity (better than 0.2%) and a bandwidth of DC to 150kHz (at –1dB). The supply voltage is +/– 15V, and its operating current requirement is extremely low. Operating temperature range from 0 to +70°C.

The high performance current transducer is said to provide new possibilities for industries such as robotics, UPS and other power supplies, controls and variable speed drives as well as for protection purposes.

Its dimensions, design and markings (optical locating mark on the housing) have been specially conceived for automatic assembly on to printed circuit boards.

For further information contact Fastron Australia, 14 Dingley Avenue, Dandenong 3175 or phone (03) 794 5566.

Crimping tool for Ethernet

Acme Electronics has released a single crimp tool from Greenpar which has been specifically designed for Ethernet Networking Systems. Until now separate tools for Ethernet and Thin Ethernet Systems have been necessary, resulting in increased termination cost and inconvenience.

The new die arrangement enables the user to crimp the centre and outer contracts of both N and BNC series connectors with the cost advantage of a single tool. An integral ratchet mechanism ensures complete closure of the tool and confidence that it provides a consistently high integrity crimp connection.

For further information, contact Acme Electronics, 205 Middleborough Road, Box Hill 3128 or phone (03) 890 0900.

Computer grade power conditioners

Designed and priced to be suitable for the small computer user, the Escort power conditioner is an ideal blend between ferroresonant technology and computer grade performance. Providing common mode noise suppression of 126dB, and excellent voltage regulation, it is suitable for use in both office and industrial environments.

Topaz Escort power conditioners will deliver high peak currents with minimal sinewave flat topping, even in response to the peak current demands of PC's and microcomputers. High efficiency of up to 92% saves on energy costs while its cooler and quieter operation is said to be unmatched by any other ferroresonant power conditioner.

All conditioners are tested to ANSI/IEEE C62.41, 1980 surge withstand guidelines and are available in sizes ranging from 140VA to 2kVA.

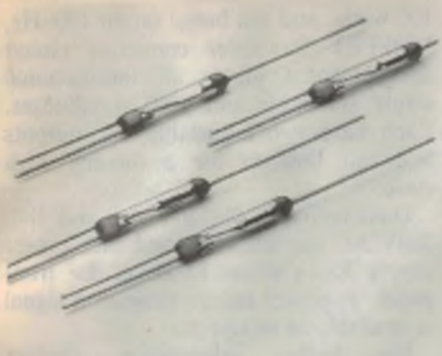
For further information, contact Online Control, 2/7 Waltham Street, Artarmon 2064 or phone (02) 436 1313.

Miniature SPDT mercury switch

C.P.Clare has developed a change-over contact, ultra small mercury HGZ switch.

The concept as well as the manufacturing methods and processes, developed for the firm's MYAD switch, made it possible to create this high performance tiny form C switch.

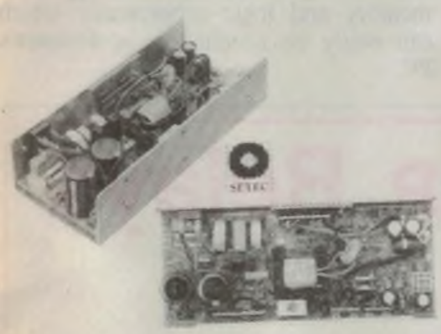
The solid stem concept allows sealing under high pressure. The result is a high performance switch, which allows many



millions of operations with high reliability. The switching performance is 50W, 1A, 350V DC switching and 3A carry current. Across open contact 1000V AC insulation is guaranteed. The maximum switching frequency is 100Hz and the magnetic sensivity from 35 to 60NI.

The use of new materials has considerably improved the resistance to mechanical shocks. The entire performance is sealed in a tiny glass envelope of only 15mm length and 2.5mm diameter.

For further information contact IRH Components, 32 Parramatta Road, Lidcombe 2141 or phone (02) 648 5455.



340W SMPS has 3 outputs

Setec's new SM340ACI power supply with correct use, meets all major EMI regulations and handles up to 340W of power.

It has wide input voltage range for brownout and high mains protection, and all outputs are overload, short-circuit and overvoltage protected.

Automatic shutdown for sustained faults reduces risk of fire and there is a convenient TTL mains power fail signal.

Sense leads are provided for the +5V output and an in-built thermal shutdown protects against fan failure. The supply also provides tightly regulated +12V and –12V outputs and there is a limiting of turn-on inrush current.

For further information contact Setec, 6 Holloway Drive, Bayswater 3153 or phone (03) 762 5777.

Fibre optic video link

Optical Systems Design has announced the release of its OSD327/OSD329 fibre optic video link for CCTV systems.

The unit is available in modular or card form and provides 10MHz video bandwidth, well suited to the latest generation of high resolution colour CCTV cameras and monitors.

Operation over 5km of low cost optical fibre cable is possible. An optical link is included for the remote control of camera functions such as pan, tilt, zoom and focus and is compatible with all the major CCTV control system data formats.

For further information, contact Optical Systems Design, 2 Villiers Place, Dee Why 2099 or phone (02) 982 6633.

Microprocessor based temperature controller

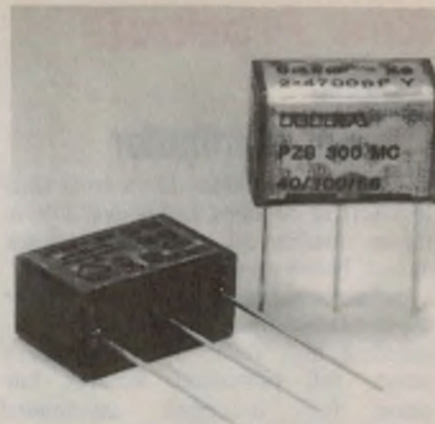
Toho Electronics' TM-51 temperature controller is supplied with a compact 48 x 96mm front bezel and features a 100mm panel depth. Measured temperature and setpoint are continuously displayed. High and low alarm setpoints are accessible by a 'mode' key on the front bezel.

As a controller for use where temperatures will not exceed 999°(C or F), the TM-51 offers user selectability of input signals. Front bezel push button selections can be made from a choice of type 'J' or 'K' thermocouples and JPt100 or Pt100 resistance thermometers.

Output configurations available include relay, SSR logic drive, 4-20mA DC, or 1-5V DC. In addition, one alarm relay is standard in all models.

It has eight user selectable alarm modes and nine user selectable temperature ranges. A security lock function returns the TM-51 to the operator level.

For further information, contact Fitter Instrument Co, 88 Carlingford Street, Sefton 2162 or phone (02) 644 6222.



Delta suppressor capacitors

Rifa interference suppression capacitors has extended its range of delta network (one 'X2' plus two 'Y' capacitors in one convenient package), with the addition of the PZB300 series specifically designed for PCB mounting.

Offering features such as a continuous rating of 275V AC, a temperature range of –40° to +100°C, high transient and DV/DT capability and a wide range of international approvals, including VDE, UL478 and UL1283, the PZB300 is available in a choice of capacitance values.

Typical applications include domestic appliances, SMPS or as a component in a larger filter.

For further information, contact Ericsson Components, PO Box 95, Preston 3072 or phone (03) 480 1211.

Microprocessor development tool

Control Dynamics has released an intelligent microprocessor development tool, the EM108 ROM Emulator. This may be used in place of most CMOS or NMOS parallel architecture ROMs up to 256K bits in size, with access delays down to 120ns.

User friendly window based PC software allows the user to load ROM data into, or read data from the EM108 via a high speed RS232C serial interface, in any of three data formats: Motorola, Intel, or binary. ROM data files may also be viewed, edited or printed.

The software includes a table driven expandable disassembler, a HEX and decimal calculator and a notepad.

For further information, contact Control Dynamics, 6/260 Main Street, Lilydale 3140 or phone (03) 735 1188.

New Products

Battery charger/eliminator

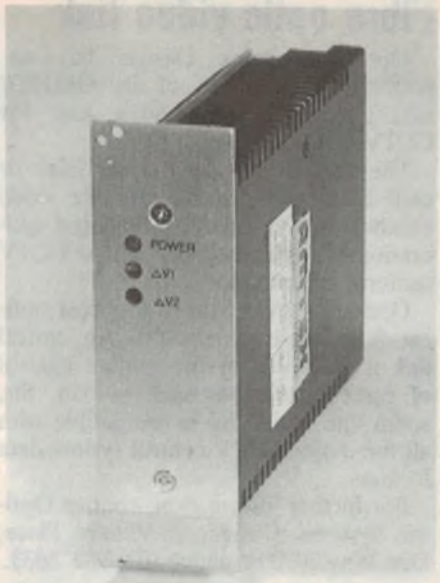
The BCE1 provides 13.65 volts (factory set) at 10 amps and is available in three mechanical variations; rack mount, bench mount and panel mount.

It has been designed specifically for telecommunications applications demanding high reliability under heavy usage, full protection features low noise, fully automatic, unattended operation and professional finish.

However, other applications should be able to take advantage of these features.

The BCE1 has three main applications: as a lead acid battery eliminator, as a lead acid battery charger and as a combined charger and power supply. In the latter application the battery supports the load, without interruption, during mains brownouts and failures. The battery is automatically disconnected when discharged and automatically reconnected when normal mains resumes.

Further information from Setec, 6 Holloway Drive, Bayswater 3153 or phone (03) 762 5777.



Power supplies for Eurocard racks

Now available from Amtex Electroncis is a range of switch mode power supplies designed to be easily mounted into the standard Eurocard rack system.

The HSU45/60/100 series includes single, dual and triple DC outputs of 45 to 100 watts, and are based on an 100kHz, MOSFET forwarder converter circuit design which meets all international safety standards and EMI regulations. Each have two adjustable DC outputs and full hold-up for a missing high cycle.

Dual inputs of 90-130V AC and 180-260V AC are selectable and each power supply has a status LED on the front panel. A power failure indication signal is available as an option.

For further information, contact Amtex Electronics, 13 Avon Road, North Ryde 2113 or phone (02)

PC driven programmer

Sprint Expert, developed by SMS Mikrocomputer Systeme of West Germany, offers a cost-effective alternative to expensive 'mainframe' device programmers, by providing what is claimed to be the same performance and features as those on a personal computer.

Sprint Expert uses new ASIC technology and proven programming algorithm design to produce a combined memory and logic programmer which can easily be installed in a designer's PC.

It provides fast programming with Intelligent and QuickPulse algorithms, and supports a wide range of devices, including PROMs, EPROMs, EEPROMs, ZRAMs, EPLDs, EEPLDs, GALs, EPLAs and MCUs.

The system uses an IBM PC, XT or AT as a 'host' for data and algorithm storage, with updates for new devices and features regularly available on floppy disk. Actual programming is controlled by the Sprint socket POD, supplying high resolution voltages and its own accurate timebase for even the highest speed devices. Sprint uses SMD technology to achieve short line lengths and low signal noise for high programming and vector test yield.

For further information, contact Dynamic Component Sales, 17 Heatherdale Road, Ringwood 3134 or phone (03) 873 4755.

Vintage radio

from page 115

combination being known as the RCA 104 Loudspeaker. The 104 could be connected to any receiver, and some existing RCA superheterodyne models were modified to take advantage of the filament and HT supplies it provided.

Fashionable receivers of the mid 1920's often stood on spinet type legs, and a similar styling was adopted for the 104 cabinet. The assembly looks to be top heavy, but the sheer weight of the contents made it reasonably stable, and quite enough for one person to handle. The side panels and rear cover had cane grills, probably more for ventilation than acoustic reasons.

Superior sound

To compare the reproduction of the 104 with that from contemporary horn and magnetic speakers is a revelation. In 1926 it must have created a sensation, with quality equivalent to a more modern large mantel radio. The catch was that the 104 sold for around $250, at a time when it was possible to buy a good magnetic speaker for $35.

However, RCA had shown the way, and by 1930 the moving coil speaker was practically universal in mains powered receivers.

Solid State Update

KEEPING YOU INFORMED ON THE LATEST DEVELOPMENTS IN SEMICONDUCTOR TECHNOLOGY

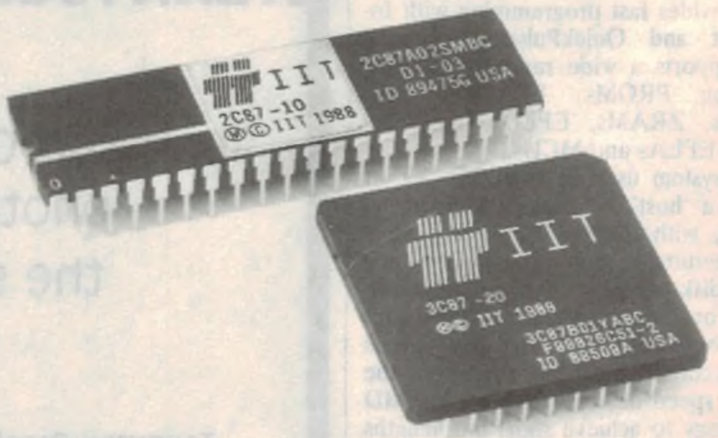
Intel compatible coprocessors

Compatible with both the Intel 80287 and 80387, the IIT range of coprocessor chips use low power CMOS technology. They combine low power consumption and performance improvement with 100% guaranteed compatibility with the Intel chips.

The IIT chips have an exclusive sleep-mode, reducing their already low power consumption of 500mW to 150mW when not being accessed.

The IIT-2C87's ability to run at the same speed as the main processor in 20MHz 286 systems extracts more performance out of these systems than has been possible up to now. CAD, CAE, scientific, test and measurement applications, as well as spreadsheet programs are particularly effected.

Applications developers working on new software can use the additional capabilities of the IIT-2C87 to gain more performance. A hardware microcode for 4 X 4 matrix transformation is embedded in the IIT-2C87 and IIT-387, to provide future functionality in performing matrix transformations up to eight times faster than the 80287.



For further information contact, CAD Connection, 220 Pacific Highway, Crows Nest 2065 or phone (02) 957 6719.

More D/A and A/D converters

Micro Network has released a series of A/D and D/A converter chips.

MN5245, MN5245A, MN5246 and MN5246A are 850ns, 12-bit, A/D converters with 1.1MHz conversion rates. When used with MN376 high-speed track-hold (T/H) amplifiers, these A/Ds can be configured to form 1MHz sample-and-convert systems that can digitise full-scale (5V) input signals with bandwidths up to 500kHz. These systems typically achieve signal-to-noise ratios of 70dB with harmonics down more than -80dB, while digitising 500kHz signals at the Nyquist rate.

MN5249 is a 400ns, 12-bit A/D converter with 2.5MHz conversion rate. When used with MN376 T/H amplifiers these A/Ds form 2MHz sample-and-convert systems that can digitise input signals with bandwidths up to 1MHz.

The MN3040 is a fast, 10-bit digital-to-analog converter with a TTL input register for easy interfacing and rapid throughputs in microprocessor-based systems. It is fast settling (typically 5us for a 20V change), and has 0.1% FSR overall accuracy. It is actively laser trimmed as a complete device for linearity, gain and offset, eliminating the need for external adjusting potentiometers.

MN3850 and MN3860 are 12-bit D/A converters, complete with internal reference and a fast output amplifier. The MN3860 also includes a high-speed (40ns setup time), 12-bit input register. Both were designed for military/aerospace, industrial and OEM applications in which high-speed D/A conversion in severe, wide-temperature-range environments is required.

In fact, all the above mentioned A/D and D/A converters are available in military specifications. For further information contact Priority Electronics, Suite 7, 23-25 Melrose Street, Sandringham 3191 or phone (03) 521 0266.

Enhanced programmable sound generator

Microchip Technology's AY8930 enhanced programmable sound generator is an LSI circuit that can produce a wide variety of complex sounds under software control. Its enhanced features include improved frequency range and noise synthesis, plus independent control of each channel's envelope and duty cycle.

The PSG is easily interfaced to any bus-oriented system. Its flexibility makes it useful in applications such as music synthesis, sound effects generation, audible alarms, tone signalling and home computer usage. In order to generate sound effects while allowing the processor to perform other tasks, the PSG can continue to produce sound after the initial commands have been given by the control processor.

All circuit control signals are digital in nature and can be provided directly by a microprocessor/microcomputer. Therefore, one PSG can produce the full range of required sounds with no change to external circuitry. Since the frequency response of the PSG ranges from sub-audible at its lowest frequency to post-audible at its highest frequency, there are few sounds which are beyond reproduction with only the simplest electrical connections.

For further information, contact Fairmont Marketing, 726 Plenty Road, Preston 3072 or phone (03) 471 0166.

Solid state lamps

The Ultrabright HLMP-3X50 series solid state lamp produced by Quality Technologies are direct, pin-for-pin replacements for the Hewlett-Packard devices with the same part numbers.

The devices provide high efficiency red, yellow and green output over a very narrow viewing angle, in a standard T-1.75 clear package.

High efficiency red (HLMP-3750, MV3750) have a power dissipation of 135mW and continuous DC forward current of 30mA.

The yellow lamps (hlmp-3850, MV3350) have a power dissipation of 85mW and continuous DC forward current of 20mA while the high efficiency green lamps (HLMP-3950, MV3450) have a power dissipation of 135mW and continuous DC forward current of 30mA.

For further information, contact Dice Engineering, 109 Maroondah Highway, Lilydale 3140 or phone (03) 739 5455.

Bipolar semi custom ASICs

The Plessey range of mixed signal semi-custom ASIC products has been developed to meet a wide range of high performance applications in short time scales. Amongst these the DA series is compatible with many products requiring low power digital and high performance analog functions.

The DA series features operation from 1 to 18 volts with complementary NPN and PNP transistors. Complexities range from 20 to 1500 gates with the peripheral cells components allowing the design of high performance analog circuits.

An extensive library of analog and digital macros are available, fully supported by the Plessey Design Modelling System (PDM).

PDM is a complete benchtop prototype modelling system which enables the designer to create and evaluate his mixed signal ASIC before committing to silicon. The PDM system is directly compatible with the DA series technology enabling a direct path to circuit integration.

For further information, contact Plessey Components, Christina Road, Villawood 2163 or phone (02) 72 0133.

DSP for modems

NEC Components has released its UPD77810 digital processor, designed to handle modulation and demodulation functions in modems. The device consists of a general purpose processor which performs modulation operations and sequence control of the overall system, DSP for demodulation and other modem function blocks.

Suitable for transmissions up to 9600 bits, the chip's modem functions conform to V22, V22bis, V26, V27, B27bis, V27ter, V29 and V32. As well as synchronous and asynchronous serial communications interfacing it includes a serial interface for both eight and 16bit ADC and DAC and a general purpose parallel interface.

Two software packages and a hardware emulation package are available for product development and in-circuit emulation. Applications for the device include high speed modems, echo cancellers, PB/MF/MFC receivers, voice band signal processing, numeric control, servo controllers, spectrum analysis, filtering, equalisers, medical electronics and sonar systems.

For further information, contact George Brown Group, 456 Spencer Street, West Melbourne 3003 or phone (03) 329 7853.

High density bilpolar gates

National Semiconductor has announced the availability of Aspect III, the latest member in the high performance Aspect bipolar process technology family. Aspect III, a 0.8 micron process, will enable the production of standard cells and custom designs with up to 100,000 gates in the first half of 1990.

The Aspect processes allow designers to build very-large-scale application specific integrated circuits (ASICs) using a bipolar process, because it implements the low power and small gate size features of CMOS technology.

When comparing the latest generation of GaAs ASICs, the gate delays are matched but the gate density of Aspect is greater. Moreover, GaAs suffers other drawbacks in comparison with bipolar processes in general.

For example, GaAs does not operate satisfactorily at standard ECL voltage levels and thus must translate the ECL level input from external sources. The translation reduces operating speed of pulses going on and off chip. Moreover, GaAs gates internal to the chip have limited drive capability. Two or more buffers must be tied together to achieve sufficient drive levels. This reduces the number of usable gates on a GaAs chip.

Aspect standard cells and gate arrays have their greatest application in data processing, high speed instrumentation and the telecommunications market. In data processing, Aspect is well suited for building numerical computing engines, with fast floating point requirements.

Computer News and New Products

386SX upgrade board

Hypertec has formally launched the Hyper 386SX, an enhancement board that upgrades 286-based computers to provide full 386 code compatibility.

The 80386SX processor provides all the sophisticated memory mapping capabilities of 32-bit 80386-based machines, but is designed for the 16 bit architecture used in 286's.

The board is said to be particularly suitable for DOS users with 'RAM cram' problems. With utilities like 386 MAX professional, device drivers can be mapped out of system memory and into 'high' memory, thus freeing up system memory for loading large applications. Because the board does not occupy an expansion slot, it can be installed in both classic-style 286 machines, such as the IBM AT, and MCA models like the IBM models, 50, 50z and 60.

For further information, contact Hypertec, 408 Victoria Road, Gladesville 2111 or phone (02) 816 1211.

Enhanced photoplotting system

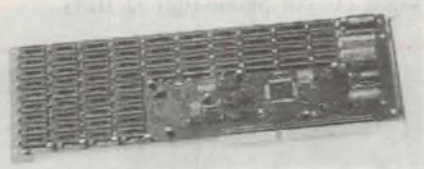
Gerber Scientific Instrument of the US has unveiled the model 9720 laser photoplotting system which provides 20″ x 26″ plots at half-mil resolution in four minutes.

The 9270's multi-tasking environment permits simultaneous imaging of one job while processing one or more other jobs from a single workstation.

It supports the efficient 'polygon area fill' technique, where input data need only contain boundary coordinates of an area to be filled. System software permits editing of incomplete or overlapping polygons. The system operator can also view a composite of merged layers, define polarity and priority of those layers, and continue to modify the data until satisfied.

The model 9720 can be configured to fit any I/O requirement including Ethernet, RS-232, and magnetic tape (800, 1600, or 6250bpi). Hard disk configurations are available from 208 to 976MB and the high resolution graphics are available in both monochrome and colour versions.

For further information, contact RCS Cadcentres, 731 Heidelberg Road, Alphington 3078 or phone (03) 499 6404.



Memory expansion card

Electronic Solutions has released an expanded/extended memory card for IBM PC/XT/AT machines.

The card has an 8/16 bit bus, providing high speed on 16 bit bus machines with backwards compatibility with older XT machines.

This card offers memory expansion up to six megabytes, using either 256K or 1Mb DRAM chips. The 1Mb chips provide much better value for money, lower power consumption and hugh expansion capability on the one card. Page mode memory addressing support allows the use of slow RAM chips, even in fast systems, providing further economies.

Compatible RAM chips are 2 x 41425 and 1 x 41256 (256K banks) or 9 x 411000 (1Mb banks).

Software utilities include software drivers for EMS, RAM disks and Print spooling. The EMS software allows selection of the segment address.

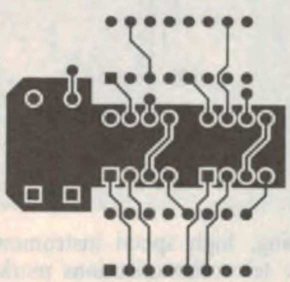
The installation program is menu driven with a simplified setup procedure. The card allows adjustment of Base I/O address, starting memory address, partitioning of memory as expanded and extended and I/O register wait states.

For further information contact Electronic Solutions, PO Box 426, Gladesville 2111 or phone (02) 906 6666.

Stepping motor control

Priority Electronics has released the PCL-738B stepping motor control card. The card is designed to control the steps, speeds and directions of stepping motors using an IBM PC/XT/AT or compatible.

The card allows three motors to be operated simultaneously and independent of each other. The PCL-738B with



DC/CAD now has ground-plane feature

Design Computation has added ground-plane intelligence to its DC/CAD PCB design software. The built-in ground-plane feature automatically puts clearance around pads and routes, which reside inside copper plane areas, and attaches the common plane to the copper net with a thermal relief.

To create arbitrarily-shaped copper areas, designers simply outline a board region, place the crosshairs on the net which is to become the common electrical connection, then bind the outlined region into a copper area. Changes to the circuitry within the copper area are handled easily as well. The designer merely makes the changes to the routes, then instructs the editor to recalculate the copper plane.

This high-end feature is especially useful to designers of oscillators, RF circuitry, and low-level analog circuitry. It is now a standard feature in all Design Computation high-performance packages.

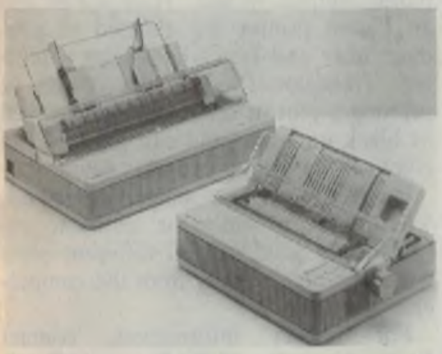
For further information, contact Advanced Solutions, 47 Karril Avenue, Beecroft 2119 or phone (02) 872 1981.

its accurate crystal based timing can be programmed for initial speed, acceleration and deceleration. It has a step rate of 3.33 to 13650pps, or 1 to 4095rpm for a motor with 200 steps per revolution. The number of steps per command are one to 32767.

The card features optoisolated stepping motor control outputs, eight digital input channels and eight digital output channels, all with TTL compatible level.

A range of accessories are available that complement the controller card.

For further information, contact Priority Electronics, 23-25 Melrose Street, Sandringham 3191 or phone (03) 521 0266.



Laser, dot matrix printers

Olivetti has introduced five new printer models, including a laser model.

Included in the new range are the DM309 and the DM309L. Print quality and fast switching between continuous stationery and single sheets are said to make these ideal for use in medium or small administration and accounting departments, production/shipping warehouses and large hotels.

The PG306 is Olivetti's new high performance laser printer, featuring a 6ppm print speed and a number of options to maximise user expandability.

These include a wide range of type styles (soft fonts and font cartridges); extended graphics (memory boards); use of all traditional software; extensive hardware compatibility (optional serial interface); and use in new environments, such as DTP (PostScript language and fonts).

Further additions to the range are the DM324 and DM324L dot matrix printers with colour option.

These are medium range, 24-needle printers that have a 300cps print speed in high speed draft mode, 240cps in draft mode and 80cps in letter quality mode.

For further information, contact Olivetti, 91 St.Hilliers Road, Auburn 2144 or phone (02) 748 2600.

Upgradeable laser printer

Texas Instruments has announced a low cost, desktop microLaser printer which allows users to upgrade themselves to PostScript in a matter of minutes. It is also one of the smallest laser printers available today.

The microLaser's modular architecture allows user installable upgrades of Adobe's PostScript interpreter and memory. The interfaces plug directly onto the printer controller board, so the printer can be expanded to meet a user's future needs. The new microLaser is capable of printing at six pages per minute.

The printer comes in two configurations. The basic microLaser is compatible with the Hewlett Packard LaserJet Series II, comes with a 0.5 megabyte of RAM and is priced at $2790. The microLaser PS35, a true Adobe PostScript Printer priced under $5000 combines the same features of the basic microLaser with 35 PostScript typeface and an additional one megabyte of RAM.

Making printers IBM compatible

Intelligent Technologies has introduced a small and powerful stand-alone protocol converter to enable all types of ASCII, matrix, shuttle, band and non-impact printers to communicate with IBM mainframe and mid-range systems.

With a footprint of approximately the size of a postcard, the Cobra is made by the Swedish company Axis, and is claimed to be the smallest IBM system Protocol Converter available. The unit measures 140 x 97 x 35mm.

The Cobra receives and interupts a bisynchronous data stream from an IBM mainframe, AS/400 or SYS/3X host computer and converts it into an asynchronous (ASCII) data stream to the printer. It can be ordered to support serial or parallel port connection attachments.

The unit supports 25 specific and five generic printers, including Epson FX, Diablo 630, HP Laser Jet, IBM Graphics and IBM Proprinter.

The Cobra requires only five volts at 120 milliamps, allowing it to be connected to most printers without a separate power supply. On printers without power on the parallel or serial port a power unit is supplied.

For further information, contact Intelligent Technologies, 5-9 Hunter Street, Parramatta 2150 or phone (02) 891 6010.

Computer News

24-port peripheral sharer

Protec Microsystems of Canada has unveiled its new network alternative, the Bytelink Plus, a 24-port 'super sharer'.

Like the firm's Byteway and Bytelink peripheral sharing devices it allows PC, mini and mainframe users in office work clusters to easily share peripherals such as expensive laser printers, plotters, digitisers and modems.

Able to allow file transfer between computers, Protec's Bytelink Plus is also an affordable and easy to use alternative to a fully fledged Local Area Network (LAN). Built-in menu-driven pop-up software simplifies operation for novice users, whilst a host of setup and command line options enable experts and power users to tailor Bytelink operation and performance in any way they require.

Combined with standard features such as bidirectional serial ports, parallel ports programmable as input or output, data throughput of up to38.4kbps, any mixture of parallel and serial interfaces (with automatic conversion from one protocol to the other), up to 4MB of buffer memory (1MB standard) and built-in power supply, the Bytelink Plus offers users the most extensive high quality data switch on the market. Users are even able to take advantage of state-of-the-art features such as being able to program hunt groups, define port and/or task priority levels and communicate via E-mail or through connected fax machines.

For further information, contact Logo Distributor Network, Henry Lawson Centre, Birkenhead Point, Drummoyne 2047 or phone (02) 819 6811.

Plotting with a printer

Epson LQ, FX, EX, LX series dot matrix printers, or an Epson GQ laser printer can now be used as a plotter to create highly detailed plots, intricate computer graphics and precise engineering drawings. All that is needed is Transplotter graphics software and an Epson or other IBM MS-DOS compatible personal computer.

With this program there is no need for both a printer and a plotter, a printer can function as both, without comprising speed or the high quality of plotter output. In fact, Transplotter and an Epson printer are claimed to produce finer and faster lines than a plotter. Transplotter offers the option of printing a plot in white on black as well as black on white and can print in full colour if the printer supports colour.

By using a single simple command, Transplotter provides the ability to automatically print several different plots while the user is away from the computer.

For further information, contact Epson Australia, 17 Rodborough Road, Frenchs Forest 2086 or phone (02) 452 0666.

Dynamos

Continued from page 46

In conclusion

There is much in this fascinating book that I have not mentioned. For example, the name of R.E. Crompton pops up fairly regularly, along with many others who have since fallen into obscurity. As well, there is a paper of 'the highest mathematical order from the pen of the eminent electrician and physicist, Professor R.J.E. Clausius.'

This eminent person introduces the technical term 'ponderomotive force', and uses integral calculus rather freely to describe it. Not bad for an electrician though.

I have presented this book in a rather light-hearted fashion, as it is a most serious book in itself. But far be it from me to belittle the magnificent efforts expended by the many pioneers of the field. Machines like the Elliptic are humourous now, but in those days would have represented much expense and effort to build.

Undoubtedly books of our times will be described in the *Electronics Australia* equivalent of the 22nd century, and will probably be presented with a view to raising a smile or two. At least, I hope so.

2m Converter

Continued from page 91

To adjust the IF filter we follow a similar routine. Set VC5 to a maximum capacitance. Adjust VC4 for a peak meter deflection. Temporarily place a capacitor of about 47pF across VC4 or L4. Adjust VC5 for a peak deflection, then remove the 47pF capacitor. This procedure will give you a reasonably flat amplitude response between 144 and 148MHz.

An input signal of 30uV should already cause limiting of the meter. If your converter appears much less sensitive, Q1 may have been damaged during the soldering process.

With the converter properly set up, it can be mounted inside the receiver case. Tighten a lug with the BNC connector, in a position which would allow soldering to the top side of the board. The connector's centre pin is soldered directly to the PCB pin at the RF input. Use a spacer with the other mounting screw, between the case and the screened box of the PLL.

Performance

The sensitivity of the converter measured less than 0.7uV (for 20dB (S+N)/N) over the 144-148MHz band. It is of the same order as that of the 50-54MHz pre-amplifier in the FM receiver itself (the sensitivity figures we quoted in the January 1990 issue are slightly optimistic, because the correct bandwidth wasn't used in the calculation).

An interfering signal at 146.35MHz is noticeable. This is due to the converter's 94MHz LO mixing with the second harmonic of the receiver's LO at 41.65MHz, and producing an 10.7MHz IF signal. It is not easy to reduce this spurious signal much, without a good deal of additional screening.

Although the screening box around the PPL circuit does significantly reduce the level of interference from the FAST TTL ICs, remnants of the harmonic frequencies are still detectable every 0.25MHz. However these are quite small, and shouldn't cause a problem except with very small signals on the same frequencies.

DROP US A LINE!
Are you concerned about something to do with electronics, and believe that others ought to know about it? If so, feel free to put pen to paper, or fingers to keyboard, and send us a Letter to the Editor. If it's clearly expressed and on a topic of interest, chances are we'll publish it – but we do reserve the right to edit those that are overlong, or potentially libellous.

Information centre

Conducted by Peter Phillips

Between us, we probably know everything!

This month we boast 100% electronic content in a range of topics covering projects, replies to reader questions and so on. As ever, I come in for a bit of criticism, and to get my own back I offer a What?? question posed by a reader.

It would be a brave and foolish soul who might claim total knowledge of electronics. My father used to joke that 'he and his brother knew everything', though it was surprising how much his brother knew! Although I don't have a brother, I have numerous colleagues to confer with, which is fortunate for me and for these pages. As well, information supplied by readers now often forms a significant part of Information Centre, prompting my rather boastful title. Yes, the 'us' is you and I, not 'us' at *EA*. Now that *would* produce some interesting letters!

The first two reader enquiries have been answered by our resident expert on matters audio and things in general, namely *EA*'s project engineer Rob Evans. Rob has developed numerous projects, written many reviews and has experience covering a range of areas in electronics including audio systems for musicians. The first letter is exactly in this area and Rob's answer is probably of general interest to everyone, as most electronic enthusiasts are involved in audio in one way or another.

DI Box hum

In the October 1987 issue of EA, an article describing an active DI box for studio and live stage use was published. I originally purchased a kit for this project from Jaycar, and was so pleased with the unit that I built seven more. However, I am currently using both outputs, (RTS out and XLR out) where previously I used either one or the other.

The problem that is now occurring is hum. I find that disconnecting the earth with the earth lift switch actually increases the hum, and using different mixing consoles, different stage amplifiers, even different power outlets has no effect on the level of the hum. In fact, the hum even contains a buzz which comes and goes. Could you please tell me what is causing the problems and how to eliminate them. (Name not available).

Chances are that the DI boxes are working perfectly. The most likely cause of the problem is the way in which the sound system has been installed. If the mains connection at the (remote) mixing console has a different earth potential to the earth of the stage GPOs, a hum will develop. This is quite a different situation to an earth loop (multiple earth paths), which is normally cured by the DI's earth lift switch.

The reason that the hum actually increases when the earth lift is switched in, is that the existing earth path (via diode D1) was reducing the potential between the stage and mixer earths.

The solution to the problem is to power the mixing console *directly* from the stage with a long extension cord. In fact, this is the way in which most professional installations are done, as it guarantees that the earths are at the same potential.

The only other cure is to fit isolating transformers to the output of the DI. Unfortunately, to maintain even a reasonable signal quality, you would have to pay at least $50 for each transformer.

Oh yes! In case readers are wondering, DI stands for 'direct injection'. A DI box is one that accepts signals from transducers fitted to musical instruments, rather than signals from a microphone placed in front of the instrument.

The next letter is about one of Rob's projects, and again Rob has supplied the answer, although I couldn't resist making a couple of suggestions myself.

Car tuning adaptor

I recently built the car tuning adaptor presented in the April 1989 edition of EA, from a kit supplied by Jaycar. Apart from wasting hours until I realised there was an error in which capacitors C2 and C3 were shown swapped on the PCB, the unit worked well when tested with an old Toyota Corona, standard ignition four cylinder engine.

However, the second time I used the adapter, it would only read properly on the 20V range, not the 2V range, where previously it had worked well on all ranges. I can find nothing wrong with the unit, and nothing else has changed.

I have fitted the unit into a plastic jiffy box, with banana plug sockets built into the box to accept leads from my Beckman 3020 DVM. I have tried putting a large electrolytic capacitor across the output of the adaptor, and have also tried separating the engine, DVM and adaptor. The symptoms are that on the 2V range, the 'tacho' setting shows random low readings that alternate between plus and minus. On 'dwell', the reading is consistently at a high negative value. On the 20V range, the readings are fine, although there is the occasional dip in the reading.

Finally, can you recommend a transistor assisted ignition or CDI circuit that I might construct, apart from those currently stocked by Jaycar. (R.A. Melbourne, Vic).

Due to a drafting error, C2 and C3 were swapped on the component overlay and an erratum note to this effect was published in July 1989.

The symptoms you are finding are certainly rather strange, particularly the high negative reading on the dwell function. After all, the unit is powered by a single positive 12V supply!

From your description, it seems as though there is an interference problem. To check this, try taking readings with an analog meter, rather than with a high impedance DVM. If this appears to cure the problem, it is safe to assume that the adaptor is picking up interference, probably from the car's ignition system. The solution here is to fit the unit into a metal box, as was the prototype.

Another possible cause is the 12V supply. It could be that there is a poor earth connection, or even excessive noise on the positive 12V line, perhaps due to a faulty regulator/alternator combination. This would give rise to the problems. Although the LM2917 IC has onboard regulation, severe power supply interference could give erratic readings.

Regarding electronic ignition systems, we can thoroughly recommend the Transistor Assisted Ignition published in *EA* for June, 1983. This unit has a proven track record, and does not use exotic components, unlike some of the more recent designs that have been presented in other publications.

Nicad charger

The next letter concerns the NiCad battery charger published in July 1989. Being the designer, I am naturally most interested in any problems readers are encountering with this project. But first the letter...

I am experiencing the following problems with the NiCad charger described in July 1989. First up, the charger will not run for the full time selected with SW2. Secondly, LED 3 does not fully extinguish when the unit enters trickle charge mode, and finally neither the charge or the trickle charge LEDs go out when there is no external current path.

I have implemented the changes described in these pages (January 1990), which improved matters slightly. Also, I am measuring 13.5V at the junction of D1 and C1, rather than the specified 15V, despite having 12V AC applied to the circuit.

Finally, is D5 a 1N4004 diode? The circuit makes no mention of the type of diode to be used here. By the way, resistor R10 in the photo on page 82 looks suspiciously like a diode and D5 looks to be a 1N914. I have replaced IC3, IC4 and IC5, but to no avail. Any hints? (P.H., Parkes NSW).

Dealing with D5 first, the circuit diagram has omitted the type number, which should be a 1N4004 type, or any 1 amp diode. The diode used in the prototype was 'any 1 amp diode', and the type used happens to look like a 1N914. R10 also looks like a diode in the photo, but I can assure readers it really is a 10 ohm resistor, just one with a dark body.

The first problem concerning the incorrect time delays being experienced by P.H. may be due to the 12V AC input. Although the text and the circuit specify this voltage, in fact the AC input to the prototype measures around 14V AC. The plug pack supplying it is one rated at 12V AC, but because it is not fully loaded, it is delivering more than its rated output voltage. I should have made this point clear, as most transformers, particularly plug packs have their output voltage specified for full load. If the DC voltage at the junction of D1 and C1 is not 15V, I suggest a higher AC input be applied.

The problem with the indicating LEDs has me a bit stumped. I initially thought the low input voltage might be a problem, but applying 12V AC (and less) to the prototype did not affect the operation of these LEDs at all. I am now wondering if some brands of 339 quad comparator ICs are oscillating in this application, rather than switching cleanly like those used in the prototype.

This can easily be confirmed with a 'scope, by looking at pins 13 or 14. Try connecting a 0.1uF bypass capacitor across the supply terminals of IC3 if oscillation is found. If this doesn't help, try the capacitor between various inputs of IC3 and ground.

The parts list specifies a *UA*339, which is a Fairchild device, available from George Brown. I have double checked the circuit and layout diagrams for any drawing errors, and can find none other than that described.

I am very keen to hear of any outcomes on this, as it is a most useful project and one that I suspect many readers would build. The prototype has worked perfectly since its construction, and I am anxious to solve any dilemmas readers might experience. All part of the service!

SSB FM

Now here's an interesting question, put by a reader who has recently read the article on FM transmission published in January 1990. I'll let the correspondent pose it:

Could you answer a question on FM which has always intrigued me. Is it possible to have single sideband FM in the same way as single sideband AM? (S.H. Canberra, ACT).

My first reaction to this question was 'why not?' and some of my colleagues who are well versed in FM agree. It may be difficult to achieve, but in principle it should be possible as the information being transmitted is definitely duplicated in both sidebands – as described in the article commencing on page 156 of the January 1990 issue. As I see it, it would be necessary to filter out all frequencies below the carrier (to get rid of the lower sideband) or all those above the carrier if only the lower sideband is to be transmitted.

If any readers can either refute or support the notion of SSB FM, I'd like to hear from you.

While on the topic of radio, here's a letter about satellite dishes, in response to a correspondent whose letter was published in these pages in the January 1990 issue.

Satellite dishes

I am writing in reply to S.K. of Hobart, whose letter appeared in January 1990. The American magazine 'Radio-Electronics', in issues August 1981 and September 1981 produced a design for a steel, wood and wire mesh home-built parabolic dish for the reception of satellite television. The dish is 3.6 metres (12 foot) across and is octagonal in shape. (Peter O'Connell, VK2EMU, Mortdale, NSW).

January's What??

In January 1990, I posed a question concerning the output impedance of an emitter follower circuit, and gave the solution in February. I used 'reasonable approximations' to arrive at the answer, but a correspondent suggests my approximations are too approximate. Here's his letter...

With reference to the answer to January's 'What??' as it appears in the February issue, I guess it depends on your interpretation of 'reasonable approximations'. I think you've been too approximate by leaving out the term hie/hfe, because your answer is in error by some 20%.

The collector current for the transistor is around 4.1mA, giving a value for hie/hfe of 6.3 ohms. This value is in series with the 25 ohms you gave as the answer, giving a total output resistance of around 31 ohms.

Since hie/hfe is usually a factor in practical circuits, I feel your answer could have been more informative if it had been included. (J.G., Brisbane, Qld).

I agree with J.G. that my answer to this particular problem should have included the term hie/hfe, but I disagree that it is always a factor that needs to be included. I usually refer to this value by the term 're' (little re) and calculate it using the approximation of 30/emitter current (mA). This equation gives the 6 ohms or so suggested by J.G., and because it is greater than 10% of the output impedance, it should have been included.

However, I ignored it in my solution for two reasons. In the first place, I wanted to show how the source resistance of a signal source is a factor in determining the output impedance of an emitter follower, and particularly that the bias network resistance is divided by the AC current gain (hfe) of the transistor. The second reason is that most emitter follower circuits operate at currents of 10mA or more, and 're' can therefore usually be ignored.

I chose nice easy values for the bias network resistors (10k), and a 1k value for the emitter resistor and forgot to check that the emitter current would be 10mA or more. I should perhaps have chosen 500 ohms for the emitter resistor, which would have given a collector current of 9mA, and a value for 're' of some 3 ohms.

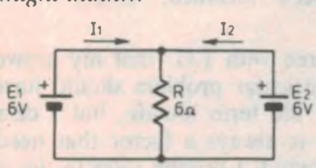
However, I take the point offered by J.G., and have printed his letter to complete the story on output impedance of an emitter follower. But if I had included it in the solution to the problem, I think it may have been a case of too much too quickly for some readers, and the point of the question would have been swamped, prompting letters suggesting a poor teaching strategy.

What??

This month's question comes from Mr Jack Middlehurst of Wahroonga, NSW. He writes...

Teaching DC circuit theory can be a rewarding experience, but one of the difficulties is how to keep the minds of the brighter students gainfully occupied while assisting the strugglers. After Ohm's law and Kirchhoff's law have been covered, this little problem can stop the brighter students' brains from rusting.

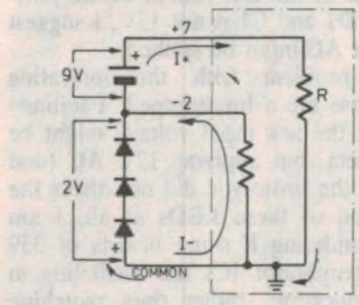
Using the values shown in Fig.1, calculate the currents I1 and I2, the current in resistor R and the voltage across the resistor. But it's not as straightforward as you might think...



From Ohm's law, I1 = E1/R, which gives 1A. Similarly, I2 = E2/R, also giving 1A. By Kirchhoff's law, this gives a total current of 2A in R, and as Ohm would tell us, the voltage across R must now equal 12V. Whoops! Where did the extra voltage come from, or is there something wrong in my reasoning?

By the way, the answer is *not* 0.5A for both currents. We'll give the solution next month, folks...

Answer to last month's What??



Last month I asked for a simple circuit to provide a dual polarity power supply from a single 9V battery. The circuit shown is one I used in a solid state analog voltmeter I designed several years ago. The 2V negative supply is produced by the voltage drop across the three diodes, caused as a result of the current taken from the positive supply. Diodes are necessary to maintain a constant voltage regardless of current variations. There will still be some minor variations in the voltages due to current variations, but filter capacitors in the circuit will smooth these out. It works, I can assure you.

NOTES & ERRATA

TV-Derived Frequency Standard (July-/October 1989): In the overlay diagram for the main PCB, given on page 114 of the October article, C29 (0.1uF) should be located one position to the right of where it is shown. It should couple from the junction of Q11's collector, R46 (1M) and R47 (2.7k) to resistor R48 (6.8k), as shown in the schematic on page 100 of the July article.

12V/30V DC-DC Converter (February 1990): The pattern for the top of the PCB should have a clearance hole around all three pins of IC2 (78L15), not just two as shown on page 111. If the PCB has been etched to the original pattern, a 3mm twist drill can be used as a 'countersink' to remove a small amount of copper around the third hole, before IC2 is fitted.

EA marketplace

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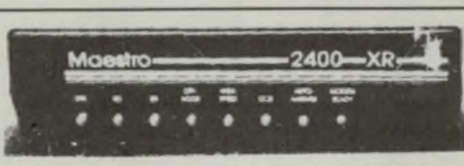

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SPECTRUM

Communications News & Comment

NEW MOBILES MADE IN OZ

Two new mobile radios, designed and produced by Philips Radio Communications Centre in Victoria, have been released in Australia. One is a hand-held personal portable (PR710), the other an in-car model (PRM80 series).

The production process employs the latest surface mounted technology (SMT), which has reduced the wires and mechanical interconnections by more than 90% and improved the operational reliability.

Surface mounted technology has been employed in the Philips Australian made cellular phones and now the benefits of this process are flowing into the company's range of mobile radios. SMT allows manufacturers to produce high reliability equipment at internationally competitive prices.

The PR710 personal portable is designed for use in the construction industry, emergency services physical distribution areas and other applications demanding the utmost in reliability and ruggedness. It incorporates a highly efficient sealing system to protect the transceiver from dust and water ingress, as well as speech processing circuitry for improved intelligibility when transmitting from areas of high ambient noise levels such as airport tarmacs.

The PRM80 series of in-car mobile radios has been released in a nine channel (PRM80) version with fixed signalling and a 40 channel (PRM8020) signalling version, with variable signalling and operator selectable scanning. The programmable features of the PRM80 make it particularly useful for fleet owners, enabling fast, on the spot customisation of the mobiles. Different frequencies within the network may be accessed by using external programming.

Further information is available from Damian Finch of Philips Mobile Radio Communications on (03) 235 3666.

RFDS TO USE AUSSAT SATELLITE

The New South Wales Division of the Royal Flying Doctor Service (RFDS) has signed an agreement with AUSSAT to develop a satellite based communications network, using the mobile satellite service that will become available on AUSSAT's B series satellites in early 1992.

The Royal Flying Doctor MOBILESAT service will be able to offer high quality, reliable voice and data communications throughout the continent. Users will also be able to send fax, computer data, ECG and EGG traces, x-rays and other medical data to medical experts anywhere in the Royal Flying Doctor Service network.

The MOBILESAT system will also allow medical staff on board aircraft to transmit 'real time' patient medical data, such as ECGs, to specialists on the ground perhaps hours before the aircraft reaches its destination.

AUSSAT plans to demonstrate MOBILESAT at the RFDS Federal meeting at Broken Hill this month.

SA-DESIGNED SATELLITE STATION

A new and improved base station designed in South Australia for domestic satellite communications via AUSSAT is now undergoing testing.

Developed jointly by the SA Government and Adelaide-based British Aerospace Australia (BAeA), the SA-SAT-COM system uses the latest technology and is compatible with both the existing AUSSAT 'A' and next-generation 'B' satellites. It is also expected to have considerable export potential, to countries lacking adequate terrestrial telecommunications facilities.

The tests are being carried out between BAeA's Technology Park headquarters and SA TAFE's college in Whyalla, a distance of about 400km. After completion of the testing, BAeA expects to move into the industrialisation and commercialisation phase of the project. The base stations will be manufactured in Australia, in a joint venture with another company.

AT&T PROPOSES USA/USSR LINK

AT&T has put forward a proposal to increase telecommunications circuits between the United States and the Soviet Union, by using for the first time the Soviet's Intersputnik satellite system.

Telephone traffic between the USA and the USSR increased by more than 140% in the past two years, in part because of improvements in the telecommunications network between the countries. Yet demand still far exceeds existing capacity.

In a letter to President George Bush announcing the company's satellite plans, AT&T Chairman Robert Allen said the use of Intersputnik will help meet customers' requests for better communications, and will serve national interests.

"Improved communications have historically been a precondition for economic expansion, and will so prove to be as the Soviet Union enters the world economic community," Mr Allen said.

Intersputnik circuits would be used for operator-assisted and direct dialled calls, as well as for customer services. The use of a Soviet Intersputnik satellite for additional circuits would accommodate the Soviet need to preserve hard currency reserves.

The Soviets prefer using their own satellite because they then incur expenses solely within the Soviet Union, payable in rubles rather than in scarce western currency. The Intersputnik satellite that AT&T would use is in a geostationary orbit at 14° west of Greenwich. The C-band satellite is 22,300 miles above a location just off the coast of Liberia.

When we reviewed the new Icom IC-R9000 communications receiver in the March issue, we were very impressed. Apparently the famous World Radio TV Handbook was too, because they've just named it 'Best Communications Receiver of 1989'.

SS7 SOFTWARE FOR PROTOCOL ANALYSER

Hewlett-Packard has introduced Signalling System No.7 (SS7) analysis software that meets CCITT specifications and is used with the HP4952A wide-area-network (WAN) protocol analyser.

The HP4952A provides network-troubleshooting capabilities for system network architecture (SNA), X.25, integrated services digital network (ISDN) and now CCITT SS7. The new HP18273A software decodes data from SS7 Protocol Layers 2, 3 and 4 into mnemonics for a quick check of network parameters.

Designed to meet 1988 CCITT standards, the HP18273A is also extremely flexible and allows users to customise data displays for their network. This is significant because the SS7 specification is evolving rapidly, causing countries to implement SS7 in various ways.

For further information, phone (008) 033 821.

SECOND SKYNET 4 LAUNCHED

The second of three Skynet 4 military communications satellites built for the UK Ministry of Defence by British Aerospace (Space Systems) Limited and Marconi Space Systems, has been successfully launched from Pad 40 at the US Air Force Base in Cape Canaveral, Florida.

The launch was aboard a Titan III expendable launch vehicle and took place after delays due to bad weather and the re-scheduling of launch site operations. Two hours after lift off, the satellite's Perigee Assist Motor (PAM) was fired to insert the satellite into geotransfer orbit. Then approximately 50 hours after launch, Skynet's on-board Apogee Kick Motor was fired, to put the satellite into geosynchronous orbit.

The satellite is now undertaking controlled drift orbit operations until it reaches its allocated orbital position at 6° east. On completion of spacecraft and payload commissioning tests, Skynet 4 is expected to be declared fully operational.

This latest launch will apparently extend the communications capacity of the UK's armed services and provide secure and reliable strategic and tactical military communications through the 1990s and beyond.

PCB Feature:

PCB design for successful manufacture - 1

There's a lot more to designing a good PC board than simply putting on the right number of pads and connecting them together with any convenient tracks, to match the schematic. Here's the first of a short series of articles explaining the techniques to ensure both successful manufacture and reliable operation of the final PCB-based equipment.

by RAY SMITH
Managing Director, RCS Cadcentres*

The challenge for printed circuit board designers today is to combine all the design tools available and to produce a PCB artwork that accommodates the requirements for board production, component loading, printed board assembly (PBA) testing, field service and user documentation.

Very few designers are involved with groups designing electronic equipment where productivity, manufacturability, and quality assurance are not important issues. For the rest of us the products that we dsign are supposed to make a profit for our employer. Regardless of where we see ourselves in the industry, that is the bottom line!

To ensure profitability, all of the manufacturing processes at every stage have to be understood. If you took the time, you would find that most production problems are caused by thoughtless design. To overcome these problems requires considerable skill, and design standards prepared in consultation with your design engineer, component supplier, the board fabricator, the board assembly and test departments.

It may be that in some small firms that you end up with a committee of one! However in most companies, a considerable number of people will need to give their two bob's worth to the discussion.

Following extensive analysis of everyone's needs, a complete design and documentation specification has to be prepared. This is necessary where designs are completed in house or by a service bureau.

A fairy tale!

Once upon a time, wiring assemblies were printed onto a substrate, unrouted material was etched away, a few holes were drilled and the resultant board stuffed with components. Minimum track size was greater than 1.27mm (0.50"). Life was so easy...

Well, generally speaking the process hasn't changed – it has simply become more specific.

PCB designers have to consider a multitude of complicating factors, many of them contradictory; so compromises may have to be made. Clock speeds are increasing, components are becoming smaller, wiring denser, pin spacing closer, heat densities higher. With every innovation in component packaging comes greater challenges for designers.

Remember?

There was a time when all we had to do was place our components in an area, leaving space for mounting holes, and join the dots. Kindergarten kids could do it. Unfortunately, a considerable number of people involved in board design still use this technique – some even forget the mounting holes!

The only difference is that now they are using a computer and CAD program to help them.

Obviously a great deal more is involved than joining dots. Over the next few articles, I will attempt to discuss some of the issues as they affect electronic packaging and specifically PBC design.

The topics covered will include such things as:

1. Design parameters
2. PCB material selection
3. Imaging
4. Conductor definition
5. Lamination
6. Plated-through holes and drilling
7. Solder mask and legend
8. Final fabrication
9. Electrical testing and inspection

Each heading embraces a vast area of expertise and the PCB designer must be familiar with each and everyone. Without this knowledge, your designs are doomed to failure, resulting in multiple prototyping and additional unnecessary expense. In addition, the effects may be felt further down the line, by way of equipment failure in the field as a result of thermal stress or vibration.

1. Design parameters

All designs require an objective to be clearly stated at the outset. The emphasis will vary depending upon what type of industry you are involved in; however guidelines do exist and one should be familiar with them.

The most widely accepted standards for PCB design are those prepared by IPC in the US. The Institute for Printed Circuits is a collective of industry people who were brought together by the need for a common set of rules governing all aspects of PCB design, documentation, electronic packaging, fabrication and testing. As a result of their work, an IPC standard has been written covering all these areas, and also includes procedures for determining how you should test for compliance with these standards.

*RCS Cadcentres is one of Australia's leading PCB design service bureaus, with experience in fine line multilayer board design, documentation and artwork generation. These articles are adapted from a paper presented by Ray Smith to the CIMA seminars on PCB Manufacture, in March 1990.

Ray Smith.

The first group to be involved in preparing a design guideline will be the corporate marketing people. You want to know what sort of product is being designed and for what market. Among other things, this will determine what level of reliability has to be incorporated. The requirement for a television circuit that is cycled on and off over many years are obviously a whole lot different to a guided missile circuit that only has to work once, but MUST work!

The products might be grouped according to subsequent use, for example:

Commercial
Communications
Automotive
Aeronautical
Defence

However, this does not in itself, provide you with any guidelines. IPC have been less than application specific and simply provide us with three classes based upon fabrication tolerances: Class 1, 2 and 3. In addition, they employ levels A, B and C to further define standards of finish.

As a guide, Class 1 would typically include high volume commercial appliances for such dish washer controllers; Class 2 would be appropriate for communication and computers; and Class 3 for aeronautical and defence applications.

The new group to be involved will be the design engineers. Be nice to these guys – you are going to work very closely with them! Some topics for discussion here include:

Component technology (DIP, SMT, axial, radial)
Assembly techniques (auto insert)
Testing methods, fixtures, test points
Soldering methods
Board material type
Circuit simulation
Thermal analysis
Design techniques (manual, CAD)
Artwork generation
Special circuit requirements (ECL, RF)
Board assembly mounting
Component mounting
Packaging, cases
Test documentation
Circuit diagram standards
Manufacturing tolerances
Assembly tolerances
Rework, field repairs
Expected completion
Delivery lead times
PWA interconnection, cabling, connectors
Heat dissipation
User documentation

PCB Design

Component availability
Relative component cost
Other problems specific to your application or product

These are not in any particular order, because there is no *one* heading more important than the others (except profit!)

A lot of these topics will be discussed in more detail later, however, what has to be very clear is this: if something can be done in more than one way (even if you are not aware of the alternatives), you must document how you want it done! This should be determined before you start a job, not after.

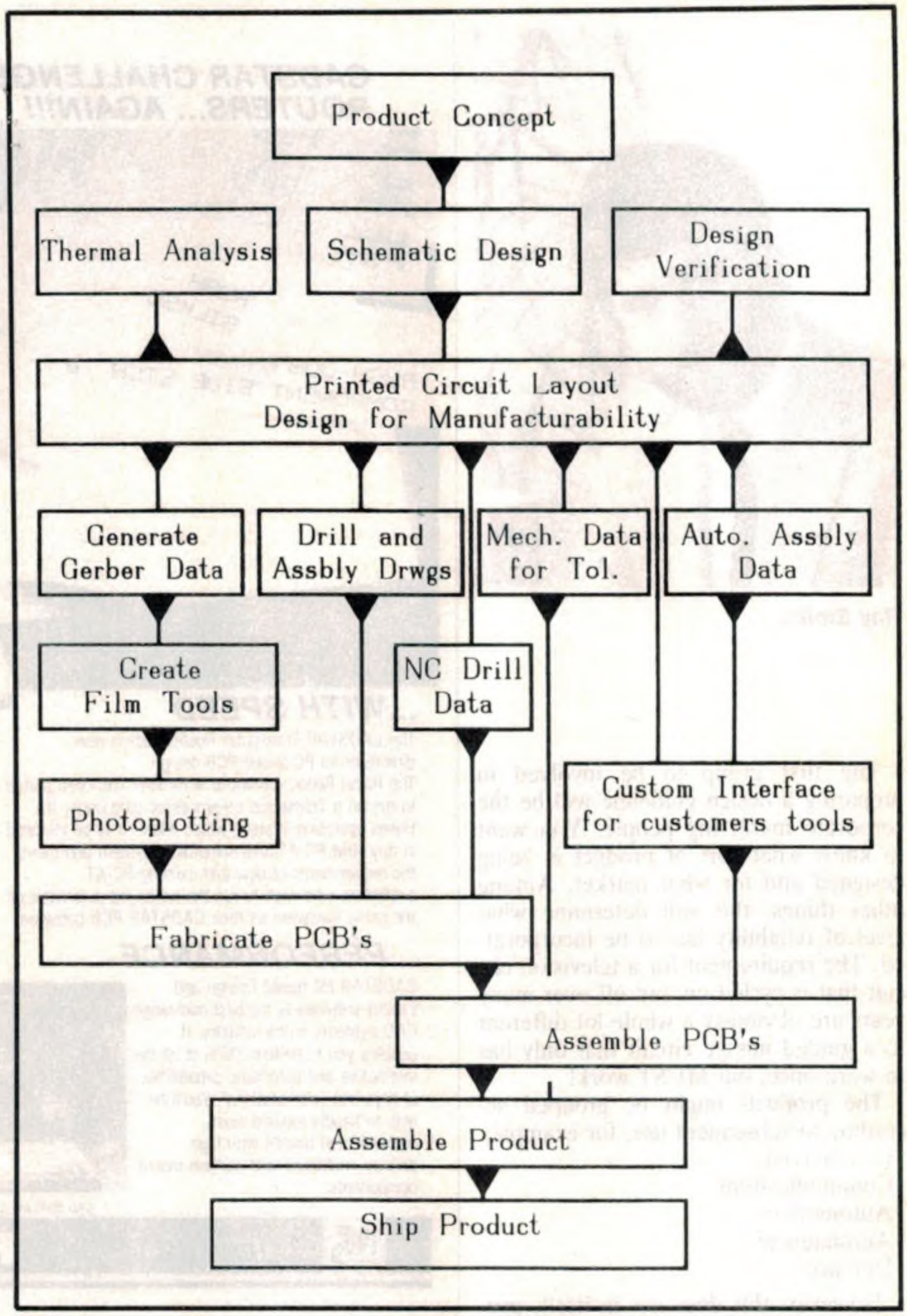
At the outset, I made the point that our job is to make a profit for the firm. If you are not aware of the alternatives, you may not be designing your product in the most cost effective way. Too many engineers skimp at the PCB design stage, only to find that it has cost twice as much as it might have, further into the manufacturing process. If you understand the process, you are able to make a valid judgement with respect to spending a few extra dollars at the start to save a whole lot later on.

Having discussed the above considerations with your engineering team, you must then talk at length to the PCB manufacturer. On the basis of what your expected requirement will be, he will advise his capability. By capability I mean best yield for the proposed technology, as it relates to unit cost. He will describe optimum manufacturing documentation and suggest methods of working that will improve yield.

From there you're off to the assembly house, to discover what their capabilities are. What components can be automatically inserted, what clamp spaces are required, soldering methods, functional testing methods, quality assurance and process documentation.

We're getting close now to having enough info for a 'Design Parameter Guidelines' document, but finally we have to talk to the product assembly people – those poor sods who try to put your entire creation together, make all the cables reach, access all the mounting screws and nuts, access test points etc.

Armed as we are with an overwhelming cornucopea of information, one now sits down to prepare a 'Guideline for Design', so that you don't have to repeat the process over each time your firm starts a new PCB. However, products and processes are changing rapidly and an important annexure to your Design Parameter guide is a set period for review of the entire process.



A block diagram showing all of the design and development steps for a modern electronic product based on a printed circuit board.

I wouldn't expect that a Design Guide be totally definitive. All we need is a guideline for those working with you, as to what questions to ask, what tolerances to work to, what minimum levels of documentation are necessary and how to maintain the documentation package as a record of revisions, amendments and so on.

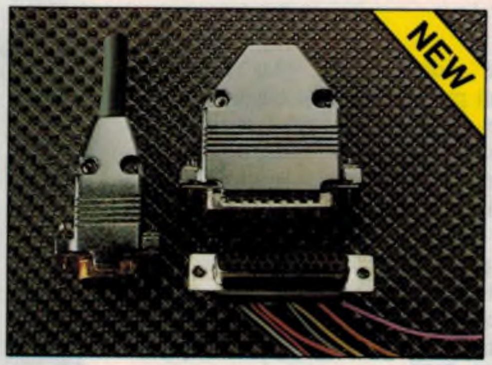
It shouldn't be necessary to produce a vast volume – nor would it be possible, as the minute you completed it, it would be out of date!

What I have described is a major task and very important if your company is to produce high quality, consistent products cost effectively. It may be advisable to engage a consultant experienced across the broad spectrum of the processes involved to prepare your design guide for you. It will cost a few dollars, but could easily save you thousands. After all, it sets the minimum standards for the products' design, and should be done properly.

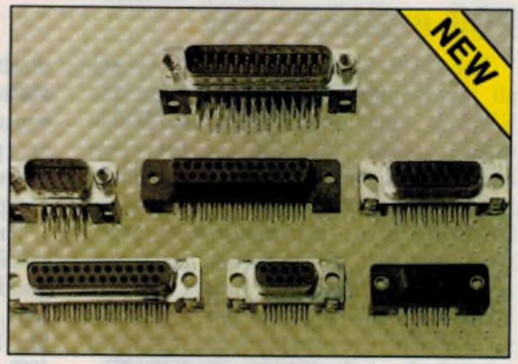
In the next article I will go into more detail on the remaining topics.

Now there's even more reasons to choose Utilux D Subminiature connectors...

High density – 15 CKTS



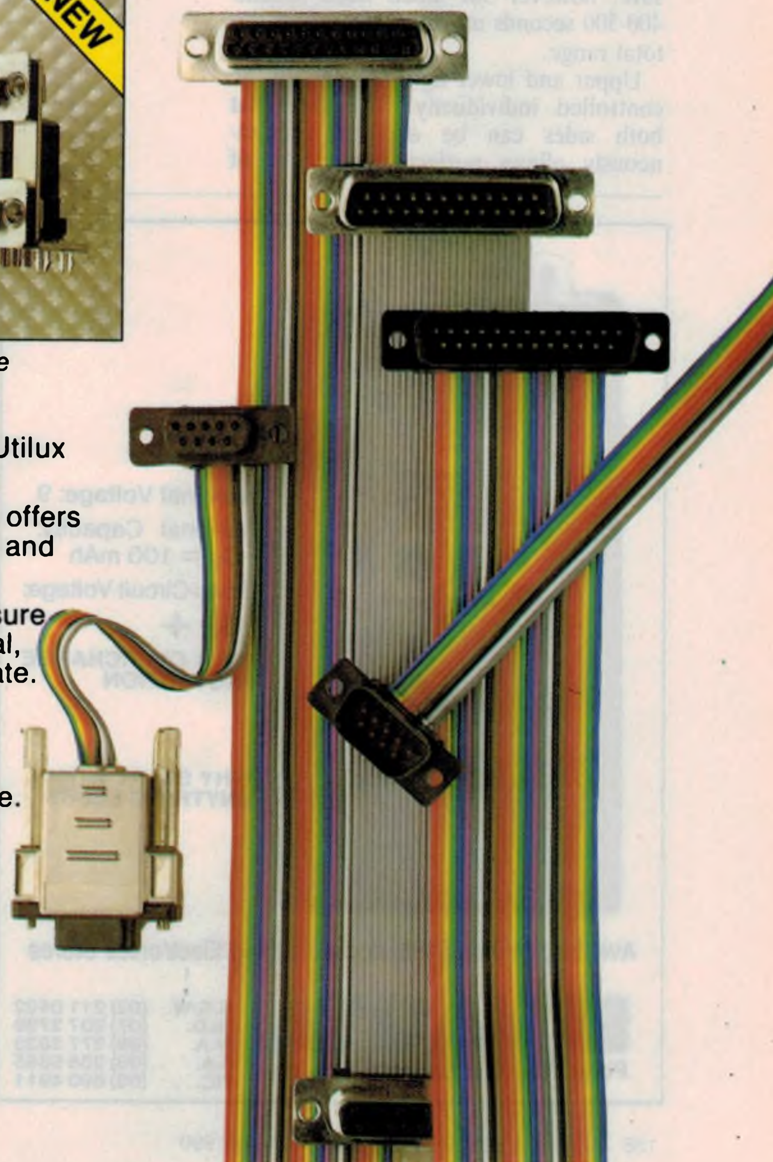
All metal hoods



Right angle 8.1mm, 10.2mm footprint

Solder cup – stamped formed and machined pin

Dual port, right angle



The Molex range of D Subminiature connectors from Utilux has been extended, across the board.

The range, widely accepted for quality and value, now offers a much wider choice of components to manufacturers and the electronics industry alike.

And when you choose Molex from Utilux, you can be sure that every D Subminiature component has dimensional, mechanical and electrical standards that are all first-rate.

Utilux is the sole licensee for Molex components in Australasia. For further details, contact the Utilux Electronics Division and get the full facts about the comprehensive Utilux D Subminiature connector range.

UTILUX

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AGENTS: Western Australia: (09) 381 5500; Tasmania: (002) 72 5711; Australian Capital Territory: (062) 80 5132.

GBP UTEL95

PCB Feature:

New PCB products

PCB exposure box

The KVB-30 exposure box maintains all the features of its predecessor, the KVB-20, such as simultaneous double sided exposure, built in vacuum table and portable case design. But it has the added feature of a digital timer – up to 999 seconds – and thumbwheel exposure time set. This enables quick and accurate identification of time set and enables setting exposure time to the last second. The presensitised positive resist printed circuit boards supplied by Kinsten require only 60-70 seconds exposure, however 3M labels need around 400-500 seconds making good use of the total range.

Upper and lower light sources can be controlled individually. The fact that both sides can be exposed simultaneously allows perfect registration of double sided PCBs. An integrated vacuum pump and table ensures perfect contact between sensitised surface and art, preventing any stray light and guaranteeing 100% track resolution and sharpness.

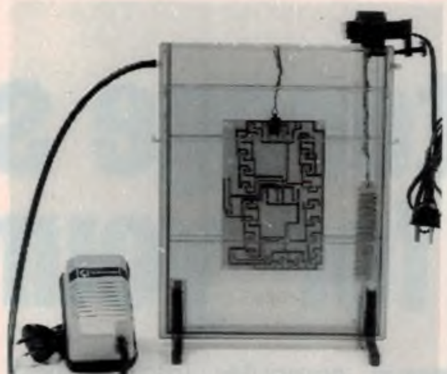
The KVB-30 price reflects only a small price increase and still represents good value at $575 plus tax. For full details, contact Computronics, 31 Kensington Street, East Perth, 6000 or phone (09) 221 2121.

Etching tank

Kinsten has released a PCB etch tank claimed to meet all the needs of prototyping, small production and the hobbyist.

The ET10 is a fully extrusion-moulded tank with several features. Normally prototyping is done in a photographic bath, with hand swooshing to speed up etch time. Kinsten has changed the orientation of the liquid in such baths from horizontal to vertical, and uses only 1.5 litres of etch solution allowing efficient agitation with a normal aquarium air pump. Add to this a special thermostatically controlled ceramic element heater and you have an effective solution to PCB etching.

The ET10 is supplied complete with clips for hanging the printed circuit boards and feet that snap in and snap out for easy etch change. The tank is calibrated in millilitres and millimetres for ease of operation.



The complete set-up including a full instruction manual is available for only $99 ex tax. Further details from Computronics, 31 Kensington Street, East Perth 6000 or phone (09) 221 2121.

Presensitised boards

Kinsten provides printed circuit boards made of fibreglass and coated with positive resist, available in a number of prepacked sizes, from 100 x 150mm to 350 x 450mm and in both single sided and double sided versions.

The boards are packed in light-tight bags and feature an additional black peel-off film, allowing cutting to size prior to exposure with no risk of damaging emulsion.

Exposure time varies between 60-70 seconds using the Kinsten KVB-20 exposure box, and development is done in a harmless Kinsten sodium silicate phosphate solution.

After etching the emulsion can be left on as it will act as a solderable lacquer.

For further information, contact Computronics, 31 Kensington Street, East Perth, 6000 or phone (09) 221 2121.

PCB CAM package

CAD Solutions Inc has added ECAM to its line of printed circuit board design products. ECAM provides the final link to manufacturing, while delivering an enhanced level of Gerber view and edit functions.

CAM (computer aided manufacturing) features include: full 32-bit data capability which allows resolutions down to .00001" and yet supports panelisation up to 64" x 48"; full interactive, on line, DRC of one or any automatic thieving and venting; automatic drill file creation, including FAB drawings; automatic extraction of test point information required for bare board testing; and full support for circular interpolation and metric.

ECAM also supports virtually all high resolution graphics cards, provides full step by step UNDO back to the beginning of the session and holds no memory limitations in either 286 or 386 versions.

ECAM retails at $3400, yet is claimed to provide PCB CAM features found in products retailing between $9500 and $40,000.

Further information is available from RCS Cadcentres, 731 Heidelberg Road, Alphington 3078 or phone (03) 499 6404.

Digital storage scope adaptor for your PC

Turn any IBM-compatible personal computer into a dual channel storage oscilloscope, with this hardware and software package from Hilink Technology.

A conventional oscilloscope, by nature, relies on a repetitive input signal to produce a usable display on its screen. While this is not much of a problem for general electronics work, there are many occasions where the signal of interest only exists for a short period of time. In this situation, the transient may only appear on the screen during one sweep of the timebase, which prevents any chance of a detailed analysis. In short, the scope hasn't a recurring signal to continuously redraw its screen image.

The solution is to capture the waveform with a storage oscilloscope, and study its parameters at leisure. When first developed, these instruments were really just a conventional scope, but with the ability to increase the screen persistence by a large degree. You simply triggered a single screen sweep at the appropriate moment, and were able to view the trace for as long as the special phosphor coating (often assisted by a charged mesh) held the image.

The evolution of these instruments took a major step forward with the arrival of low-cost digital memories and analog-to-digital conversion devices (ADCs and DACs), which led to the *Digital* Storage Oscilloscope (DSO). In its most basic form, the DSO is also an enhancement of a conventional instrument, where the signals are first captured by a digital box of tricks based on this new technology.

This unit samples the incoming waveform at regular intervals, and converts each instantaneous voltage into a discrete digital byte or word, via an ADC. The data is then stored in successive locations of a digital memory, which holds the information for an indefinite period. After that, the memory may be rescanned at will, and the stored codes converted back to an analog form by a complementary DAC. The final result is a 'frozen' version of the selected waveform, which may be displayed continuously by the remaining analog sections of the DSO.

More recently, DSOs have advanced to a point where the display electronics and the input amplifiers are the only remaining analog sections of the circuit. All of the range switching, trigger

The complete storage scope package from Hilink. The card is installed in the PC's expansion slot, while the analog interface box sits outside the host computer or in a spare disk drive cavity.

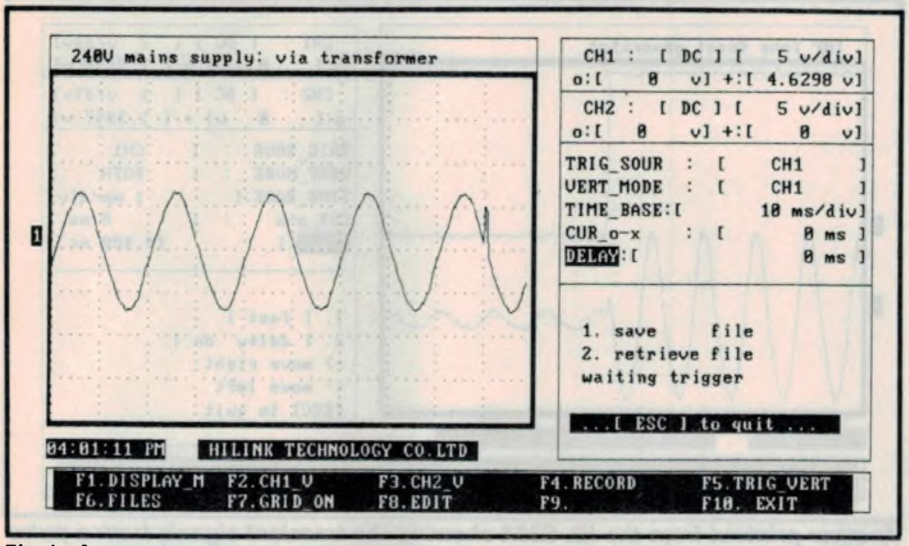


Fig.1: A sample printout of the scope's 'screen' while displaying a captured waveform. In this case, it's the 240V mains supply – complete with voltage spike.

modes, timebase settings and display graphics are controlled by digital techniques, under the control of a main microprocessor. This enables the instrument to display a far greater range of information on the screen, store settings and automate many of its functions.

Further to this, the instrument's internal bus system is often made accessible to the outside world, via a standard interface and connector (IEEE-488 or RS-232C). This allows for a variety of interconnections to other machines (often a computer), for the purpose of remote control or data transfer and storage.

In fact the contemporary DSO itself is rather like a dedicated computer, but equipped with a high quality, analog input stage. As it happens, it's this input circuitry (including the ADC) that tends to set both the performance level, and the final cost of the instrument – high quality ADCs can have a price tag in the thousands of dollars range.

So there we have the DSO as a standalone instrument, as developed from the basic analog scope. There is however, an entirely different path that may be taken to create a broadly equivalent instrument.

The PC-based DSO

The alternative approach for modern test instruments is to develop appropriate interfaces for computers, as opposed to including computer capabilities in the instruments themselves. The data processing and storage capabilities of a PC make it an ideal basis for a DSO – all that's missing is the analog input and conversion stages. Fortunately, cards with these features may be added to a typical PC via the system board's expansion slots.

Such is the case with the DSO package from Hilink Technology. The review model (HL-S20A) included a highly populated (full length) interface card, a remotely connected analog module, two probes, operation manual and a software diskette. To install the system in a PC, you simply plug the interface card into a spare expansion slot, connect the analog module, and run the supplied DSO software.

The analog module is housed in a small metal box measuring 215 x 145 x 45mm, and connects to the main interface card via a 25-way flat cable. Its front panel contains three BNC-style connectors for the two input probes and an external trigger source, and three standard rotary controls for the vertical trace positions and the general trigger level.

As rather a neat solution to the usual space problems, the module's dimensions and mounting holes match those of a standard floppy disk drive. This allows the unit to be permanently installed in the host PC, if a spare drive space is available. Otherwise there's sufficient cable length to sit the module alongside or on top of the host computer.

When the supplied DSO software is loaded, the PC displays a image representing the front panel and screen of a conventional scope (see Fig.1). The image also displays the current settings for the channel attenuation, trigger status and timebase 'speed'. To change settings, the PC's function keys access sub-menus from the main menu bar at the bottom of the display. This is generally quite straightforward, with the 'controls' operating as you would expect in a more conventional instrument.

Storing a sample

As with the majority of DSOs, the HL-S20A uses a combination of real-time and equivalent sampling to cover its complete timebase range (100ms to 1us). Real-time sampling (as mentioned above), is where an ADC samples the instantaneous voltage level of the incoming waveform at regular intervals. Each point is then represented by a digital code, which is stored in memory.

If for example, the samples are taken at 50us intervals, we can expect each cycle of a 1kHz input signal (which has a period of 1ms) to be sampled 20 times – and eventually appear as 20 points on the screen. However if the signal frequency is increased to say 10kHz (with a period of 100us), the ADC will only read each cycle twice. As you can imagine, this will not represent an accurate version of the incoming waveform.

The answer is equivalent sampling, which relies on a repetitive input waveform. In this case the signal is only sampled once per cycle, but as the waveform repeats, the next sample is taken a little later. In this way an 'image' of the waveform is slowly built up (and the memory filled) from a large number of identical cycles.

In our example above, the 10kHz waveform might be sampled at 5us into the first cycle, then at 10us in the second, 15us in the third and so on. This would represent actual times of 5us, 110us, 215us etc. So finally, the waveform is *effectively* sampled every 5us, which has ultimately produced 20 samples for each cycle and restored our resolution.

You may notice from the above figures that the ADC is now sampling the continuous waveform at a period of at least 100us (between samples) in real-time. In the case of the HL-S20A, this is quite within the capabilities of its ADC, which handles a minimum sampling period of 50us.

This in turn represents a maximum real-time sampling clock of 20kHz producing 20ksps (kilosamples per second), whereas the above example (5us) indicates an equivalent sampling rate of 200kHz. In fact the maximum equivalent rate for this unit is 20MHz, or an effective sampling period of 50ns.

So how does all of this jockeying of sample rates work in practice? In the HL-S20A, the software controls the process automatically, with the user being largely unaware of the mode at any time. Real-time sampling is selected for timebase periods of 100, 40, 20, 10, 4, 2 and 1ms per division, at sampling rates of 0.2, 0.5, 1, 2, 5, 10 and 20kHz respectively. If you work it out, this provides a consistent resolution of 20 samples per division.

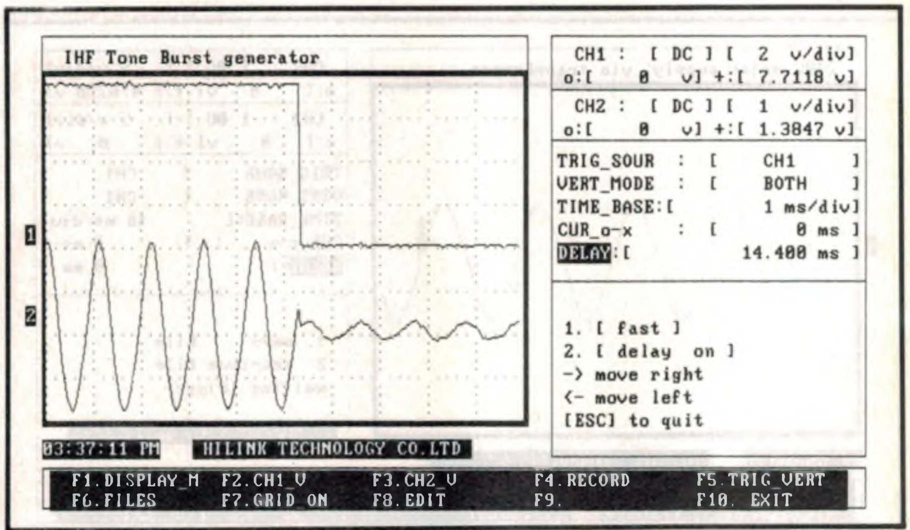
Equivalent mode sampling on the other hand, is switched in for the faster timebase settings of 400, 200, 100, 40, 20, 10, 4, 2 and 1us per division. The first three settings sample at an equivalent rate of 200kHz, while the following groups of three speeds effectively sample at 2MHz and 20MHz respectively. This provides screen resolutions of 80, 40 and 20 samples per division, depending upon the sweep speed.

The actual memory for the samples is arranged as a 2048-word-deep buffer for all ranges and sampling modes. Since there are ten graticule divisions across the 'screen' at (mostly) 20 samples per division, we can generally see only 200 samples at any one time. However the 'delay' mode, which operates in a similar fashion to the trigger delay mode on a conventional instrument, allows the user to progressively scan through the buffer's remaining memory.

As a further insight to the stored waveform, the HL-S20A software offers two independent cursor markers for relative and absolute time and voltage measurements. These are shown as a '+' and a 'O' on the screen, and may be shuttled to any point along the waveform where the computer calculates their exact position. After that, it's simply a matter of reading the figures from the information box on the right-hand side of the PC's display – no more squinting at the screen graticule to record measurements.

One of the most exciting features of computer-based DSOs is their ability to save individual waveforms to disk, and retrieve the file at a later date to redisplay the image. In this respect the HL-S20A offers quite a versatile retrieval system, where a new waveform may be loaded from disk *without* erasing the previous image. This option allows any number of stored waveforms to be added to the screen for comparison purposes – very handy indeed. Of course, the waveforms can also be loaded and viewed one at a time, in a more normal manner.

For maximum detail, the stored files can also be analysed with the software's 'view data' facility. This simply prints a list of figures representing each sample time and its matching voltage level to the PC's screen. The list covers the full range of 2048 samples, and allows the user to scrutinize the readings for each data point in the waveform.



Another printout from the HL-S20A showing the transient signals from a pulse generator. The scope is in its dual-trace mode, with the 1ms timebase 'delayed' by 14.4ms.

The other highly attractive aspect of the HL-S20A (and other PC-based DSO's), is the ability to generate an instant hardcopy of any stored or displayed waveform, on a common printer. With this feature, the user can build up a file of results for publication, presentation etc. To assist in record keeping, the 'edit' function enables each waveform to be individually labeled with a description of up to 40 characters.

Using the HL-S20A

From the broad description above, you can see that the Hilink DSO is a well thought-out package, and offers some rather neat and useful features. Unfortunately, the quality has slipped with the English translation of the operation manual. Its actual use of language is quite bizarre, and many of the operating and function descriptions left *this* reader thoroughly perplexed – to coin a phrase, it must have lost something in the translation.

Nevertheless, the HL-S20A software is really quite straightforward to use, with most functions being self-evident and easy to find in the menu system. The few aspects that *are* a little confusing aren't covered in the manual anyway!

For example, the changeover from real to equivalent sampling modes occurs between the timebase speeds of 1ms/div and 0.4ms/div, with no screen indication to alert the user (or any mention in the manual). This isn't a problem for an input signal with a repetitive waveform, since when operating in equivalent mode, the unit just samples over a longer period. However, if the signal is of a transient nature (non-repetitive), equivalent sampling can't provide any meaningful results.

The end result is that the DSO simply won't sample. Presumably, it needs a regular trigger from each cycle of the waveform to compute its instantaneous sampling points. So to the user, it appears that the scope suddenly won't trigger – very confusing.

But as with most software packages, there's no substitute for hands-on experience, and you soon learn the pitfalls and advantages of the HL-S20A system with a little experimentation.

Performance wise, the specifications for a DSO can be misleading. In the case of the HL-S20A, the maximum conversion rates for equivalent and real-time sampling are 20MHz and 20kHz respectively. According to Nyquist's sampling theorem, these clock rates should allow us to reproduce waveforms with frequencies up to 10MHz and 10kHz for each mode. But in practice, we can expect waveforms at only one tenth of the sampling frequency to be faithfully reproduced – that is, 2MHz and 2kHz.

So don't think that a DSO with a maximum sampling frequency of 20MHz has an equivalent performance to a conventional 20MHz analog scope – it hasn't. The HL-S20A for example, will produce quite clear images of waveforms only up to the frequency limits mentioned above, where the trace becomes noticeably 'stepped' between each sample.

To further confuse matters, the manual lists the DSO's input signal bandwidth as 1MHz, which is a lower figure than the unit's capabilities when sampling in the equivalent mode. This was confirmed on test, where the signal had dropped by about 4dB at 1MHz.

However the fidelity of the waveform was still quite acceptable.

So the maximum frequency which may be reproduced on the HL-S20A is somewhat dependent on your use at the time. If changing or transient signals are of interest (real-time), you are limited to a few kilohertz. On the other hand, steady-state signals of up to a few megahertz are fine, if don't mind the waveform's amplitude falling – but reasonably accurate level measurements are only possible at less than a megahertz.

In terms of resolution, the unit will display between 20 and 80 samples per division, for a standard screen of 10 divisions. Although there's no contest, the software allows the user to choose between a line or dot mode for the waveform image – the line mode is vastly superior.

However, a close inspection of the hardcopy for both a line and dot version of the same waveform was revealing. It seems that in the line mode, the software interpolates the data by calculating and inserting a point between each actual sample. So in this case, the image has a smooth 40 to 160 points per division, whereas the actual data resolution is still the same as in the dot mode (20 to 80 samples/div).

As a typical example of a real-time use, we tried monitoring the 240V mains supply for those notorious transients that seem to plague industrial areas – like the location of our EA offices. This was done via a step-down transformer for safety reasons, and to keep the level with the DSO's maximum input level of 40V AC. With the trigger level adjusted so that any increase in level (as from a transient superimposed on the mains) would trigger the record function, we were able capture the image of quite a number of the little demons.

However to view these waveforms, we were running the timebase at 10ms/div, which in turn means that samples were taken every 0.5ms (20 samples/div). Now, if a transient had occurred for less than this time (say between samples), it may have been completely missed. This is the limitation imposed by a moderate sampling rate of 2kHz.

As a further complication, it appears that while the DSO's circuits organize themselves after a trigger, the very first part of the waveform is not recorded. In the above case, the spike that actually triggered the DSO was rarely shown, and we were only able to record any following anomalies. Nevertheless, it was quite an interesting exercise.

Summary

So just how useful is the HL-S20A as a DSO? Well, once again it depends upon the area of interest. If you work in the radio or high-speed computing field, this unit won't offer the bandwidth that you require – particuarly on transient signals. On the other hand, it may be just the shot for the audio or machine control electronics area, where such a wide frequency response may not be as crucial.

If you already have a conventional analog scope with a reasonable bandwidth, and access to a suitable PC, the HL-S20A will certainly increase the total power of your test gear. Its hardcopy and mass storage capabilities are a great asset, yet the real-time sampling performance is a limitation for some tasks. At $940 (including tax), some readers may find the price a bit steep – particularly if you have to buy a PC as well! However the convenience of indefinitely stored waveforms to analyse at your leisure can be quite alluring.

For more information on the Hilink HL-S20A DSO, and an enormous range of other computer related products, contact Microgram Computers at 17 Barry St, Bateau Bay, NSW 2261, or phone (043) 32 8651. (R.E.)

50 and 25 years ago..

'Electronics Australia' is one of the longest running technical publications in the world. We started as 'Wireless Weekly' in August 1922 and became 'Radio and Hobbies in Australia' in April 1939. The title was changed to Radio, Television and Hobbies' in February 1955 and finally, to 'Electronics Australia' in April 1965. Below we feature some items from past issues.

May 1940

Aust Canned Radio Booms:

A big boom is taking place in the recording of transcriptions for radio in Australia. The government prohibition on the import of foreign transcriptions has provided a golden opportunity for local firms, which are working at high pressure.

One firm has nearly a dozen serials running at the present time, giving work to a large number of actors and actresses. Some of the transcriptions are being exported to other countries. One 'star' actor is reported to be earning £150 per week!

Artificial 'echo' for Electric Organ:

The recreation of reverberation effects artifically has recently been accomplished by the Hammond organ interests. The reverberation unit is about three feet long, and it may be mounted in the output cabinet (loudspeaker enclosure) of the conventional Hammond organ.

Part of the electrical output of the organ proper is fed directly to the loudspeaker in the usual manner, thus supplying the basic tone output. The remainder of the output is fed to a driving unit resembling the voice coil of a dynamic loudspeaker.

May 1965

3D Laser Produces Image:

In a Boston hotel suite recently, a few dozen normally sedate scientists and engineers were playing with a toy locomotive, a toy train conductor and other such items.

The train wasn't really there at all. But if you stood in exactly the right place and looked into a piece of equipment, you would have seen it, real as life. The toys had been "reconstructed" by a technique that looks simple, yet is one of the most advanced developments in modern science.

The "reconstruction" was done with a gas laser made by the Perkin-Elmer Corp., and a "hologram," a special photographic plate made by researchers at the University of Michigan.

Storm Warning Radar:

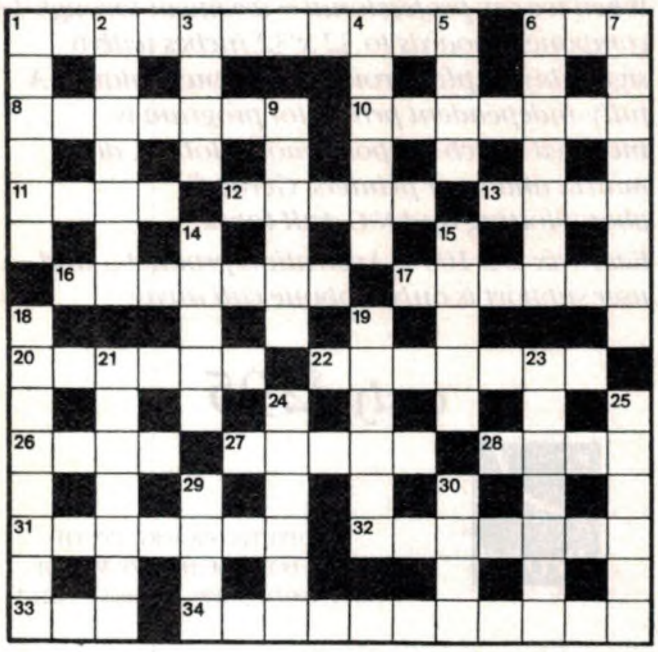
High power, long range, ease of installation and relatively low cost are four of the main features of Rainbow – a new meteorological radar system developed by the Marconi Company. This accurate and reliable new system can track and pin point storms and rain producing clouds within an area of 125,000 square miles.

Rainbow has been designed to provide an inexpensive equipment suitable for use at airports, where it can provide first hand meteorlogical information to the air traffic control centre. Rainbow is also particularly suited to meteorological surveillance in large areas where a number of equipments may be required.

EA CROSSWORD

Across

1. Interest of EA readers. (11)
6. Unit of data. (3)
8. Part of iron. (7)



10. Form of 1 down. (7)
11. Unit of mass. (4)
12. Add data via keyboard. (5)
13. Famous American laboratories. (4)
16. Name of effect involving temperature and current. (7)
17. Tape machine. (6)
20. Makes a deduction. (6)
22. Type of gauge used to measure pressure. (7)
26. Unit of time. (4)
27. Famous Italian scientist. (5)
28. Slow oscillations. (4)
31. Electrical pathway. (7)
32. Notes heard in phone fault. (7)
33. Abbreviation showing copying in progress. (3)
34. Conductive liquid. (11)

Down

1. Ability to do work. (6)
2. Raise to a higher level. (7)
3. Fittings to secure cables. (4)
4. Type of printer. (3-3)
5. Transmit a signal. (4)
6. Bank of cells. (7)
7. Coils used in regeneration. (8)
9. The ---- effect is used by a certain diode. (6)
14. Source of electrical interference. (5)
15. A given name of Maxwell. (5)
18. The laser! (5,3)
19. Physical universe. (6)
21. Concerned with the non-metal having the symbol F. (7)
23. The condition of being opaque. (7)
24. British start. (6)
25. Significant point in orbit of satellite. (6)
29. Adjust for optimum performance. (4)
30. Useful data (abbr.) (4)

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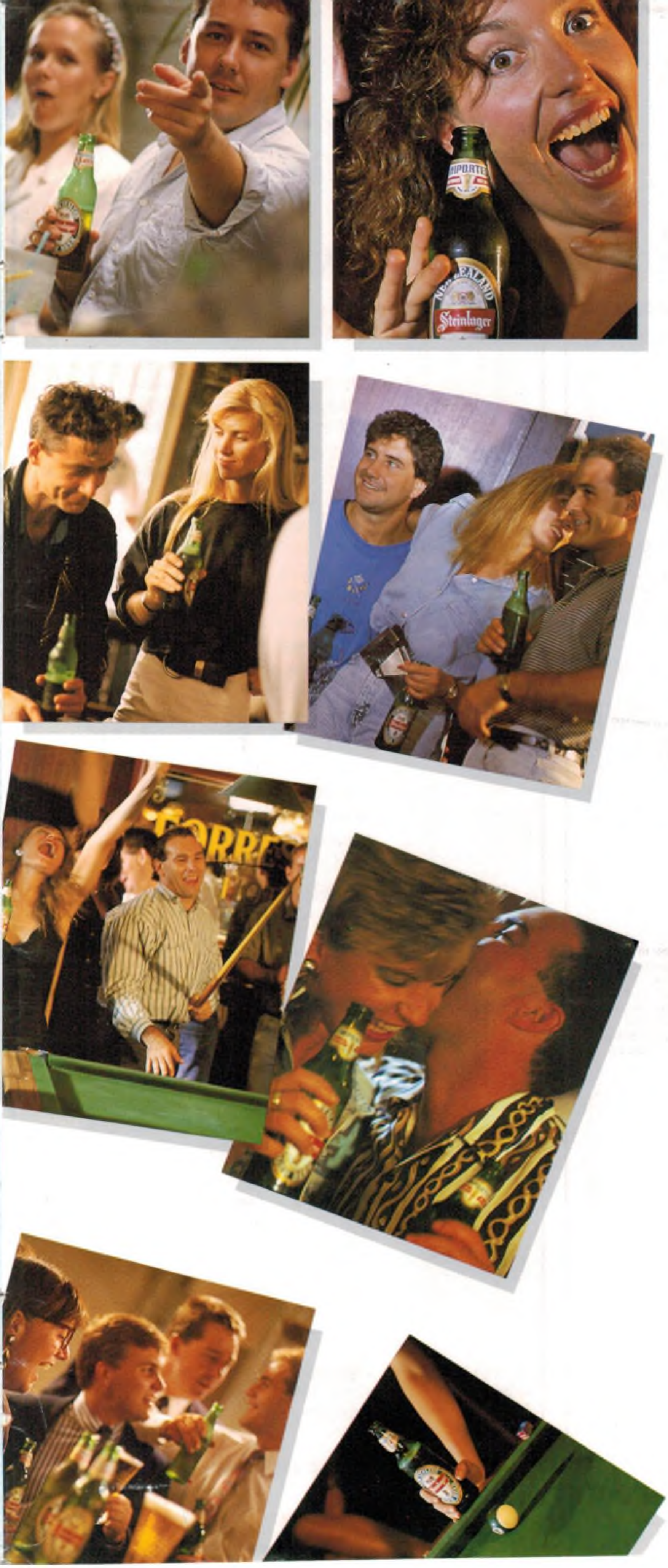

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